CHEMISTRY

BOOKS - UNIVERSAL BOOK DEPOT 1960 CHEMISTRY (HINGLISH)

THERMODYNAMICS AND THERMOCHEMISTRY

ORDINARY THINKING (Objective Questions) Basic Concepts

1. A reaction occurs spontaneously if

A. $T\Delta S < \Delta H$ and both ΔH and ΔS are +ve

B. $T\Delta S > \Delta H$ and both ΔH and ΔS are +ve

C. $T\Delta S = \Delta H$ and both ΔH and ΔS are +ve

D. $T\Delta S > \Delta H$ and ΔH is +ve and ΔS is -ve

Answer: B

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2. Which of the following are not state functions?

(I) $q + w$

(II)q

(III) w

(IV) $H - TS$

A. (I), (II) and (III)

B. (II) and (III)

C. (I) and (IV)

D. (II), (III) and (IV)

Answer: B

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3. A well stoppered thermoflask contains some ice cubes. This is an example of a-

A. Closed system

B. Open system

C. Isolated system

D. Non-thermodynamic system

Answer: C

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4. Internal energy does not include

A. Nuclear energy

B. Rotational energy

C. Vibrational energy

D. Energy arising by gravitational pull

Answer: D

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5. Which of the following is not a state function

A. Internal energy

B. Enthalpy

C. Work

D. Entropy

Answer: C

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6. If a refrigerator's door is opened , then we get

A. Room heated

B. Room cooled

C. More amount of heat is passed out

D. No effect on room

Answer: A

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7. One calorie is equal to _____.

A. 0.4184 Joule

B. 4.184 Joule

C. 41.84 Joule

D. 418.4 Joule

Answer: B

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8. Which of the following units represent the largest amount of energy?

A. Electron volt

B. Erg

C. Joule

D. Calorie

Answer: D

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9. Which of the following is true for an adiabatic process:

A. $\Delta H = 0$

B. $\Delta W = 0$

C. $\Delta Q = 0$

D. $\Delta V = 0$

Answer: C

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10. Energy equivalent to one erg, one joule and one calorie is in the order

A. 1erg $>$ 1 joule $>$ 1 calorie

B. 1 erg $>$ 1 calorie $>$ 1 joule

C. 1 calorie $>$ 1 joule $>$ 1 erg

D. 1 joule $>$ 1 calorie $>$ 1 erg

Answer: C

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11. Among them intensive property is

A. Mass

B. Volume

C. Surface tension

D. Enthalpy

Answer: C

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12. The process in which no heat enters or leaves the system is termed as

A. Isochoric

B. Isobaric

C. Isothermal

D. Adiabatic

Answer: D

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13. In the thermodynamics which one of the following is not an intensive property ?

A. Pressure

B. Density

C. Volume

D. Temperature

Answer: C

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14. If W is the amount of work done by the system and q is the amount of heat supplied to the system, identify the type of the system

A. Isolated system

B. Closed system

C. Open system

D. System with thermally conducting walls

Answer: B

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15. For an isolated system, $\Delta U = 0$, then

A. $\Delta S = 0$

B. $\Delta S < 0$

C. $\Delta S > 0$

D. The value of ΔS cannot be predicted

Answer: C

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16. For a cyclic process

A. W = 0

B. $\Delta E = 0$

C. $\Delta H \neq 0$

D. $\Delta E \neq 0$

Answer: B

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17. Mark the correct statement

A. For a chemical reaction to be feasible, ΔG should be zero

B. Entropy is a measure of order in a system

C. For a chemical reaction to be feasible, ΔG should be positive

D. The total energy of an isolated system is constant

Answer: D

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18. It is general principle that the less energy a system constains, it is

A. Less stable

B. More stable

C. Unstable

D. More unstable

Answer: B

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19. Changes in a system from an initital state to the final state were made by a different manner that ΔH remains same but q changes because

A. ΔH is a path function and q is a state function

B. ΔH is a state function and q is a path function

C. Both ΔH and q are state functions

D. Both ΔH and q are path functions

Answer: B

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20. The temperature of the system decreases in an

A. Adiabatic compression

B. Isothermal compression

C. Isothermal expansion

D. Adiabatic expansion

Answer: D

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21. The cooling in refrigerator is due to

A. Reaction of the refrigerator gas

B. Expansion of ice

C. The expansion of the gas in the refrigerator

D. The work of the compressor

Answer: C

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22. Which of the following is correct option for the free expansion of an ideal gas under adiabatic condition ?

A. $q = 0, \Delta T \neq 0, W = 0$

B. $q = 0, \Delta T \neq 0, W \neq 0$

C. $q = 0, \Delta T = 0, W = 0$

D. $q = 0, \Delta T = 0, W \neq 0$

Answer: C

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23. A gasesous system during a thermodynamic process does not undertake any volume changes, it is called

A. Isochoric process

B. Isobaric process

C. Isothermal process

D. Isoentropic process

Answer: A

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24. thermochemistry

A. $0^\circ C$ and 1 atm

B. $20^\circ C$ and 1 atm

C. 25°C and 1 atm

D. 0 K and 1 atm

Answer: C

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25. Point out the wrong statement in relation to enthalpy

A. It is a state function

B. It is an intensive property

C. It is independent of the path followed for the change

D. Its value depends upon the amount of substance in the system

Answer: B

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26. Which of the following is zero for an isochoric process

A. dP

B. dV

C. dT

D. dE

Answer: B

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27. Internal energy of an ideal gas depends on :-

A. Volume

B. Temperature

C. Pressure

D. None of these

Answer: B

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28. Any series of operations so carried out that at the end, the system is back to its initial state is called

A. Boyle's cycle

B. Reversible process

C. Adiabatic process

D. Cyclic process

Answer: D

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29. The total internal energy change for a reversible isothermal cycles is

A. Always 100 calories per degree

B. Always negative

C. 0

D. Always positive

Answer: C

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30. Heat produced in calories by the combustion of one gram of carbon is called

A. Heat of combustion of carbon

B. Heat of formation of carbon

C. Calorific value of carbon

D. Heat of production of carbon.

Answer: C

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31. Assertion: We feel cold on touching the ice.

Reason: Ice is a solid form of water.

A. If both assertion and reason are true and the reaction is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If the assertion and reason both are false.

D. If assertion is false but reason is true.

Answer: B

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32. Assertion: Mass and volume are extensive properties.

Reason: Mass/volume is also an extensive parameter.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: C

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33. Assertion: Molar entropy of vaporization of water is different from ethanol.

Reason: Water is more polar than ethanol.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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34. Assertion : T, P and V are state variables or state functions.

Reason : Their values depends on the state of the system and how it is reached.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: C

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ORDINARY THINKING (Objective Questions) First law of thermodynamics and Hess law

1. If ΔH is the change in enthylpy and ΔU, the change in internal energy accompanying a gaseous reactant then

A. ΔH is always greater than ΔE

B. $\Delta H < \Delta E$ only if the number of moles of the products is greater than the number of the reactants

C. ΔH is always less than ΔE

D. $\Delta H < \Delta E$ only if the number of moles of the products is less than number of moles of the reactants

Answer: D

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2. During an isothermal expansion of an ideal gas its

A. Internal energy increases

B. Enthalpy decreases

C. Enthalpy remains unaffected

D. Enthalpy reduces to zero

Answer: C

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3. Which of the following is/are correct equations in Boolean algebra?

A. $\Delta U = Q - W$

B. $W = \Delta U + Q$

C. $\Delta U = W + Q$

D. None of these

Answer: C

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4. 6 moles of an ideal gas expand isothermally and reversibly from a volume of 1 litre to a volume of 10 litres at 27° C. What is the maximum work done.

A. 47 kJ

B. 100 kJ

C. 0

D. 34.465 kJ

Answer: D

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5. In a closed insulated container, a liquid is stirred with a paddle to increase the temperature, which of the following is true?

A. $\Delta E = W = Q = 0$

B. $\Delta E \neq 0, Q = W = 0$

C. $\Delta E = W \neq 0, Q = 0$

D. $\Delta E = Q \neq 0, W = 0$

Answer: C

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6. For the reaction

$C_3H_8(g) + 5O_2)(g) \rightarrow 2CO_2(g) + 4H_2O(l)$ at constant temperature , $\Delta H - \Delta E$ is`

A. $-RT$

B. $+RT$

C. $-3RT$

D. $+3RT$

Answer: C

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7. The work done during the expanision of a gas from a volume of $4dm^3$ to $6dm^3$ against a constant external pressure of 3 atm is (1 L atm = 101.32 J)

A. $+304J$

B. $-304J$

C. $-6J$

D. $-608J$

Answer: D

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8. The enthalpy of hydrogenation of cyclohexene is $-119.5kJmol^{-1}$. If resonance energy of benzene is $-150.4kJmol^{-1}$, its enthalpy of hydrogenation would be :

A. $-269.9kJmol^{-1}$

B. $-358.5kJmol^{-1}$

C. $-508.9kJmol^{-1}$

D. $-208.1kJmol^{-1}$

Answer: D

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9. Two moles of an ideal gas expand spontaneouly into vacuum. The work done is :-

A. 2 Joule

B. 4 Joule

C. Zero

D. Infinite

Answer: C

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10. Consider the following processes :-

	$\Delta H(kJ/mol)$
$\frac{1}{2}A \rightarrow B$	$+150$
$3B \rightarrow 2C + D$	-125
$E + A \rightarrow 2D$	$+350$

For $B + D \rightarrow E + 2C$, ΔH will be

A. $-325 \text{kJ} / \text{mol}$

B. $325 \text{kJ} / \text{mol}$

C. $525 \text{kJ} / \text{mol}$

D. $-175 \text{kJ} / \text{mol}$

Answer: D

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11. For a sample of perfect gas when its pressure is changed isothermally from p_i to p_f , the entropy change is given by

A. $\Delta S = RT \ln\left(\frac{p_i}{p_f}\right)$

B. $\Delta S = nR \ln\left(\frac{p_f}{p_i}\right)$

C. $\Delta S = nR \ln\left(\frac{p_i}{p_f}\right)$

D. $\Delta S = nRT \ln\left(\frac{p_f}{p_i}\right)$

Answer: C

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12. Which one of the following is incorrect for ideal solution?

A. $\Delta G_{\text{mix}} = 0$

B. $\Delta H_{\text{mix}} = 0$

C. $\Delta U_{\text{mix}} = 0$

D. $\Delta P = P_{\text{obs}} - P_{\text{calculated by Raoult's law}} = 0$

Answer: A

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13. At constant $T and P$,Which of the following statements is correct for the reaction,

$CO(G) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$,

A. ΔH is independent of the physical state of the reactants of that compound

B. $\Delta H > \Delta E$

C. $\Delta H < \Delta E$

D. $\Delta H = \Delta E$

Answer: C

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14. Hess's law is application for the determination of heat of heat of

A. Reaction

B. Formation

C. Tansition

D. All of these

Answer: D

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15. Work done during isothermal expansion of one mole of an ideal gas form 10atm to 1atm at 300K is (Gas constant=2)

A. 938.8 cal

B. 1138.8 cal

C. 1381.8 cal

D. 1581.8 cal

Answer: C

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16. The internal energy of a substance:

A. Increases with increase in temperature

B. Decreases with increase in temperature

C. Can be calculated by the relation $E = mc^2$

D. Remains unaffected with change in temperature

Answer: A

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17. One mole of an ideal gas is allowed to expand reversible and adiabatically from a temperatureof$27^{\circ} C)$if the work done during the process is3kJ,the final temperature will be equal to$(C_v = 20JK^{-1})$

A. 100 K

B. 150 K

C. 195 K

D. 255 K

Answer: B

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18. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter $\Delta U \text{and} w$ correspond to

A. $\Delta U < 0, w = 0$

B. $\Delta U = 0, w < 0$

C. $\Delta U > 0, w = 0$

D. $\Delta U < 0, w > 0$

Answer: A

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19. The enthalpy change (ΔH) for the reaction

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

is -92.38kJ at 298K. The internal energy change ΔU at 298K is

A. -92.38kJ

B. -87.42kJ

C. -97.34kJ

D. -89.9kJ

Answer: B

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20. If a gas, at constant temperature and pressure expands, then its

A. Internal energy remains same

B. Internal energy decreases

C. Internal energy increases

D. Entropy first increases and then decreases

Answer: A

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21. At 27°C, one mole of an ideal gas is compressed isothermally and reversibly from a pressure of 2 atm to 10 atm. The values of ΔE and q are (R=2)

A. $0, \ -965.84\text{cal}$

B. $-965.84\text{cal}, \ +965.84\text{cal}$

C. $+865.58\text{cal}, \ -865.58\text{cal}$

D. $-865.58\text{cal}, \ -865.58\text{cal}$

Answer: A

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22. The work done by the system is 8 joule, when 40 joule heat is supplied to it. What is the increases in internal energy of system.

A. 25 J

B. 30 J

C. 32 J

D. 28 J

Answer: C

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23. The volume of a gas decreases from $500 cc$ to $300 cc$ when a sample of gas is compressed by an average pressure of 0.6 atm. During this process 10 J of heat is liberated. The change in internal energy is

A. $-2.16 J$

B. $12.156 J$

C. $2.16 J$

D. $101.3 J$

Answer: C

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24. According to Hess's law , the heat of reaction depends upon

A. Initial condition of reactants

B. Initial and final conditions of reactants

C. Intermediate path of the reaction

D. End conditions of reactants

Answer: B

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25. The relation between change in internal energy(ΔE)change in enthalpy(ΔH) and work done$(W)$is represented as

A. $\Delta H = \Delta E + W$

B. $W = \Delta E - \Delta H$

C. $\Delta E = W - \Delta H$

D. $\Delta E = \Delta H + W$

Answer: A

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26. A mixture of 2 moles of carbon monoxide and one mole of oxygen in a closed vessel is ignited to get carbon dioxide. If ΔH is the enthalpy change and ΔE is the change in internal energy, then :-

A. $\Delta H > \Delta E$

B. $\Delta H < \Delta E$

C. $\Delta H = \Delta E$

D. The relationship depends on the capacity of the vessel

Answer: B

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27. For the gaseous reaction: $N_2O_4 \rightarrow 2NO_2$

A. $\Delta H < \Delta E$

B. $\Delta H = \Delta E$

C. $\Delta H = 0$

D. $\Delta H > \Delta E$

Answer: D

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28. The value of $\Delta H - \Delta E$ for the following reaction at $27^{\circ}C$ will be

$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$

A. $8.314 \times 273 \times (-2)$

B. $8.314 \times 300 \times (-2)$

C. $8.314 \times 27 \times (-2)$

D. $8.314 \times 300 \times (2)$

Answer: D

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29. Which one of the following equations does not correctly respresents the first law of thermodynamics for the given process?

A. Isothermal process : q = - w

B. Cyclic process : q = - w

C. Isochoric process : $\Delta E = q$

D. Adiabatic process : $\Delta E = -w$

Answer: D

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30. Change in internal energy when 4kJ of work is done on the system and 1kJ of heat is given out of the system is

A. $+1\text{kJ}$

B. -5kJ

C. $+5\text{kJ}$

D. $+3\text{kJ}$

Answer: D

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31. The average molar heat capacities of ice and water are 37.6mol^{-1} and $75.2\text{J}\,\text{mol}^{-1}$ respectively and the enthalpy of fusion of ice is 6.020 kJ mol^{-1}. The amount of heat required to change 10 g of ice at -10°C to water at 10°C would be

A. 2376 J

B. 4752 J

C. 3970 J

D. 1128 J

Answer: C

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32. According to the first law of thermodynamics which of the following quantities represents change in a state function ?

A. q_{rev}

B. $q_{rev} - w_{rev}$

C. q_{rev} / w_{rev}

D. $q_{rev} + w_{rev}$

Answer: D

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33. Choose the reaction in which ΔH is not equal to ΔU

A. $C_{(gr)} + O_{2(g)} \rightarrow CO_{2(g)}$

B. $C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$

C. $2C_{(gr)} + H_{2(g)} \rightarrow C_2H_{2(g)}$

D. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$

Answer: B

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34. The enthalpy of solution of sodium chloride is 4kJmol^{-1} and its enthalpy of hydration of ion is -784kJmol^{-1}. Then the lattice enthalpy of NaCl (in kJmol^{-1}) is

A. $+788$

B. $+4$

C. $+398$

D. $+780$

Answer: A

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35. Enthalpy for the reaction $C + O_2 \rightarrow CO_2$ is

A. Positive

B. Negative

C. Zero

D. None

Answer: B

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36. Which expression is correct for the work done in adiabatic reversible expansion of an ideal gas

A. $W = nRT \ln. \frac{V_2}{V_1}$

B. $W = n_e \ln. \frac{T_2}{T_1}$

C. $W = P\Delta V$

D. $W = -\int_1^2 P dV$

Answer: C

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37. The work done by the gas liberated when 50 g of iron (molar mass 55.85 g mol^{-1}) reacts with hydrochloric acid in an open beaker at $25^\circ C$

A. Zero

B. -2.2kJ

C. 2.2 kJ

D. 0.22 kJ

Answer: B

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38. "The resultant heat change in a reaction is the same whether it takes place in one or several stages." This statement is called

A. Lavoisier and Laplace law

B. Hess's law

C. Joule's law

D. Le-chatelier's principle

Answer: B

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39. The relation between ΔE and ΔH is

A. $\Delta H = \Delta E - P\Delta V$

B. $\Delta H = \Delta E + P\Delta V$

C. $\Delta E = \Delta V + \Delta H$

D. $\Delta E = \Delta H + P\Delta V$

Answer: B

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40. In an isochoric process the increase in internal energy is

A. Equal to the heat absorbed

B. Equal to the heat evolved

C. Equal to the work done

D. Equal to the sum of the heat absorbed and work done

Answer: A

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41. For which of the following $\Delta E = \Delta H$

A. $N_2O_4(g) \Leftrightarrow 2NO_2(g)$

B. $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

C. $H_2(g) + Cl_2(g) \Leftrightarrow 2HCl(g)$

D. $H_2(g) + \frac{1}{2}O_2(g) \Leftrightarrow H_2O(l)$

Answer: C

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42. The work done to contract a gas in a cylinder, is 462 joules. 128 joule energy is evolved in the process. What will be the internal energy change in the process

A. $+590$ joules

B. -334 joules

C. $+334$ joules

D. -590 joules

Answer: C

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43. The enthalpy change (ΔH) for the process, $N_2H_4(g) \rightarrow 2N(g) + 4H(g)$

is

is 1724 kJ mol^{-1}. If the bond energy of N-H bond in ammonia is 391 kJ mol^{-1}, what is the bond energy for N-N bond in N_2H_4?

A. $160 kJ mol^{-1}$

B. $391 kJ mol^{-1}$

C. $1173 kJ mol^{-1}$

D. $320 kJ mol^{-1}$

Answer: A

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44. For a gaseous reaction at 300K, $\Delta H - \Delta U = -4.98\text{kJ}$ assuming that $R = 8.3\text{JK}^{-1}\text{mol}^{-1}$, $\Delta n_{(g)}$ is

A. 1

B. 2

C. -2

D. 0

Answer: C

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45. The heat change at constant volume (q_v) is equal to

A. ΔU

B. ΔH

C. RT

D. ΔG

Answer: A

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46. Hess's law of constant heat summation is bases on

A. $E = mc^2$

B. Conservation of mass

C. First law of thermodynamics

D. None of the above

Answer: C

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47. In an isothermal process

A. q=0 and $\Delta E = 0$

B. $q \neq 0$ and $\Delta E = 0$

C. $q = 0$ and $\Delta E \neq 0$

D. $q \neq 0$ and $\Delta E \neq 0$

Answer: B

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48. The standard enthalpy of formation of $H_2(g)$ and $Cl_2(g)$ and $HCl(g)$ are $218 kJ/mol$, $121.88 kJ/mol$ and $-93.31 kJ/mol$ respectively. Calculate standard enthalpy change in kJ for

$$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g)$$

A. $+431.99$

B. -262.14

C. -431.99

D. $+247.37$

Answer: B

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49. If butane on combustion gives carbon monoxide. Find the number of O_2 molecule required

A. 6

B. 5.5

C. 4.5

D. 4

Answer: C

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50. An ideal gas expands from $10^{-3} m^3$ to $10^{-2} m^3$ at 300 K against a constant pressure of $10^5 N m^{-2}$. The workdone is

A. 270 kJ

B. -900kJ

C. -900J

D. 900 kJ

Answer: C

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51. Consider the reaction, $N_2 + 3H_2 \rightarrow 2NH_3$ carried out at constant temperature and pressure. If ΔH and ΔU are the enthalpy and internal energy changes for the reaction, which of the following expressions is true?

A. $\Delta H = 0$

B. $\Delta H = \Delta U$

C. $\Delta H < \Delta U$

D. $\Delta H > \Delta U$

Answer: C

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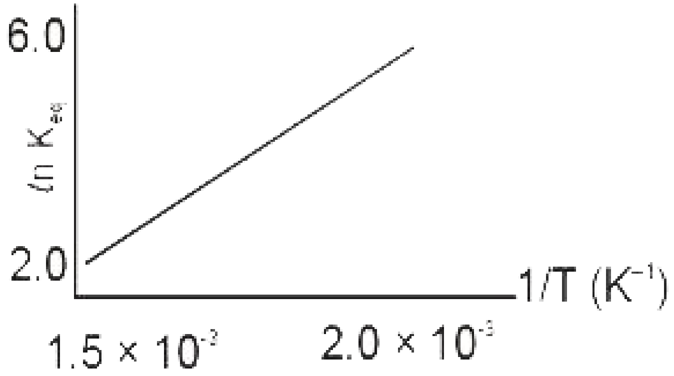
52. A schematic plot of ln K_{eq} versus inverse of temperature for a reaction is shown below



The reaction must be

A. Exothermic

B. Endothermic

C. One with negligible enthalpy change

D. Highly spontaneous at ordinary temperature

Answer: A

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53. The enthalpy changes for the following process are listed below :

$Cl_2(g) = 2Cl(g), \qquad 242.3 \ \ kJmol^{-1}$

$I_2(g) = 2I(g), \qquad 151.0 \ \ kJmol^{-1}$

$ICl(g) = 2I(g) + Cl(g), \qquad 211.3 \ \ kJmol^{-1}$

$I_2(s) = I_2(g), \qquad 62.76 \ \ kJmol^{-1}$

Given that standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standerd enthalpy of formation for ICl(g) is :

A. $-14.6kJmol^{-1}$

B. $-16.8kJmol^{-1}$

C. $+16.8kJmol^{-1}$

D. $+244.8kJmol^{-1}$

Answer: C

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54. $(\Delta H - \Delta U)$ for the formation of carbon monoxide (CO) from its elements at 298 K is $(R = 8.314 kJ^{-1} \quad mol^{-1})$

A. $-1238.78 J mol^{-1}$

B. $1238.78 mol^{-1}$

C. $-2477.57 J mol^{-1}$

D. $2477.57 J mol^{-1}$

Answer: B

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55. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when $1 mol$ of water is vapourised at 1 bar pressure and $100^{\circ} C$, (Given: Molar enthalpy of vapourization of water at 1 bar and $373K = 41 kJ mol^{-1}$ and $R = 8.3 J mol^{-1} K^{-1}$) will be:

A. 4.100kJmol^{-1}

B. 3.7904kJmol^{-1}

C. 37.904kJmol^{-1}

D. 41.00kJmol^{-1}

Answer: C

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56. Calculate the ΔH in joules for

$C(\text{graphite}) \rightarrow C(\text{diamond})$

from the following data:

$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g): \quad \Delta H^\circ = -393.5 \text{kJ}$

$C(\text{diamond}) + O_2(g) \rightarrow CO_2(g), \quad \Delta H^\circ = -395.4 \text{kJ}$

A. 1900

B. -788.9×10^3

C. 190000

D. $+788.9 \times 10^3$

Answer: B

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57. One mole of an ideal gas is allowed to expand freely and adiabatically into vacuum until its volume has doubled. A statement which is not true concerning this expression is

A. $\Delta H = 0$

B. $\Delta S = 0$

C. $\Delta E = 0$

D. W = 0

Answer: D

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58. A system absorb 600J of heat and work equivalent to 300J on its surroundings. The change in internal energy

A. 300 J

B. 400 J

C. 500 J

D. 600 J

Answer: A

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59. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter, ΔU and w correspond to

$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

A. $\Delta H = \Delta E$

B. $\Delta H > \Delta E$

C. $\Delta H < \Delta E$

D. None of these

Answer: B

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60. Enthalpy is equal to

A. Internal energy (E)

B. Product of pressure (P) and volume (V) of gas

C. Internal energy (E)+PV

D. Work (W) done by a system

Answer: C

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61. The heat change for the following reaction at $298K$ and constant pressure is $+7.3kcal$

$$A_{\circ}B(s) \rightarrow 2A(s) + \frac{1}{2}B_2(g), \Delta H = +7.3kcal$$

The heat change at constant volume would be

A. 7.3 kcal

B. More than 7.3

C. Zero

D. None of these

Answer: D

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62. ΔE° of combustion of isobutylene is $-XkJmol^{-1}$. The value of ΔH° is

A. $= \Delta E^{\circ}$

B. $> \Delta E^{\circ}$

C. $= 0$

D. $< \Delta E^{\circ}$

Answer: D

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63. One gram sample of NH_4NO_3 is decomposed in a bomb calorimeter. The temperature of the calorimeter increases by $6.12K$. The heat capacity of the system is $1.23KJ/g/deg$. What is the molar heat of decomposition for NH_4NO_3 ?

A. $-7.53kJmol^{-1}$

B. $-398.1kJmol^{-1}$

C. $-16.1kJmol^{-1}$

D. $-602kJmol^{-1}$

Answer: C

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64. The enthalpy of certain reaction at 273K is -20.75kJ. The enthalpy of the same reaction at 373K provided heat capacities fo reactants and products are the same) will be

A. -20.75kJ

B. -2075kJ

C. Zero

D. $-20.75 \times \frac{373}{273}\text{kJ}$

Answer: A

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65. The reaction $A \rightarrow B$, $\Delta H = +24 \text{kJ}/\text{mole}$. For the reaction $B \rightarrow C$, $\Delta H = -18 \text{kJ}/\text{mole}$. The decreasing order of enthalpy of A, B, C follow the order

A. A, B, C

B. B, C, A

C. C, B, A

D. C, A, B

Answer: B

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66. The law of Lavoisier and Laplace illustrates

A. The principle of conservation of energy

B. Equivalence of mechanical and thermal energy

C. The principle of conservation of matter

D. Equivalence of mechanical and chemical energy

Answer: A

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67. Which of the following statements is true

A. ΔE is always greater than ΔH

B. ΔE is always less than ΔH

C. ΔE may be lesser or greater or equal to ΔH

D. ΔE is always proportional to ΔH

Answer: C

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68. 0.06 mole of KNO_3 is added to $100cm^3$ of water at $298K$. The enthalpy of $KNO_3(aq)$ solution is $35.8kJmol^{-1}$. After the solute is dissolved, the temerature of the solution will be

A. 293 K

B. 298 K

C. 301 K

D. 304 K

Answer: A

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69. If one mole of ammonia and one mole of hydrogen chloride are mixed in a closed container to form ammonium chloride vapor, then

A. $\Delta H < \Delta U$

B. No relationship

C. $\Delta H > \Delta U$

D. $\Delta H = \Delta U$

Answer: A

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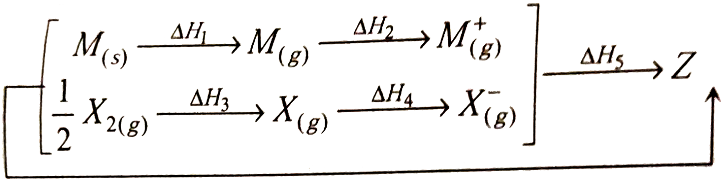
70. Consider the Born- Haber cycle for the formation of an ionic compound given below and identify the compound (Z) formed.



A. MX

B. $M^+X^-_{(g)}$

C. $M^+X^-_{(s)}$

D. $M^-X^-_{(s)}$

Answer: C

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71. Which of the following is always negative for exothermic reaction

A. ΔH

B. ΔS

C. ΔG

D. None of these

Answer: A

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72. Under which of the following condition is the relation $\Delta H = \Delta U + P \Delta V$ valid for a closed system at

A. Constant pressure

B. Constant temperature

C. Constant temperature and pressure

D. Constant temperature, pressure and composition

Answer: A

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73. For isothermal expansion of an ideal gas, the correct combination of the thermodynamic parameters will be

A. $\Delta U = 0, Q = 0, w \neq 0$ and $\Delta H \neq 0$

B. $\Delta U \neq 0, Q \neq 0, w \neq 0$ and $\Delta H \neq 0$

C. $\Delta U = 0, Q \neq 0, w = 0$ and $\Delta H \neq 0$

D. $\Delta U = 0, Q \neq 0, w \neq 0$ and $\Delta H \neq 0$

Answer: D

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74. Pressure-volume (PV) work done by an ideal gaseous system at constant volume is (where E is internal energy of the system)

A. $-\Delta P / P$

B. Zero

C. $-V\Delta P$

D. $-\Delta E$

Answer: B

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75. For the reaction

$CH_3COOH(l) + 2O_2(g) \Leftrightarrow 2CO_2(g) + 2H_2O(l)$ at $25^\circ C$ and 1 atm. Pressure, $\Delta H = -874 kJ$. Then the change in internal energy (ΔE) is ....

A. $-874 \mathrm{kJ}$

B. $-871.53 \mathrm{kJ}$

C. $-876.47 \mathrm{kJ}$

D. $+874 \mathrm{kJ}$

Answer: A

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76. For the reaction,

$A(s) + 3B(s) \rightarrow 4C(s) + D(l)$

ΔH and ΔU are related as-

A. $\Delta H = \Delta U$

B. $\Delta H = \Delta U + 3RT$

C. $\Delta H = \Delta U + RT$

D. $\Delta H = \Delta U - 3RT$

Answer: D

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77. ΔE is always positive when

A. System absorbs heat and work is done on it

B. System emits heat and work is done by it

C. System emits heat and not work is done on it

D. System absorbs heat and work is done by it

Answer: A

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78. Standard enthalpy of formation is zero for

A. CH_3OH

B. HF

C. H_2O

D. F_2

Answer: D

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79. The maximum work obtainable from a reversible process is given as

A. $-\Delta A$

B. ΔA

C. $-\Delta G$

D. ΔG

Answer: A

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80. Calculate the work done when 1 mol of an ideal gas is compressed reversibly from 1 bar to 4 bar at a constant temperature of 300 K

A. 4.01 kJ

B. 3.458 kJ

C. 18.02 kJ

D. 14.01kJ

Answer: B

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81. An endothermic reaction has a positive internal energy change ΔU. In such a case, what is the minimum value that activation energy can have ?

A. ΔU

B. $\Delta U = \Delta H + \Delta nRT$

C. $\Delta U = \Delta H - \Delta nRT$

D. $\Delta U = E_a + RT$

Answer: C

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82. The Joule. Thomson expansion of a gas is an

A. Isobaric

B. Isoenthalpic

C. Isothermal

D. None of these

Answer: B

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83. The work done in ergs for the reversible expansion of one mole of an ideal gas from a volume of 10 litres to 20 litres at $25^\circ C$ is

A. $2.303 \times 298 \times 0.082 \log 2$

B. $298 \times 10^7 \times 8.31 \times 2.303 \log 2$

C. $2.303 \times 298 \times 0.082 \log 0.5$

D. $8.31 \times 10^7 \times 298 - 2.303 \log 0.5$

Answer: B

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84. Internal energy is sum of

A. Kinetic energy and potential energy

B. All types of energy of the system

C. Energy of internal system

D. None of these

Answer: B

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85. $2C + O_2 \rightarrow 2CO, \Delta H = -220 \text{kJ}$ which of the following statements is correct for this reaction

A. Heat of combustion of carbon is 110 kJ

B. Reaction is exothermic

C. Reaction needs no initiation

D. All of these are correct

Answer: B

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86. Assertion: The heat absorbed during the isothermal expansion of an ideal gas against vacuum is zero.

Reason: The volume occupied by the molecules of an ideal gas is zero.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: C

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87. Assertion:Absolute values of intenal energy of substances cannot be determined.

Reason:It is impossible to determine exact values of constituent energies of the substances.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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88. Assertion: The increase in internal energy (ΔE) for the vaporisation of 1 mole of water at 1 atm and $373K$ is zero.

Reason: For all isothermal processes $\Delta E = 0$.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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89. Assertion: ΔH and ΔE are almost the same for the reaction. $N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$

Reason: All reactants and products are gases.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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90. According to the tranistion state theory, for the formation of on activation complex, one of the vibrational degree of freedom is converted into the tranistion degree of freedom.

Reason (R): The energy of the activated complex is higher than the energy of the reactant molecules.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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91. Assertion : For the combustion of methane, $\Delta E > \Delta H$.

Reason : ΔH is related to ΔE by the expression, $\Delta H = \Delta E + \Delta n_g RT$

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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92. (A) For reaction $2NH_3(g) \rightarrow N_2(g) + 3H_2(g), \quad \Delta H > \Delta E$

(R) Enthalpy change is always greater than internal energy change.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: C

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93. Assertion : Zeroth law can also be termed as law of thermal equilibrium.

Reason : Two objects in thermal equilibrium with the third one, are in thermal equilibrium with each other.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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94. Assertion : Internal energy is an extensive property.

Reason : Internal energy depends upon the amount of the system.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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95. Assertion(A) : For the combustion reactions, the value of ΔH is always negative.

Reason(R) : The combustion reactions are always endothermic.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: C

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96. Assertion : For an isothermal reversible process Q = - w i.e., work done by the system equals the heat absorbed by the system.

Reason : Enthalpy change (ΔH) is zero for isothermal process.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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97. Assertion (A): The enthalpy of both graphite and diamond is taken to be zero, being elementary substances

Reason (R) : The enthalpy of formation of an elementary substance in any state is taken as zero.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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98. Assertion : Enthalpy and entropy of any elementary substance in the standard state are taken as zero.

Reason : At zero degree completely motionless.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: D

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99. Assertion:- A process is called adiabatic if the system does not exchange heat with the surrounding.

Reason:- It does not involve increase or decrease in temperature of the system.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: C

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100. A gas is allowed to expand in a well insulated container against a constant external pressure of 2.5atm from an initial volume of 2.50L to a final volume of 4.50L. The change in internal energy ΔU of the gas in joules will be:

A. $-500J$

B. $-505J$

C. $+505J$

D. $1136.25J$

Answer: B

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ORDINARY THINKING (Objective Questions) II^{nd}&III^(rd)` Law of thermodynamics and Entropy

1. Identify the correct statement regarding entropy

A. At $0^{\circ}C$, the entropy of a perfectly crystalline substance is taken to be zero

B. At absolute zero of temperature, the entropy of a perfectly crystalline substance is +ve

C. At absolute zero of temperature, the entropy of all crystalline substance is taken to be zero

D. At absolute zero of temperature, the entropy of a perfectly crystalline substance is taken to be zero

Answer: D

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2. Which of the following endothermic processes are spontaneous

A. Melting of ice

B. Evaporation of water

C. Heat of combustion

D. Both (a) and (b)

Answer: D

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3. The unit of entropy is

A. Jmol^{-1}

B. JKmol^{-1}

C. $\mathrm{Jmol}^{-1}\mathrm{K}^{-1}$

D. $\mathrm{J}^{-1}\mathrm{K}^{-1}\mathrm{mol}^{1}$

Answer: C

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4. The molar heat capacity of water at constant pressure, C_P , is $75\mathrm{JK}^{-1}\mathrm{mol}^{-1}$. When $1.0\mathrm{kJ}$ of heat is supplied to $100\mathrm{g}$ of water which is free to expand, the increase in temperature of water is

A. 6.6 K

B. 1.2 K

C. 2.4 K

D. 4.8 K

Answer: C

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5. What is the entropy change (in $JK^{-1}mol^{-1}$) when one mole of ice is converted into water at $0^{\circ}C$?

(The enthalpy change for the conversion of ice to liquid water is $6.0KJmol^{-1}$ at $0^{\circ}C$)

A. 21.98

B. 20.13

C. 2.013

D. 2.198

Answer: A

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6. Considering entropy (S) as a thermodynamics parameter, the criterion for the spontaneity of any process is

A. $\Delta S_{\text{system}} > 0 \quad \text{only}$

B. $\Delta S_{\text{surroundings}} > 0 \quad \text{only}$

C. $\Delta S_{\text{system}} + \Delta S_{\text{surroundings}} > 0$

D. $\Delta S_{\text{system}} - \Delta S_{\text{surroundings}} > 0$

Answer: C

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7. Which of the following pairs of a chemical reaction is certaion to result a spontaneous reaction ?

A. Exothermic and decreasing disorder

B. Endothermic and increasing disorder

C. Exothermic and increasing disorder

D. Endothermic and decreasing disorder

Answer: C

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8. The enthalpy and entropy change for the reaction

$Br_2(l) + Cl_2(g) \rightarrow 2BrCl(g)$ are $40 kJ mol^{-1}$ and $110 JK^{-1} mol^{-1}$ respectively. The temperature at which the reaction will be in equilibrium is

A. 450 K

B. 300 K

C. 363.64 K

D. 273 K

Answer: C

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9. The values of ΔH and ΔS for the reaction,

$C_{graphite} + CO_2(g) \rightarrow 2CO(g)$

are $170 KJ$ and $170 JJK^-$ respectively. This reaction will be spontaneous at

A. 710 K

B. 910 K

C. 1110 K

D. 510 K

Answer: C

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10. Standard entropy of X_2 , Y_2 and XY_3 are $60, 40$ and $50JK^{-1}mol^{-1}$, respectively. For the reaction, $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3, \Delta H = -30KJ$, to be at equilibrium, the temperature will be:

A. 500 K

B. 750 K

C. 1000 K

D. 1250 K

Answer: B

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11. If the enthalpy change for the transition of liquid water to steam is 300kJ mol^{-1} at $27^{\circ}C$, the entropy change for the proces would be

A. $100Jmol^{-1}K^{-1}$

B. $10Jmol^{-1}K^{-1}$

C. $1.0 \mathrm{J mol}^{-1} \mathrm{K}^{-1}$

D. $0.1 \mathrm{J mol}^{-1} \mathrm{K}^{-1}$

Answer: A

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12. The enthalpy of fusion of water is $1.435 \mathrm{kcal}/\mathrm{mol}$. The molar entropy change for the melting of ice at $0^{\circ} \mathrm{C}$ is

A. 10.52 cal/(mol K)

B. 21.04 cal/(mol K)

C. 5.260 cal/(mol K)

D. 0.526 cal/(mol K)

Answer: C

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13. For which reaction from the following, ΔS will be maximum?

A. $Ca(s) + \frac{1}{2}O_2(g) \rightarrow CaO(s)$

B. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

C. $C(s) + O_2(g) \rightarrow CO_2(g)$

D. $N_2(g) + O_2(g) \rightarrow 2NO(g)$

Answer: B

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14. Following data is known about melting of a compound AB . $\Delta H = 9.2 \text{kJmol}^{-1}, \Delta S = 0.008 \text{kJK}^{-1} \text{mol}^{-1}$ Its melting point is

A. 736 K

B. 1050 K

C. 1150 K

D. $1150^\circ C$

Answer: C

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15. For a spontaneous process the correct statement is -

A. Entropy of the system always increases

B. Free energy of the system always increases

C. Total entropy change is always negative

D. Total entropy change is always positive

Answer: D

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16. The enthalpy of water is 386 kJ. What is entropy of water

A. 0.5 kJ

B. 1.3 kJ

C. 1.5 kJ

D. 22.05 kJ

Answer: B

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17. If $900J/g$of heat is exchanged at boiling point of water then water is the increase in entropy.

A. $43.4J/mol$

B. $87.2J/mole$

C. $900J/mole$

D. Zero

Answer: A

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18. A container has hydrogen and oxygen mixture in ratio of 4 : 1 by weight, then

A. Internal energy of the mixture decreases

B. Internal energy of the mixture increases

C. Entropy of the mixture increases

D. Entropy of the mixture decreases

Answer: C

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19. For a carnot engine, the source is at 500 K and the sink at 300 K. What is efficiency of this engine

A. 0.2

B. 0.4

C. 0.6

D. 0.3

Answer: B

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20. Given the following entropy values (in $JK^{-1}mol^{-1}$) at 298 K atm : $H_2(g): 130.6. Cl_2(g): 223.0$ and $HCl(g): 186.7$. The entropy change (in $JK^{-1}mol^{-1}$) for the reaction

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$is

A. $+540.3$

B. $+727.3$

C. -166.9

D. $+19.8$

Answer: D

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21. If the enthalpy of vaporization for water is 198.5KJmol^{-1} , the entropy of its vaprization will be

A. 0.5 $\text{JK}^{-1}\text{mol}^{-1}$

B. 1.0 $\text{JK}^{-1}\text{mol}^{-1}$

C. 1.5 $\text{JK}^{-1}\text{mol}^{-1}$

D. 2.0 $\text{JK}^{-1}\text{mol}^{-1}$

Answer: A

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22. The standard entropies of $CO_{2(g)}, C_{(s)},$ and $O_{2(g)}$ are 213.5, 5.740 and 205 JK^{-1} respectively. The standard entropy of formation of CO_2 is ________.

A. 1.86JK^{-1}

B. $1.96 JK^{-1}$

C. $2.76 JK^{-1}$

D. $2.86 JK^{-1}$

Answer: C

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23. If 0.75 mole of an ideal gas expands isothermally at $27^{\circ} C$ from 15 litres to 25 litres, the maximum work obtained is

A. 840 J

B. -956 J

C. 1086 J

D. 1043 J

Answer: B

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24. Entropy change involve in conversation of 1mole of liquid water at 373Kto vapour at the same temperature (latent heat of vaporisation of water=$2.257 kJ g^{-1}$)

A. $105.9 JK^{-1}$

B. $107.9 JK^{-1}$

C. $108.9 JK^{-1}$

D. $109.9 JK^{-1}$

Answer: C

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25. The change is entropy for the fusion of 1 mole of ice is [M.P of ice = 273 K molar, enthalpy of fusion for ice = 60 kJ mol^{-1}]

A. $11.73 JK^{-1} mol^{-1}$

B. $18.84 \text{JK}^{-1} \text{mol}^{-1}$

C. $219.7 \text{JK}^{-1} \text{mol}^{-1}$

D. $24.47 \text{JK}^{-1} \text{mol}^{-1}$

Answer: C

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26. Which law of thermodynamics helps in calculating the absolute entropies of various substances at different temperatures?

A. First law

B. Second law

C. Third law

D. Zeroth law

Answer: C

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27. The law formulated by Nernst is

A. First law of thermodynamics

B. Second law of thermodynamics

C. Third law of thermodynamics

D. Both (a) and (b)

Answer: C

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28. The value of ΔH and ΔS for five different reaction are given below.

Reaction	$\Delta H(kJmol^{-})$	$\Delta S(JK^{-}mol^{-})$
I	$+98.0$	$+14.8$
II	$+55.5$	$+14.8$
III	$+28.3$	-84.8
IV	-40.5	$+24.6$
V	$+34.7$	0.0

On the basis of these values, predict which one of these will be spontaneous at all temperature?

A. Reaction I

B. Reaction II

C. Reaction III

D. Reaction IV

Answer: D

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29. For the homogeneous reactions:

$xA + yB \rightarrow lY + mZ$

$\Delta H = -30 kJ \quad mol^{-1}, \Delta S = -100 JK^{-1} \quad mol^{-1}$

At what temperature the reaction is at equilibrium?

A. $50^\circ C$

B. $250^\circ C$

C. 100 K

D. $27^\circ C$

Answer: D

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30. For the reaction

$$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$$

ΔH and ΔS are $-283kJ$ and $-87JK^{-1}$, respectively. It was intended to carry out this reaction at 1000,1500,3000, and 3500 K. At which of these temperatures would this reaction be thermodynamically spontaneous?

A. 1500 and 3500 K

B. 3000 and 3500 K

C. 1000, 1500 and 3000 K

D. 1500, 3000 and 3500 K

Answer: C

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31. A reaction is spontaneous at low temperature but non- spontaneous at high temperature. Which of the following is true for the reaction?

A. $\Delta H > 0, \Delta S > 0$

B. $\Delta H < 0, \Delta S > 0$

C. $\Delta H > 0, \Delta S = 0$

D. $\Delta H < 0, \Delta S < 0$

Answer: D

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32. Choose the reaction with negative ΔS value

A. $2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$

B. $Cl_{2(g)} \rightarrow 2Cl_{(g)}$

C. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

D. $2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$

Answer: C

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33. $\underset{S^\circ(298K)K^{-1}mol^{-1}}{H^+(aq)} + \underset{-10.7}{OH^-(aq)} \rightarrow \underset{+70}{H_2O(l)}$

Standard entropy change for the above reaction is

A. $60.3JK^{-1}mol^{-1}$

B. $80.7JK^{-1}mol^{-1}$

C. $-70JK^{-1}mol^{-1}$

D. $+10.7JK^{-1}mol^{-1}$

Answer: B

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34. One mole of $NaCl_{(s)}$ on melting absorbed 30.5 kJ of heat and its entropy is increased by 28.8 JK^{-1}. The melting point of NaCl is ________.

A. 1059 K

B. 30.5 K

C. 28.8 K

D. 28800 K

Answer: A

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35. Entropy of a perfect crystalline solid at absolute zero is

A. Positive

B. Negative

C. Zero

D. Not definite

Answer: C

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36. Which of the following conditions may lead to a non-spontaneous change?

A. Positive ΔH and positive ΔS

B. Negative ΔH and negative ΔS

C. Positive ΔH and negative ΔS

D. Negative ΔH and positive ΔS

Answer: C

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37. Entropy changesh for the process, $H_2O(l) \rightarrow H_2O$ at normal pressure and 274K are given below

$\triangle S_{system} = -22.13, \triangle S_{surr} = +22.05,$ the process is non spontaneous because

A. ΔS_{system} is $-$ ve

B. ΔS_{surr} is +ve

C. ΔS_{u} is -ve

D. $\Delta S_{\text{system}} \neq \Delta S_{\text{surr}}$

Answer: C

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38. Which of the following statements is true? The entropy of the universe

A. Increases and tends towars maximum value

B. Decreases and tends to be zero

C. Remains constant

D. Decreases and increases with a periodic rate

Answer: A

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39. The positive value of ΔS indicates that ________ .

A. The system becomes less disordered

B. The system becomes more disordered

C. The system is in equilibrium position

D. The system tends to reach at equilibrium position

Answer: B

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40. In which reaction ΔS is negative :-

A. $H_2O(l) \rightarrow H_2O(g)$

B. $H_2O(s) \rightarrow H_2O(l)$

C. $H_2O(g) \rightarrow H_2O(s)$

D. $H_2O(s) \rightarrow H_2O(g)$

Answer: C

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41. If molar heat of vaporization is 9698 cals mol^{-1} then entropy of vaporization of water at 100°C will be

A. 20.0 cals $\text{mol}^{-1}\text{k}^{-1}$

B. 24.0 cals $\text{mol}^{-1}\text{k}^{-1}$

C. 26.0 cals $\text{mol}^{-1}\text{k}^{-1}$

D. 28.0 cals $\text{mol}^{-1}\text{k}^{-1}$

Answer: C

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42. Entropy will not change for the reaction

A. Crystallization of sucrose from the solution

B. Corrosion of iron

C. Conversion of ice into water

D. Vaporisation of Camphor

Answer: B

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43. In a spontaneous irreversible process the total entropy of the system and surroundings

A. Equals zero

B. Decreases

C. Increases

D. Remains constant

Answer: C

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44. Which is the correct expression that relates changes of entropy with the change of pressure for an ideal gas at constant temperature, among the following?

A. $\Delta S = nRT \ln. \frac{P_2}{P_1}$

B. $\Delta S = T(P_2 - P_1)$

C. $\Delta S = nR \ln. \frac{P_1}{P_2}$

D. $\Delta S = 2.303nRT \ln. \frac{P_1}{P_2}$

Answer: C

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45. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$ when the above reaction occurs, the entropy

A. Remains same

B. Decreases

C. Increases

D. None of the above

Answer: C

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46. A heat engine absorbs heat Q_1 at temperature T_1 and Q_2 at temperature T_2 . Work done by the engine is $(Q_1 + Q_2)$. This data:

A. Violates I^{st} law of thermodynamics

B. Violates I^{st} law of thermodynamics if Q_1 is -ve

C. Violates I^{st} law of thermodynamics if Q_2 is -ve

D. Does not violate I^{st} law of thermodynamics

Answer: D

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47. An endotthermic reaction is non-spontaneous at freezing point of water and becomes feasible at its boiling point, then:

A. ΔH is -ve, ΔS is + ve

B. ΔH and ΔS both are + ve

C. ΔH and ΔS both are -ve

D. ΔH is +ve, ΔS is -ve

Answer: B

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48. Identify the correct statement regarding a spontaneous process.

A. For a spontaneous process in an isolated system, the change in entropy is positive

B. Endothermic process are never spontaneous

C. Exothermic process are always spontaneous

D. Lowering of energy in the reaction process is the only criterion for spontaneity

Answer: A

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49. The reaction. $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$ is an exampl for a

A. Spontaneous process

B. Non-spontaneous process

C. Isobaric process

D. Reversible process

Answer: A

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50. If an endothermic reaction occurs spontaneously at constant temperature and pressure, then which of the following is true?

A. $\Delta G > 0$

B. $\Delta H < 0$

C. $\Delta S > 0$

D. $\Delta S < 0$

Answer: C

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51. For which of the following processes is ΔS negative?

A. $H_2(g) \rightarrow 2H(g)$

B. $N_2(g)1atm \rightarrow N_2(g)8atm$

C. $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$

D. $C_{(\text{diamond})} \rightarrow C_{(\text{graphite})}$

Answer: B

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52. One mole of water at 100° C is converted into steam at 100° C at a constant pressure of 1 atm. The change in entropy is __________. (heat of vaporization of water at 100° C=540 cal/g)

A. 8.74

B. 18.76

C. 24.06

D. 26.06

Answer: D

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53. An engine operating between $150^\circ C$ and $25^\circ C$ takes 500 J heat from a higher temperature reservoir if there are no frictional losses, then work done by engine is

A. 147.7 J

B. 157.75 J

C. 165.85 J

D. 169.95 J

Answer: A

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54. For the reaction $Ag_2O(s) \rightarrow 2Ag(s) + 1/2O_2(g)$ the value of $\Delta H = 30.56 KJ mol^{-1}$ and $\Delta S = 66 JK^{-1} mol^{-1}$. The temperature at which the free energy change for the reaction will be zero is :-

A. 373 K

B. 413 K

C. 463 K

D. 493 K

Answer: C

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55. Mass and energy are conserved is demonstrated by

A. First law of thermodynamics

B. Law of conservation of energy

C. Law of conservation of mass

D. Modified form of I^{st} law of thermodynamics

Answer: D

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56. The entropy of a crystalline substance a absolute zero on the basis of the third law of thermodynamics should be taken as

A. 100

B. 50

C. Zero

D. Different for different substances.

Answer: C

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57. The incorrect statement among the following is

A. The entropy of the universe remains constant

B. Heat cannot be completely converted into work

C. This absolute entropy of a perfectly crystalline solid at absolute zero temperature is zero

D. The total energy of an isolated system remains constant

Answer: A

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58. When water is converted into ice, its entropy

A. Increases

B. Decreases

C. Remains same

D. Becomes zero

Answer: B

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59. Entropy change in a process where 1 litre of liquid He is poured into ice cold water is

A. Finite and positive

B. Finite and negative

C. Zero

D. Infinity

Answer: A

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60. Heat required to raise the temperature of 1 mole of a substance by 1° C is called

A. Specific heat

B. Molar heat capacity

C. Water equivalent

D. Specific gravity

Answer: B

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61. Maximum entropy will be in which of the following?

A. Ice

B. Liquid water

C. Snow

D. Water vapours

Answer: D

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62. In which case reaction is spontaneous

A. $\Delta H - ve, \Delta S + ve$

B. $\Delta H + ve, \Delta S - ve$

C. Both (a) and (b)

D. None of these

Answer: A

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63. For a reaction $\Delta H = (+ 3kJ), \Delta S = (+ 10J / K)$ beyond which temperature this reaction will be spontaneous

A. 300 K

B. 200 K

C. 273 K

D. 373 K

Answer: D

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64. In which reaction there will be increase in entropy ?

A. $Na(s) + H_2O(l) \rightarrow NaOH(l) + \frac{1}{2}H_2(g)$

B. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

C. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$

D. $Cu^{2+}(aq) + 4NH_3(g) \rightarrow [Cu(NH_3)_4]^{2+}(aq)$

Answer: A

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65. For reaction $2Cl_{(s)} \rightarrow Cl_{2(s)}$, the signs of $\Delta H$and ΔS respectively are ______ .

A. $+, \ -$

B. $+, \ +$

C. $-, \ -$

D. $-, \ +$

Answer: C

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66. For the reaction $H_2O_{(s)} \Leftrightarrow H_2O_{(l)}$ at $0^\circ C$ and normal pressure

A. $\Delta H > T\Delta S$

B. $\Delta H = T\Delta S$

C. $\Delta H = \Delta G$

D. $\Delta H < T \Delta S$

Answer: B

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67. A process is taking place at constant temperature and pressure. Then

A. $\Delta H = \Delta E$

B. $\Delta H = T \Delta S$

C. $\Delta H = 0$

D. $\Delta S = 0$

Answer: B

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68. Molar heat of vaporization of a liquid is 6 KJmol^{-1}. If its entropy change is $16\text{JK}^{-1}\text{mol}^{-1}$, then boiling point of the liquid is

A. 375°C

B. 375 K

C. 273 K

D. 102°C

Answer: B

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69. Which of the following has highest entropy?

A. Mercury

B. Diamond

C. Liquid nitrogen

D. Hydrogen gas

Answer: D

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70. Enthalpy of vapourization of benzene is $+35.3\text{kJmol}^{-1}$ at its boiling point of 80°C. The entropy change in the transition of the vapour to liquid at its boiling points [in $\text{K}^{-1}\text{mol}^{-1}$] is

A. -441

B. -100

C. $+441$

D. $+100$

Answer: B

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71. For which reaction change of entropy be positive ?

A. $H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)}$

B. $HCl_{(g)} + NH_{3(g)} \Leftrightarrow NH_4Cl_{(s)}$

C. $NH_4NO_{3(s)} \Leftrightarrow N_2O_{(g)} + 2H_2O_{(g)}$

D. $MgO_{(s)} + H_{2(g)} \Leftrightarrow Mg_{(s)} + H_2O_{(l)}$

Answer: C

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72. The second law of thermodynamic states that in a cyclic process,

A. Work cannot be converted into heat

B. Heat cannot be converted into work

C. Work cannot be completely converted into heat

D. Heat cannot be completely into work

Answer: D

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73. Which of the following is correct

A. Evaporation of water causes an increase in disorder of the system

B. Melting of ice causes a decrease in randomness of the system

C. Condensation of steam causes an increase in disorder of the system

D. There is practically no change in the randomness of the system when water is evaporated

Answer: A

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74. The change of entropy (dS) is defined as

A. $dS = \delta q / T$

B. $dS = dH / T$

C. $dS = \delta q_{eqv}/T$

D. $dS = (dH - dG)/T$

Answer: C

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75. The condition of spontaneity of process is

A. Lowering of entropy at constant temperature and pressure

B. Lowering of Gibbs free energy of system at constant temperature and pressure

C. Increase of entropy of system at constant temperature and pressure

D. Increase of Gibbs free energy of the universe at constant temperature and pressure

Answer: B

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76. Mixing of two different ideal gases under isothermal reversible condition will lead to

A. Increase of Gibbs free energy of the system

B. No change of entropy of the system

C. Increase of entropy of the system

D. Increase of enthalpy of the system

Answer: C

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77. Predict the sign/value of ΔS° for the following reaction

$2H_2S_{(g)} + 3O_{2(g)} \rightarrow 2H_2O_{(g)} + 2SO_{2(g)}$

A. $+$ve

B. $-\text{ve}$

C. Zero

D. Can not be predicted

Answer: B

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78. When you freeze water in your freezer to make ice cubes, the amount of order in the molecules of water increases. However, second law of thermodynamics says that the amount of order in an isolated system can only stay constant or decrease with time. How can this making of ice violates second law

A. Because water expands during ice formation

B. Because ice formation takes place at 0°C

C. Because ice is solid

D. Because ice cubes do not constitute isolated system

Answer: D

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79. Under equilibrium conditions, which of the following is true

A. $\Delta S = 0$

B. $\Delta H > 0$

C. $\Delta S > 0$

D. $\Delta H < 0$

Answer: A

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80. When a liquid boils, there is

A. An increase in entropy

B. A decrease in entropy

C. An increase in heat of vaporization

D. An increase in freee pressure

Answer: A

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81. The spontaneous flow of heat is always

A. From low to high pressure

B. From high to high pressure

C. Unidirectional from lower temperature to higher temperature

D. Unidirectional from the higher to lower temperature

Answer: D

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82. An irreversible process occuring isothermally in an isolated system leads to

A. Zero entropy

B. An increase in the total entropy of the system

C. A decrease in the total entropy of the system

D. None of these

Answer: B

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83. Which one of the following process is non-spontaneous

A. Dissolution of $CuSO_4$ in water

B. Reaction between H_2 and O_2 to form water

C. Water flowing down hill

D. Flow of electric current from low potential to high potential

Answer: B

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84. The ΔS for the vaporization of 1 mol of water is 88.3 J/mol K. The value of ΔS for the condensation of 1 mol of vapour will be _______ .

A. 88.3 J/mol K

B. $(88.3)^2$ J/mol K

C. -88.3 J/mol K

D. $\frac{1}{88.3}$ J/mol K

Answer: C

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85. In conversation of lime-stone ti lime, $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)7$ the value of ΔH° and ΔS° are $+179.1 KJ mol^{-1}$ and $160.2 J/K$

respectively at 298K and 1 bar. Assuming that ΔH and ΔS do not change with temperature, temperature above which coversation of lime-stone to lime will be just spontaneous is:

A. 1008 K

B. 1200

C. 845 K

D. 1118 K

Answer: D

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86. For chemical reactions, the calculation of change in entropy is normally done

A. At constant pressure

B. At constant temperature

C. At constant temperature and pressure both

D. At constant volume

Answer: C

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87. Assertion: The enthalpy of formation of gaseous oxygen molecules at $298K$ and under1 atm is zero.

Reason: The entropy of formation of gaseous oxygen molecules under the same condition is zero.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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88. Assertion: Entropy of ice is less than water. Reason: Ice has cage-like structure.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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89. Assertion :- Water in liquid state is more stable than ice at room temperature.

Reason :- Water in liquid from has higher entropy than ice.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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90. Assertion : In an isolated system the entropy increases.

Reason : The processes in an isolated system are adiabatic.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: B

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91. For a given reaction, $\Delta H = 35.5 \text{kJmol}^{-1}$ and $\Delta S = 83.6 \text{JK}^{-1}\text{mol}(-1)$. The reaction is spontaneous at : (Assume that ΔH and ΔS do not vary with temperature)

A. $T > 425K$

B. All temperatures

C. $T > 298K$

D. $T < 425K$

Answer: A

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ORDINARY THINKING (Objective Questions) Heat of reaction

1. $C_{\text{diamond}} + O_2(g) \rightarrow CO_2(g), \Delta H = -395kJ$ ......(i)

$C_{\text{graphite}} + O_2(g) \rightarrow CO_2(g), \Delta H = -393.5KJ \quad \ldots(ii)$

The ΔH , when diamond is formed from graphite, is

A. $-1.5kJ$

B. $+1.5kJ$

C. $+3.0kJ$

D. $-3.0kJ$

Answer: B

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2. Based on the following thermochemical equations

$H_2O(g) + C(s) \rightarrow CO(g) + H_2(g), \Delta H = 131KJ$

$CO(g) + 1/2O_2(g) \rightarrow CO_2(g), \Delta H = -282KJ$

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(g), \Delta H = -242KJ$

$C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = XKJ$

The value of X will be

A. $-393kJ$

B. $-655kJ$

C. $+393kJ$

D. $+655kJ$

Answer: A

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3. The enthalpy of formation for $C_2H_4(g)$, $CO_2(g)$ and $H_2O(l)$ at $25^\circ C$ and 1 atm. Pressure be 52, -394 and $-286 kJ mol^{-1}$ respectively. The enthalpy of combustion of $C_2H_4(g)$ will be

A. $+1412 kJ mol^{-1}$

B. $-1412 kJ mol^{-1}$

C. $+141.2 kJ mol^{-1}$

D. $141.2 kJ mol^{-1}$

Answer: B

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4. In an endothermic reaction, the value of ΔH is

A. Zero

B. Positive

C. Negative

D. Constant

Answer: B

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5. Given : $S_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow SO_{3(g)} + 2X\text{Kcal}$

$SO_{2(s)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)} + Y\text{ Kcal}$

The heat of formation of SO_2 is : $-$

A. $2x - y$

B. $2x + y$

C. $x + y$

D. $2x/y$

Answer: A

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6. The values of heat of formation of SO_2 and SO_3 are - 298.2 kJ and - 98.2 kJ. The heat of reaction of the following reaction will be

$SO_2(g) + \frac{1}{2}O_2(g) \rightarrow SO_3(g)$

A. -200 kJ

B. -356.2 kJ

C. $+200\text{kJ}$

D. -396.2kJ

Answer: C

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7. Heat of combustion ΔH° for $C(s)$, $H_2(g)$ and $CH_4(g)$ are 94, -68 and -213Kcal/mol. Then ΔH° for $C(s) + 2H_2(g) \rightarrow \Delta CH_4(g)$ is

A. -85kcal

B. -111kcal

C. -17kcal

D. -170kcal

Answer: C

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8. For which of the following reaction $\Delta H^{\circ}_{\text{reaction}}$ is not equal to ΔH_f° of product ?

A. $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

B. $N_2(g) + O_3(g) \rightarrow N_2O_3(g)$

C. $CH_4(g) + 2Cl_2(g) \rightarrow CH_2Cl_2(l) + 2HCl(g)$

D. $Xe(g) + 2F_2(g) \rightarrow XeF_4(g)$

Answer: D

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9. The internal energy change when a system goes fromk state A to B is $40 \mathrm{kJmol}^{-1}$. If the system goes from A to B by a reversible path and returns to state A by an irreversible path, what would be the net change in internal energy?

A. 40 kJ

B. > 0 kJ

C. < 40 kJ

D. Zero

Answer: D

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10. The absolute enthalpy of neutralisation of the reaction $\mathrm{MgO(s)} + 2\mathrm{HCl(aq)} \rightarrow \mathrm{MgCl_2(aq)} + \mathrm{H_2O(l)}$ will be

A. Less than -57.33 kJ mol^{-1}

B. -57.33kJmol^{-1}

C. Greater than -57.33kJmol^{-1}

D. 57.33kJmol^{-1}

Answer: A

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11. The following two reactionas are known

$FeO_3(s) + 3CO(g) \rightarrow 2Fe(s) + CO_2(g):$

$\Delta H = -26.8KJ$

$FeO(s) + CO(g) \rightarrow Fe(s) + CO_2(g): \Delta H = -16.5KJ$

The value of ΔH for the following reaction

$Fe_2O_3(s) + CO(g) \rightarrow 2FeO_2(s) + CO_2(g)$ is

A. $+10.3$ kJ

B. -43.3 kJ

C. -10.3 kJ

D. $+6.2\text{kJ}$

Answer: D

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12. The enthalpy change for a reaction does not depend upon:

A. The physical states of reactants and products

B. Use of different reactants for the same product

C. The nature of intermediate reaction steps

D. The differences in initial or final temperature of involved substances

Answer: C

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13. Which of the following neutralisation reactions,the heat of neutralisation will be highest?

A. NH_4OH and CH_3COOH

B. NH_4OH and HCl

C. $NaOH$ and CH_3COOH

D. $NaOH$ and HCl

Answer: D

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14. The heat of neutralisation of a strong acid and a strong alkali is $57.0 KJmol^{-1}$. The heat released when 0.5 mole of HNO_3 solution is mixed with 0.2 mole of KOH is

A. 57.0 kJ

B. 11.4 kJ

C. 28.5 kJ

D. 34.9 kJ

Answer: B

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15. When $4g$ of iron is burnt to ferric oxide at constant pressure, $29.28KJ$ of heat is evolved. What is the enthalpy of formation of ferric oxide (At wt. of $Fe = 56$)

A. $-81.98kJ$

B. $-819.8kJ$

C. $-40.99kJ$

D. $+819.8kJ$

Answer: B

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16. Enthalpy of neutralisation of acetic acid by $NaOH$ is $-50.6KJ/mol$ and the heat of neutralisation of a storng acid with a strong bases is $-55..9KJ/mol$. What is the value of ΔH for the ionisation of CH_3COOH ?

A. $+5.3kJ/mol$

B. $+6.2kJ/mol$

C. $+8.2kJ/mol$

D. $+9.3kJ/mol$

Answer: A

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17. One gram sample of NH_4NO_3 is decomposed in a bomb calorimeter. The temperature of the calorimeter increases by $6.12K$. The heat capacity of the system is $1.23 KJ/g/deg$. What is the molar heat of decomposition for NH_4NO_3 ?

A. -7.53 kJ/mol

B. $-398.1 kJ/mol$

C. -16.1 kJ/mol

D. -602 kJ/mol

Answer: D

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18. How much energy is released when 6 mole of octane is burnt in air ? Given ΔH_f° for $CO_2(g), H_2O(g)$ and $C_8H_{18}(l)$ respectively are $-490, \ -240$ and $+160 KJ/mol$

A. $-6.2 kJ$

B. $-37.4 kJ$

C. $-35.5 kJ$

D. -20.0kJ

Answer: B

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19. $\Delta H_f^{\Theta}{}'$ 298K of methanol is given by the chemical equation

A. $CH_4(g) + 1/2O_2(g) \rightarrow CH_3OH(g)$

B. $C(\text{graphite}) + 1/2O_2(g) + 2H_2(g) \rightarrow CH_3OH(l)$

C. $C(\text{diamond}) + 1/2O_2(g) + 2H_2(g) \rightarrow CH_3OH(l)$

D. $CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$

Answer: B

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20. What will be the heat of formation of methane, if the heat of combustion of carbon is '-x' kJ, heat of formation of water is '-y' kJ heat of combustion of methane is '-z' kJ?

A. $(-x-y+z)\text{kJ}$

B. $(-x-y+z)\text{kJ}$

C. $(-x-2y-z)\text{kJ}$

D. $(-x-2y+z)\text{kJ}$

Answer: D

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21. In the reaction for the transition of carbon in the diamond form to carbon in the graphite form, ΔH is -453.5 cal. This points out that

A. Graphite is chemically different from diamond

B. Graphite is as stable as diamond

C. Graphite is more stable than diamond

D. Diamond is more stable than graphite

Answer: C

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22. If $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = X$ and $CO(g) + 1/2O_2(g) \rightarrow CO_2(g), \Delta H = Y$, then the heat of formation of CO is

A. X-Y

B. Y-2X

C. X+Y

D. 2X-Y

Answer: A

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23. Equal volumes of methanoic acid and sodium hydroxide are mixed. If x is the heat of formation of water from its ions then heat evolved on neutralisation is

A. More than x

B. Equal to x

C. Twice of x

D. Less than x

Answer: D

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24. Heat exchanged in a chemical reaction at constant temperature and pressure is called

A. Internal energy

B. Enthalpy

C. Entropy

D. Free energy

Answer: B

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25. The values of heat of combustion of ethane (C_2H_6) and ethyne (C_2H_2) are -341 and -310Kcal respectively. Then which of the following is better fuel on mass basis:

A. C_2H_2

B. C_2H_4

C. Both of these

D. None of these

Answer: B

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26. If ΔH_f° for $H_2O_2(l)$ and $H_2O(l)$ are -188kJ and mol^{-1} and -286 kJ mol^{-1}, what will be the enthalpy change of the reaction $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$?

A. -196 kJ/mole

B. $146 kJ / mole$

C. $-494 kJ / mole$

D. $-98 kJ / mole$

Answer: A

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27. The standard ethelpy of combustion at $25^\circ C$ of hydrogen, cyclohexene (C_6H_{10}), and cyclohexane (C_6H_{12}) are -241, -3800, and

$-3920 \mathrm{kJ} \mathrm{mol}^{-1}$ repectively. Calculate the heat of hydrogenation of cyclohexane.

A. -121 KJ/mole

B. $+121$ KJ/mole

C. -242 KJ/mole

D. $+242$ KJ/mole

Answer: A

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28. A cylinder of gas supplied by Bharat Petroleum is assumed to contain $14 \mathrm{kg}$ of butane. If a normal family requires 20,000 kJ of energy per day for cooking, butane gas in the cylinder lasts

$(\Delta_{C} H^{\circ}$ of $C_4H_{10} = -2658 \mathrm{kJ} \mathrm{mol}^{-1})$

A. 15 days

B. 20 days

C. 50 days

D. 32 days

Answer: D

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29. In the reaction,

$CO_2(g) = H_2(g) \rightarrow CO(g) = H_2O(g), \qquad \Delta H = 2.8 kJ$

ΔH represents :

A. Heat of formation

B. Heat of combustion

C. Heat of neutralization

D. Heat of reaction

Answer: D

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30. The enthalpy combustion of a substance

A. Is always positive

B. Is always negative

C. Is equal to heat of formation

D. Nothing can be said without reaction

Answer: B

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31. Thermochemical reactions

$$\mathrm{C(graphite)} + \frac{1}{2}\mathrm{O_2(g)} \rightarrow \mathrm{CO(g)}, \Delta H = -110.5\mathrm{kJ}$$

$$\mathrm{CO(g)} + \frac{1}{2}\mathrm{O_2(g)} \rightarrow \mathrm{CO_2(g)}, \Delta H = -283.2\mathrm{kJ}$$

From the above reaction, the heat of reaction for C(graphite) $+\mathrm{O_2(g)} \rightarrow \mathrm{CO_2(g)}$ will be

A. -393.7 kJ

B. $+393.7$ kJ

C. -172.7 kJ

D. $+172.7$ kJ

Answer: A

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32. If $H_2 + 1/2O_2 \rightarrow H_2O, \Delta = -68.39$ Kcal

$K + H_2O + \text{water} \rightarrow KOH(aq) + 1/2H_2, \Delta H = -48.0$ Kcal

$KOH + \text{water} \rightarrow KOH(aq)\Delta H = -14.0$ Kcal the heat of formation of KOH is -

A. $-68.39 + 48 - 14$

B. $-68.39 - 48 + 14$

C. $68.39 - 48 + 14$

D. $68.39 + 48 + 14$

Answer: B

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33. In an exothermic reaction ΔH is

A. Positive

B. Negative

C. Zero

D. Both positive or negative

Answer: B

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34. In the reaction: $H_2 + Cl_2 \rightarrow 2HCl, \Delta HCl, \Delta H = 194kJ$. Heat of formation of HCl is

A. $+97$ kJ

B. $+194\text{kJ}$

C. -194kJ

D. -97kJ

Answer: A

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35. If the heat of combustion of carbon monoxide at constant volume and at 17° C is -283.3kJ, then its heat of combustion at constant pressure is ________ .

(R = 8.314 J $\text{kelv}\in^{-1}\text{ mol}^{-1}$)

A. -284.5 kJ

B. 284.5 kJ

C. 384.5 kJ

D. -384.5kJ

Answer: A

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36. Which of the following reactions corresponds to the definition of enthalpy of formation

A. $C_{(g)} + O_{2(g)} \rightarrow CO_{2(g)}$

B. $C_{(s)} + O_{2(l)} \rightarrow CO_{2(g)}$

C. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

D. $C_{(l)} + O_{2(s)} \rightarrow CO_{2(g)}$

Answer: C

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37. $NH_3(g) + 3Cl_2 \rightarrow NCl_3(g) + 3HCl(g), \Delta H_1$

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g), \Delta H_2$

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g), \Delta H_3$

The heat of formation of $NCl_3(g)$ in the terms of

$\Delta H_1, \Delta H_2, \Delta H_3$ is :

A. $\Delta H_f = -\Delta H_1 + \frac{\Delta H_2}{2} - \frac{3}{2}\Delta H_3$

B. $\Delta H_f = \Delta H_1 + \frac{\Delta H_2}{2} - \frac{3}{2}\Delta H_3$

C. $\Delta H_f = -\Delta H_1 - \frac{\Delta H_2}{2} - \frac{3}{2}\Delta H_3$

D. None of these

Answer: C

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38. Which of the following reaction is endothermic?

A. $CaCO_3 \rightarrow CaO + CO_2$

B. $Fe + S \rightarrow FeS$

C. $NaOH + HCl \rightarrow NaCl + H_2O$

D. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Answer: A

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39. Ozone is prepared by passing silent electric discharge through oxygen. In this reaction

A. Energy is given out

B. Energy is absorbed

C. Oxygen is loaded with energy

D. Oxygen is dissociated into atoms

Answer: A

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40. Combustion fo glucose takes place according to the equation, $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O, \Delta H = -72\text{kcal}$ How much energy will be required for the production of 1.6g of glucose (Molecular mass of glucose=180g)

A. 0.064 kcal

B. 0.64 kcal

C. 6.4 kcal

D. 64 kcal

Answer: B

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41. The enthalpy of combustion of $C_6H_6(l)$ is -3250KJ . When 039g of benzene is burnt excess of oxygen in an open vessel, the amount of heat evolved is

A. 16.25 J

B. 16.25 kJ

C. 32.5 J

D. 32.5 kJ

Answer: B

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42. When 5 g of sulphur is burnt to SO_2, 46 kJ of heat is liberated. What is the enthalpy of formation of sulphur dioxide?

A. $+147.2kJ$

B. $-147.2kJ$

C. $-294.4kJ$

D. $+294.4kJ$

Answer: C

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43. If a mole of hydrogen molecule is heated to a high temperature then which of the following reactions take place ?

A. $H_2(g) + 436kJ = H(g) + H(g)$

B. $H_2(g) + 820kJ = 2H_2(g)$

C. $2H_2(g) + 436J = 2H_2$

D. $H_2 + H_2 = H^+ + H^+$

Answer: A

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44. One mole of magnesium in the vapor state absorbed $1200kJmol^{-1}$ of enegry. If the first and second ionization energies of Mg are 750 and $1450kJmol^{-1}$, respectively, the final composition of the mixture is

A. $31\ \%\ Mg^{+} + 69\ \%\ Mg^{2+}$

B. $69\ \%\ Mg^{+} + 31\ \%\ Mg^{2+}$

C. $86\ \%\ Mg^{+} + 14\ \%\ Mg^{2+}$

D. $14\ \%\ Mg^{+} + 86\ \%\ Mg^{2+}$

Answer: B

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45. Four grams of graphite is burnt in a bomb calorimeter of heat capacity $30 kJK^{-1}$ is excess of oxygen at 1 atmospheric pressure. The temperature rises from 300 to 304 K. What is the enthalpy of combustion of graphite (in kJ mol^{-1})?

A. 360

B. 1440

C. -360

D. -1440

Answer: C

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46. The standard enthalpies of combustion of $C_6H_{6(l)}$, $C_{(graphite)}$ and $H_{2(g)}$ are respectively -3270kJ mol^{-1}, -394kJ mol^{-1} and -286kJ mol^{-1}. What is the standard enthalpy of formation of $C_6H_{6(l)}$ in kJ mol^{-1}

A. -48

B. $+48$

C. -480

D. $+480$

Answer: B

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47. The compound with negative value of heat of formation are called :

A. Endothermic compound

B. Exothermic compound

C. Heat of formation compound

D. None of the above

Answer: B

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48. Evaporation of water is

A. An endothermic change

B. An exothermic change

C. A process where no heat change occurs

D. A process accompanied by chemical reaction

Answer: A

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49. If $S + O_2 \rightarrow SO_2, (\Delta H = -298.2)$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3, (\Delta H = -98.2)$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O, (\Delta H = -287.3)$

then the enthalpy of formation of H_2SO_4 at 298 K will be

A. -433.7kJ

B. -650.3kJ

C. $+320.5\text{kJ}$

D. -813.9kJ

Answer: D

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50. For the allotropic change represented by equation C(diamond) → C(graphite), the enthalpy change is $\Delta H = -1.89$ kJ. If 6g of diamond and 6g of graphite are separately burnt to yield carbon dioxide, the heat liberated in the first case is

A. Less than in the second case by 1.89 kJ

B. More than in the second case by 1.89 kJ

C. Less than in the second case by 11.34 kJ

D. More than in the second case by 0.945 kJ

Answer: D

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51. The enthalpy change ΔH for the neutralisation fo $1 M HCI$ by caustic potash in dilute solution at $298 K$ is

A. 68 kJ

B. 65 kJ

C. 57.3 kJ

D. 50 kJ

Answer: C

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52. A reaction that takes place with the absorption of energy is

A. Burning of a candle

B. Rusting of iron

C. Electrolysis of water

D. Digestion of food

Answer: C

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53. A solution of 500 ml of 0.2 M KOH and 500ml of 0.2 M HCl is mixed and stirred, the rise in temperature is T_1. The experiment is repeated using 250ml each of solution, the temperature raised is T_2. Which of the following is true

A. $T_1 = T_2$

B. $T_1 = 2T_2$

C. $T_1 = 4T_2$

D. $T_2 = 9T_1$

Answer: A

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54. In which of the following reaction does the heat change represent the heat of formation of water ?

A. $2H_2(g) + O_2(g) \rightarrow 2H_2O(l), \Delta H = -116\text{kcal}$

B. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H = -58\text{kcal}$

C. $H^+(aq.) + OH^-(aq.) \rightarrow 2H_2O(l), \Delta H = -13.7\text{kcal}$

D. $C_2H_2(g) + 2\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l), \Delta H = -310\text{kcal}$

Answer: B

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55. The heat of formations of $CO_{(g)}$ and $CO_{2(g)}$ are -26.4 kcal and -94.0 kcal respectively. The heat of combustion of carbon monoxide will be ________ .

A. $+26.4$ kcal

B. -67.6 kcal

C. -120.6 kcal

D. `+52.8 kcal

Answer: B

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56. In the complete combustion of butanol $C_4H_9OH(l)$, if ΔH is enthalpy of combustion and ΔE is the heat of combustion at constant volume, then

A. $\Delta H < \Delta E$

B. $\Delta H = \Delta E$

C. $\Delta H > \Delta E$

D. $\Delta H, \Delta E$ relation cannot be predicted

Answer: C

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57. The heat of combustion of $CH_4(g)$, C (graphite), $H_2(g)$ are 20kcal, -40 kcal-10 kcal respectively. The heat of formation of methane is

A. -4.0 kcal

B. $+40$ kcal

C. -80 kcal

D. $+80$ kcal

Answer: C

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58. Calculate ΔH° for the reaction

$Na_2O(g) + SO_3(g) \rightarrow Na_2SO_4(s)$

Given the following

$(i)Na(s) + H_2O(l) \rightarrow NaOH(s) + \frac{1}{2}H_2(g), \Delta H^{\circ} = -146kJ$

$(ii)Na_2SO_4(s) + H_2O(l) \rightarrow 2NaOH(s) + SO_3(g), \Delta H = +418kJ$

$(iii)2Na_2O(s) + 2H_2(g) \rightarrow 4Na(s) + 2H_2O(l), \Delta H = +259kJ$

A. $+823$ kJ

B. -581 kJ

C. -435 kJ

D. $+531$ kJ

Answer: B

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59. When a strong acid, strong base or their salt are dissolved in water, they are completely ionised. If a strong acid is added to a strong base, H^{+} ions from the former combine with OH^{-} ions of the latter forming water. The formation of each water molecule liberates a certain quantity of energy and the reaction is exothermic. The heat liberated when one mole of water is formed by combining hydrochloric acid sodium hydroxide is 13.7 kcal. The heat liberated when one mole of water is formed by combining sulphuic acid and sodium hydroxide is

A. 25.5 kcal

B. 8.5 kcal

C. 13.7 kcal

D. 34 kcal

Answer: C

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60. 2.1g of Fe combines with S evolving $3.77KJ$. The heat of formation of FeS in KJ/mol is

A. -1.79

B. -100.5

C. -3.77

D. None of these

Answer: B

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61. Which compound will absorb the maximum amount of heat when dissolved in the same amount of water ? (Integral heats of solution at $25^{\circ}C$ in kcal/mol of each solute are given in brackets)

A. $HNO_3(\Delta H = -33)$

B. $KCl(\Delta H = +17.64)$

C. $NH_4NO_3(\Delta H = +25.5)$

D. $HCl(\Delta H = -74.1)$

Answer: C

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62. In the reaction $C + 2S \rightarrow CS_2 + \Delta H$, ΔH is the

A. Heat of combustion

B. Heat of neutralization

C. Heat of solution

D. None of these

Answer: D

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63. The following thermochemical reactions are given :

$M+\frac{1}{2}O_2 \rightarrow MO+351.4kJ$ $X+\frac{1}{2}O_2 \rightarrow XO+90.8kJ$

It follows that the heat of reaction for the following process

$M+XO \rightarrow MO+X$ is given by

A. 422.2 kJ

B. 268.7 kJ

C. $-442.2kJ$

D. 260.6 kJ

Answer: D

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64. A cylinder of gas is assumed to contain 11.2 kg of butane (C_4H_{10}). If a normal family needs 20000 kJ of energy per day. The cylinder will last: (Given that ΔH for combustion of butane is -2658 kJ)

A. 20 days

B. 25 days

C. 26 days

D. 24 days

Answer: C

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65. Thermodynamically the most stable form of carbon is

A. Diamond

B. Graphite

C. Fullerenes

D. Coal

Answer: B

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66. Which of the following is an example of endothermic reaction

A. $C_2H_2 + 2H_2 \rightarrow C_2H_6, \Delta E = -314.0 kJ$

B. $C + O_2 \rightarrow CO_2, \Delta E = -393.5 kJ$

C. $N_2 + O_2 \rightarrow 2NO, \Delta E - 180.5 kJ$

D. $2H_2 + O_2 \rightarrow 2H_2O, \Delta E + 571.8 kJ$

Answer: C

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67. The mutual heat of neutralisation of 40gNaOH and $60 \text{CH}_3\text{COOH}$ will be

A. 56.1 kcal

B. Less than 56.1 kcal

C. More than 56.1 kcal

D. 13.7 kcal

Answer: B

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68. The heats evolved in combustion of rhombic and monoclinic sulphur are, respectively, 70960 and 71030calmol^{-1}. What will be the heat of conversion of rhomic sulphur to monoclinic?

A. 70960 calories

B. 71030 calories

C. -70 calories

D. $+70$ calories

Answer: C

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69. The formation of water from $H_2(g)$ and $O_2(g)$ is an exothermic process because :

A. The chemical energy of $H_2(g)$ and $O_2(g)$ is more than that of water

B. The chemical energy of $H_2(g)$ and $O_2(g)$ is less than that of water

C. Not dependent on energy

D. The temperature of $H_2(g)$ and $O_2(g)$ is more than that of water

Answer: A

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70. Which of the following reaction can be used to define the heat of formation of $CO_2(g)$?

A. $C(\text{graphite}) + O_2(g) = CO_2(g)$

B. $CH_4(g) + 2O_2(g) = CO_2(g) + 2H_2O(l)$

C. $CO(g) + \frac{1}{2}O_2(g) = CO_2(g)$

D. $C_6H_6(l) + 7\frac{1}{2}O_2(g) = 6CO_2 + 3H_2O(l)$

Answer: A

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71. The molar neutralization heat for KOH and HNO_3 as compared to molar neutralization heat of NaOH and HCl

A. Less

B. More

C. Equal

D. Depends on pressure

Answer: C

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72. In Kirchoff's equation which factor affects the heat of reaction :

A. Pressure

B. Temperature

C. Volume

D. Molecularity

Answer: B

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73. An exothermic reaction is one which

A. Takes place only on heating

B. Is accompanied by a flame

C. Is accompanied by a absorption of heat

D. Is accompanied by evolution of heat

Answer: D

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74. Which of the following fuels will have the highest calorific value (kJ/kg)

A. Charcoal

B. Kerosene

C. Wood

D. Dung

Answer: B

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75. If $H^{+} + OH^{-} \rightarrow H_2O + 13.7\text{Kcal}$, the heat of neutralisation for complete neutralisation of 1 mole of H_2SO_4 by base will be

A. 13.7 kcal

B. 27.4 kcal

C. 6.85 kcal

D. 3.425 kcal

Answer: B

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76. The lowest value of heat of neutralization is obtained for

A. $HCl + NaOH$

B. $CH_3COOH + NH_4OH$

C. $NH_4OH + HCl$

D. $NaOH + CH_3COOH$

Answer: B

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77. All reaction with chemical dissociation are

A. Reversible

B. Reversible and endothermic

C. Exothermic

D. Reversible or irriversible and endothermic or exothermic

Answer: B

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78. Which of the following values of heat of formation indicates that the product is least stable?

A. -94 kcal

B. -231.6 kcal

C. $+21.4$ kcal

D. $+64.8$ kcal

Answer: D

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79. In the combustion of 2.0 g of methane 25 kcal heat is liberated, heat of combustion of methane would be __________ .

A. 100 kcal

B. 200 kcal

C. 300 kcal

D. 400 kcal

Answer: B

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80. The heat of formation of the compound in the following reaction is

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) + 44\text{kcal}$

A. 44 kcal

B. 44000 kcal

C. 22 kcal

D. 11 kcal

Answer: C

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81. When water is added to quick lime, the reaction is

A. Exothermic

B. Endothermic

C. Explosive

D. None of these

Answer: A

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82. The heat change for the following reaction at 298K and at constant pressure is +7.3 kcal

$A_2B(s) \rightarrow 2A(s) + 1/2B_2(g), \Delta H = +7.3\text{kcal}$

The heat change at constant volume would be $C(s) + 2S(s) \rightarrow CS_2(l)$ is known as

A. Heat of vaporization

B. Heat of solution

C. Heat of fusion

D. Heat of formation

Answer: D

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83. If the enthalpy of B is greater than of A, the reaction $\mathrm{A} \rightarrow \mathrm{B}$ is

A. Endothermic

B. Exothermic

C. Instantaneous

D. Spontaneous

Answer: A

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84. The heat of reaction at constant pressure is given by

A. $E_P - E_R$

B. $E_R - E_P$

C. $H_P - H_R$

D. $H_R - H_P$

Answer: C

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85. The heat of neutralisation will be highest in

A. NH_4OH and CH_3COOH

B. NH_4OH and HCl

C. KOH and CH_3COOH

D. $NaOH$ and HCl

Answer: D

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86. Calculate the ebullioscopic constant for water. The heat of vaporisation is 40.685 kJ mol^{-1}

A. 0.512Kkgmol^{-1}

B. 1.86Kkgmol^{-1}

C. 5.12Kkgmol^{-1}

D. 3.56Kkgmol^{-1}

Answer: A

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87. The enthalpy change for the reaction $C_2H_2(g) + \frac{5}{2}O_2 \rightarrow 2CO_2(g) + H_2O(g)$ is known as enthalpy of

A. Formation

B. Fusion

C. Vaporization

D. Combustion

Answer: D

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88. On the basis of following equations the heat of dimerisation of NO_2 will be

(i) $N_2 + 2O_2 \rightarrow 2NO_2 \qquad \Delta H = 67.9 kJ$

(ii) $N_2 + 2O_2 \rightarrow N_2O_4 \qquad \Delta H = 09.3 kJ$

A. $+77.2 kJ$

B. $-77.2 kJ$

C. $-58.6 kJ$

D. $+58.6 kJ$

Answer: C

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89. If $C + O_2 \rightarrow CO_2 + 94.2\text{kcal}$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + 68.3\text{kcal}$

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 210.8\text{kcal}$

Then, the heat of formation of methane will be

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90. The heat evolved in combustion of benzene is given by the following equation :

$C_6H_6 + 15/2O_2 \rightarrow 3H_2O + 6CO_2 : \Delta H = -3264.6\text{kJ}$

Which of the following quantities of heat will be evolved when 39g of benzene are burnt in an open container ?

A. 816.15 kJ

B. 1632.3 kJ

C. 6528.2 kJ

D. 2448.45 kJ

Answer: B

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91. Reaction, $H_2(g) + I_2(g) \rightarrow 2HI, \Delta H = 12.40 \text{kcal}$ ltbr. According to this, heat of formation of HI will be:

A. 12.4 kcal

B. -12.4 kcal

C. -6.20 kcal

D. 6.20 kcal

Answer: D

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92. For an exothermic reaction

A. H of the products is less than H of the reactants

B. H of the products is more than H of the reactants

C. H of the products is equal to H of the reactants

D. ΔH is always positive

Answer: A

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93. The energy evolved is highest for which of the following reactions

A. $F + e^{-} \rightarrow F^{-1}$

B. $Cl + e^{-} \rightarrow Cl^{-}$

C. $S + 2e^{-} \rightarrow S^{2-}$

D. $O + 2e^{-} \rightarrow O^{2-}$

Answer: B

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94. Carbon and carbon monoxide burn in oxygen to form carbon dioxide according to the following reactions

$C + O_2 \rightarrow CO_2, \Delta H = -394 \ \text{kJ mol}^{-1}$

$2CO + O_2 \rightarrow 2CO_2, \Delta H = -569 \ \text{kJ mol}^{-1}$

The heat of formation of 1 mol of carbon monoxide is thus

A. -219.0kJmol^{-1}

B. -109.5kJmol^{-1}

C. -175.0kJmol^{-1}

D. -87.5kJmol^{-1}

Answer: B

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95. For complete neutralization of HCl with NaOH, the heat of neutralization is

A. $+13.70 \text{kJmol}^{-1}$

B. -13.70kJmol^{-1}

C. -57.32kJmol^{-1}

D. -57.32kJmol^{-1}

Answer: C

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96. The enthalpy of neutralisation of HCl by NaOH IS -55.9kJ and that of HCN by NaOH is -12.1kJmol^{-1}. The enthalpy of ionisation of HCN is

A. -68.0kJmol^{-1}

B. -43.8kJmol^{-1}

C. 68.0 kJ mol^{-1}

D. 43.8 kJ mol^{-1}

Answer: D

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97. Which of the following reactions is not exothermic

A. $C(s) + O_2(g) \rightarrow CO_2(g)$

B. $C(s) + 2S(s) \rightarrow CS_2(g)$

C. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

D. $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

Answer: B

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98. Heat of neutralisation will be minimum for which of the following combination?

A. $NaOH + H_2SO_4$

B. $NH_4OH + CH_3COOH$

C. $NaOH + HCl$

D. $NaOH + CH_3COOH$

Answer: B

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99. Heat of formation off SO_2 is -298 kJ. What is the heat of combustion of 4 g of S?

A. $+37$ kJ

B. -37.25 kJ

C. $+298$ kJ

D. 18.6 kJ

Answer: B

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100. The enthalpies of combustion of carbon and carbon monoxide are -393.5 and -283 kJ mol^{-1} respectively. The enthaly of formation of carbon monoxide per mole is :

A. -676.5kJ

B. 676.5 kJ

C. 110.5 kJ

D. -110.5kJ

Answer: D

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101. 2.2016 gm of acetaldehyde produceed 13.95 Kcal of heat on combustion. The heat of combustion of CH_3CHO will be

A. 279 kcal

B. 972 kcal

C. 27.9 kcal

D. 2.79 kcal

Answer: A

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102. Fermentation is a reaction called

A. Endothermic

B. Exothermic

C. Isotemperature

D. Reversible

Answer: B

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103. The standard enthalpy of formation $(\Delta_f H^\circ)$ at $298K$ for methane $(CH_{4(g)})$ is $-74.8 kJ mol^{-1}$. The additional information required to determine the average energy for $C - H$ bond formation would be :

A. The dissociation energy of H_2 and enthalpy of sublimation of carbon

B. Latent heat of vapourization of methane

C. The first four ionization energies of carbon and electron gain enthalpy of hydrogen

D. The dissociation energy of hydrogen molecule, H_2

Answer: A

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104. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below

$$\frac{1}{2}CL_2(g)\xrightarrow{\frac{1}{2}\Delta_{diss}H^{\Theta}}Cl(g)\xrightarrow{\Delta H^{\Theta}_{Eg}}$$

$$Cl^-(g)\xrightarrow{\Delta_{hyd}H^{\Theta}}Cl^-(aq)$$

The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to

$Cl^-(aq)$

(Using the data $\Delta_{diss}H^{\Theta}_{Cl_2} = 240 KJmol^{-1}$)

$\Delta_{Eg}H^{\Theta}_{Cl} = -349 KJmol^{-1}$,

$\Delta_{Eg}H^{\Theta}_{Cl} = -381 KJmol^{-1}$) will be

A. $-610 kJmol^{-1}$

B. $-850 kJmol^{-1}$

C. $+120 kJmol^{-1}$

D. $+152 kJmol^{-1}$

Answer: A

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105. On the basis of the following thermochemical data :

$(\Delta_f G^\circ H^+_{(aq.)} = 0)$

$H_2O_{(l)} \rightarrow H^+_{(aq.)} + OH^-_{(aq.)}, \Delta H = 57.32 kJ$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -286.20 kJ$

The value of enthalpy of formation of OH^- ion at $25^\circ C$ is :

A. -22.88 kJ

B. -228.88 kJ

C. $+228.88$ kJ

D. -343.52 kJ

Answer: B

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106. Given that

$C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -394 kJ$

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l), \Delta H = -568 kJ$

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \Delta H = -892 kJ$

Heat of formation of CH_4 is

A. -70 kJ

B. 71.8 kJ

C. -244 kJ

D. $+782$ kJ

Answer: A

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107. What is Δn for combustion of 1 mole of benzene, when both the reactants and the products are gas at 298 K?

A. 0

B. $3/2$

C. $-3/2$

D. $1/2$

Answer: D

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108. A system is changed from state A to state B by one path and from B to A by another path. If ΔE_1 and ΔE_2 are the corresponding changes in internal energy, then

A. $E_1 + E_2 = -ve$

B. $E_1 + E_2 = +ve$

C. $E_1 + E_2 = 0$

D. None of these

Answer: C

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109. The enthalpy of formation of methane $C_{(S)} + 2H_{2(g)} \rightarrow CH_4(g)$ at constant pressure is 18500 cal at $25^{\circ} C$. The enthalpy of reaction at constant volume would be

A. 17904 cal

B. 18202 cal

C. 18798 cal

D. 19096 cal

Answer: D

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110. The heat evolved during the combination of 24 g C and 128 g S following the change is

$C + S_2 \rightarrow CS_2, \Delta H = 22.0 \text{kcal}$

A. 11 kcal

B. 32 kcal

C. 44 kcal

D. 22 kcal

Answer: C

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111. 1 mole of conc. HCl requires X moles of dilute NaOH for neutralisation and 1 mole of concentrate H_2SO_4 requires Y moles of small dilute NaOH then which of the following reaction is true

A. $Y = \frac{1}{2}X$

B. $X = \frac{1}{2}Y$

C. $X = 2Y$

D. None of these

Answer: B

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112. If the heat formation of CO_2 is -393kJ. The amount of heat evolved in the formation of 0.176 kg of CO_2 is

A. -1357.9kJ

B. -1275.9 kJ

C. -1572.0 kJ

D. -1165.5 kJ

Answer: C

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113. In which of the following reactions, the heat liberated is known as "heat of combustion".

A. $H^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow H_2O_{(l)} + \text{heat}$

B. $C(\text{graphite}) + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)} + \text{heat}$

C. $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)} + \text{heat}$

D. $H_2SO_{4(aq)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)} + \text{heat}$

Answer: C

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114. When 400 ml of 2.0 N solution of a weak acid is neutralized by a dilute aqueous solution of sodium hydroxide under standard conditions, 4.4 kJ amount of heat is liberated. Therefore, the standard enthalpy of neutralization of this weak acid in kJ eq^{-1} is

A. -11

B. -44

C. -55

D. -22

Answer: C

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115. Which one of the following is always not negative

A. Enthalpy of combustion

B. Enthalpy of formation

C. Enthalpy of neutralisation

D. Lattice enthalpy

Answer: B

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116. In which of the following pairs the enthalpy of neutralization is less than or more than the standard value

A. HNO_3 and $NaOH$

B. HCl and $NaOH$

C. HCN and NaOH

D. H_2SO_4 and NaOH

Answer: C

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117. The heat of combustion of carbon to CO_2 is -393.5 kJ/mol. The heat released upon formation of 35.2 g of CO_2 from carbon and oxygen gas is

A. $+315$ kJ

B. -31.5 kJ

C. -315 kJ

D. $+31.5$ kJ

Answer: C

Watch Video Solution

118. $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -94$ kcal

$2CO(g) + O_2 \rightarrow 2CO_2, \Delta H = -135.2$ kcal

The heat of formation of $CO(g)$ is

A. -26.4 kcal

B. 41.2 kcal

C. 26.4 kcal

D. -229.2 kcal

Answer: A

Watch Video Solution

119. Which of the following pairs has heat of neutralisation equal to 13.7 Kcals

A. HCl, NH_4OH

B. HNO_3, KOH

C. $NaOH, CH_3COOH$

D. H_2SO_4, NH_4OH

Answer: B

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120. The sublimation energy of I_2 (solid) is 57.3 KJ/mole and enthalpy of fusion is 15.5 KJ/mole. The enthalpy of vapourisation of I_2 is

A. 41.8 kJ/mol

B. $-41.8 kJ/mol$

C. $72.8 kJ/mol$

D. $-72.8 kJ/mol$

Answer: A

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121. The enthalpy of vaporisation of liquid water using the data

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H = -285.77 kJ/mol$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g), \Delta H = -241.84 kJ/mol$$

A. $+43.93 kJ/mol$

B. $-43.93 kJ/mol$

C. -527.61

D. $-527.61 kJ/mol$

Answer: A

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122. Heat of neutralization of strong acid by a strong base is a constant value due to:

A. Salt formed does not hydrolyse

B. Only H^+ and OH^- ions react in every case

C. The strong base and strong acid react completely

D. The strong base and strong acid react in aqueous solution

Answer: B

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123. Heat of transition is the heat evolved or absorbed when a substance is converted from

A. Solid to liquid

B. Solid to vapour

C. Liquid to vapour

D. One allotropic form to another allotropic form

Answer: D

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124. Heat of neutralization of an acid by a base is highest when

A. Both the acid and base are weak

B. Both the acid and base are strong

C. The acid is strong and the base is weak

D. The acid is weak and the base is strong

Answer: B

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125. Conversion of oxygen to ozone represented by the equation $3O_2 \rightarrow 2O_3$ is an endothermic reaction. Enthalpy change ΔH accompanying the reaction ________ .

A. Is negative

B. Is positive

C. Is zero

D. Depends on temperature

Answer: B

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126. Given that -

$2C(s) + 2O_2(g) \rightarrow 2CO_2(g) \Delta H = -787 KJ$

$H_2(g) + 1/2 O_2(g) \rightarrow H_2O(l) \Delta = -286 KJ$

$C_2H_2(g) + \frac{5}{2} O_2(g) \rightarrow H_2O(l) \Delta H = -1310 KJ$

Heat of formation of acetylene is :-

A. -1802 kJ

B. $+1802$ kJ

C. -800 kJ

D. $+237$ kJ

Answer: D

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127. Values of heats of formation for SiO_2 and MgO are -48.4 and -34.7kJ respectively. The heat of the reaction $2Mg + SiO_2 \rightarrow 2MgO + Si$ is

A. 21.16 kJ

B. -21.0kJ

C. -13.62 kJ

D. 13.6 kJ

Answer: B

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128. An exothermic reaction is one in which the reacting substances :

A. Have more energy than the products

B. Have less energy than the products

C. Are at a higher temperature than the product

D. None of the above

Answer: A

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129. The heat of formation is the change in enthalpy accompanying the formation of a substance from its elements at 298 K and 1 atm pressure. Since the enthalpies of elements are taken to be zero, the heat of formation (ΔH) of compounds

A. Is always negative

B. Is always positive

C. May be negative or positive

D. Is zero

Answer: C

View Text Solution

130. When 50cm^3 of a strong acid is added to of an alkali, the temperature rises by 5°C. If 250cm^3 of each liquid are mixed, the temperature rise would be

A. 5°C

B. 10°C

C. 25°C

D. 20°C

Answer: A

Watch Video Solution

131. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$,

$\Delta H \quad \text{at} \quad 298\text{K} = -285.8\text{kJ}$

The molar enthalpy of vaporization of water at 1 atm and $25^\circ C$ is 44 kJ.

The standard enthalpy of formation of 1 mole of water vapour at $25^\circ C$ is

A. -241.8 kJ

B. 241.8 kJ

C. 329.8 kJ

D. -329.8 kJ

Answer: A

Watch Video Solution

132. If, $H_2(g) + Cl_2(g) \rightarrow 2HCl(g), \Delta H^\circ = -$ 44 Kcal

$2Na(s) + 2HCl(g) \rightarrow 2NaCl(s) + H_2(g), \Delta H = -152$ Kcal Then, $Na(s) + 0.5Cl_2(g) \rightarrow NaCl(s), \Delta H^\circ = ?$

A. -108kcal

B. -196kcal

C. -98kcal

D. 54 kcal

Answer: C

Watch Video Solution

133. In order to decompose 9 grams of water 142.5 KJ heat is required. Hence the enthalpy of formation of water is

A. -142.5kJ

B. $+142.5\text{kJ}$

C. -285kJ

D. $+285\text{kJ}$

Answer: C

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134. Compounds with high heat of formation are less stable because

A. High temperature is required to synthesise them

B. Molecules of such compounds are distorted

C. It is difficult to synthesis them

D. Energy rich state leads to instability

Answer: D

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135. The enthalpy of combustion of methane at 25°C is 890 kJ. The heat liberated when 3.2 g of methane is burnt in air is

A. 445 kJ

B. 278 kJ

C. -890kJ

D. 178 kJ

Answer: D

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136. The enthalpy of the reaction

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$ is ΔH_1 and that of $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ is ΔH_2. Then

A. $\Delta H_1 < \Delta H_2$

B. $\Delta H_1 + \Delta H_2 = 0$

C. $\Delta H_1 > \Delta H_2$

D. $\Delta H_1 = \Delta H_2$

Answer: C

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137. The enthalpy of formation of ammonia is $-46.0 \mathrm{KJmol}^{-1}$. The enthalpy change for the reaction $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$ is :

A. 46.0 kJ mol^{-1}

B. $92.0 \mathrm{kJmol}^{-1}$

C. $-23.0 \mathrm{kJmol}^{-1}$

D. $-92.0 \mathrm{kJmol}^{-1}$

Answer: B

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138. 8 gm of CH_4 is completely burnt in air. The number of moles of water produced are

A. 0.5

B. 1

C. 2

D. 18

Answer: B

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139. If $(I)\ C + O_2 \rightarrow CO_2, Q_1\ (II)\ C + \frac{1}{2}O_2 \rightarrow CO, Q_2\ (III)\ CO + \frac{1}{2}O_2 \rightarrow CO_2, Q_3$ The heats of reaction Q_1 and Q_2 are $-12, -10$ respectively. Then $Q_3 =$

A. -2

B. 2

C. -22

D. -16

Answer: C

View Text Solution

140. Given:

i. $2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s), \Delta H^{\Theta} = -193.4kJ$

ii. $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s), \Delta H^{\Theta} = -140.2kJ$

What is ΔH^{Θ} of the reaction?

$3Mg + Fe_2O_3 \rightarrow 3MgO + 2Fe$

A. $-1802kJ$

B. $+1802kJ$

C. $-800kJ$

D. $-228kJ$

Answer: D

Watch Video Solution

141. The standard heats of formation of CH_4, H_2O and CH_3OH are $-76, -242$ and -266 kJ/mole respectively. The enthalpy $CH_3OH_{(l)} + H_{2(g)} \rightarrow CH_{4(g)} + H_2O_{(l)}$

A. $-4\text{kJ}/\text{mole}$

B. $-556\text{kJ}/\text{mole}$

C. $-318\text{kJ}/\text{mole}$

D. $-52\text{kJ}/\text{mole}$

Answer: D

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142. During the melting of solid, which of the following is true

A. $\Delta S = -\text{ve}$

B. $\Delta H = +\text{ve}$

C. $\Delta S = 0$

D. $\Delta H = -\text{ve}$

Answer: B

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143. The energy released on combustion of 1 mole of $C_{(s)}$ with gaseous oxygen is

A. $\Delta H^{\circ}_{\text{combustion}}$

B. $\Delta H^{\circ}_{\text{formation}} \text{ of } CO_2$

C. Both are true

D. None is true

Answer: B

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144. For an exothermic reaction, which is true

A. $\Delta S_{\text{sys}} > 0$

B. $\Delta S_{\text{surr}} > 0$

C. $\Delta S_{\text{total}} > 0$

D. None of these

Answer: B

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145. The enthalpy of neutralization of oxalic acid by strong acid is $-25.4 \text{kcalmol}^{-1}$. The enthalpy of neutralization of strong acid and strong base is $-13.7 \text{kcalequil}^{-1}$. The enthalpy of dissociation of

$H_2C_2O_4 \Leftrightarrow 2H^+ + C_2O_4^{2-}$ is

A. 1.0 kcal mol^{-1}

B. 2.0 kcal mol^{-1}

C. 18.55 kcal mol^{-1}

D. 11.7 kcal mol^{-1}

Answer: B

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146. Which of these species has a standard enthalpy of formation equal to zero

A. $F_2(g)$

B. F(g)

C. HF(aq)

D. F^-(aq)

Answer: A

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147. How many grams of ice at $0^\circ C$ can be melted by the addition of 500 J of heat ? (The molar heat of fusion for ice is 6.02Kamal^{-1})

A. 0.0831 g

B. 1.50 g

C. 3.01 g

D. 12.0 g

Answer: A

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148. Heat of neutralization of strong acid and weak base is

A. 57.1 kJ mol^{-1}

B. 13.7 kJ mol^{-1}

C. Less than 13.7 kcal mol^{-1}

D. More than 13.7 kcal mol^{-1}

Answer: C

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149. The heat of formation of $PCl_5(s)$ from the following data will be :

$2P(s) + 3Cl_2(g) \rightarrow 2PCl_3(l), \Delta H = -151.8$ Kcal and

$PCl_3(l) + Cl_2(g) \rightarrow PCl_5(s), \Delta H = -32.8$ Kcal

A. -108.7 kcal

B. $+108.7$ kcal

C. -184.6 kcal

D. $+184.6$ kcal

Answer: A

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150. Heat of nrutralization of the acid-base reaction is 57.32 KJ for :

A. $HNO_3 + LiOH$

B. HCOOH+KOH

C. $HCl + NH_4OH$

D. $CH_3COOH + NaOH$

Answer: A

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151. On combustion carbon forms two oxides CO and CO_2, heat of formation of CO_2 is -94.3kcal and that of CO is -26. kcal. Heat of combustion of carbon is:

A. 26.0 kcal

B. -94.3 kcal

C. 68.3 kcal

D. -120.3 kcal

Answer: B

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152. Enthalpy of a compound is equal to its :- (When it is formed from constituent particles)

A. Heat of combustion

B. Heat of formation

C. Heat of reaction

D. Heat of solution

Answer: B

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153. Which is the best definition of "heat of neutralization"

A. The heat set free when one gram molecule of a base is neutralized by one gram molecule of an acid in dilute solution at a stated temperature

B. The heat absorbed when one gram molecule of an acid is neutralized by one gram molecule of a base in dilute solution at a stated temperature

C. The heat set free or absorbed when one gram atom of an acid is neutralized by one gram atom of a base at a stated temperature

D. The heat set free when one gram equivalent of an acid is neutralized by one gram equivalent of a base in dilute solution at a stated temperature

Answer: D

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154. Which of the following is combustion reactions ?

A. $C + O_2 \rightarrow CO_2$

B. $CH_4 + O_2 \rightarrow CO_2 + H_2O$

C. $Mg + O_2 \rightarrow MgO$

D. All of these

Answer: B

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155. What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene?

A. 9.6 kg

B. 96.0 kg

C. 6.4 kg

D. 2.8 kg

Answer: A

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156. For $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ at $977^\circ C, \Delta H = 174$ KJ/mol , then ΔE is :-

A. 180 kJ

B. 186.4 kJ

C. 165.6 kJ

D. 160 kJ

Answer: C

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157. When 5 litres of a gas mixture of methane and propane is perfectly combused at $0^\circ C$ and 1 atmosphere, 16 litres of oxygen at the same temperature and pressure is consumed. The amount of heat released from this combustion in kJ

$[\Delta H_{comb.}(CH_4) = 890 \text{ kJ mol}^{-1}, \Delta H_{comb}(C_3H_8) = 2220 \text{ kJ mol}^{-1}]$ is

A. 38

B. 317

C. 477

D. 32

Answer: B

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158. Given :

(i) $C(\text{graphite}) + O_2(g) \rightarrow CO(g), \Delta_r H^\circ = x\text{kJmol}^{-1}$

(ii) $C(\text{graphite}) + \frac{1}{2}O_2(g) \rightarrow CO_2(g), \Delta_r H^\circ = y\text{kJmol}^{-1}$

(iii) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g), \Delta_r H = z\text{kJmol}^{-1}$

Based on the above thermochemical equations, find out which one of the following algebraic relationships is correct ?

A. z=x+y

B. x=y+z

C. y=2z-x

D. x=y-z

Answer: D

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159. What would be the heat released when an aqueous solution containing 0.5mol if HNO_3 is mixed with 0.3 mol of OH^{-1} (enthalpy of neutralisation is -57.1kJ)

A. 28.5 kJ

B. 17.1 kJ

C. 45.7 kJ

D. 1.7 kJ

Answer: B

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160. Which of the following statement is correct

A. ΔH is positive for exothermic reaction

B. ΔH is negative for endothermic reaction

C. The heat of neutralization of strong acid and strong base is always the same

D. The enthalpy of fusion is negative

Answer: C

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161. Correct relationship between heat of fusion (ΔH_{fus}), heat of vaporization (ΔH_{vap}) and heat of sublimation (ΔH_{sub}) is

A. $\Delta H_{fus} = \Delta H_{vap} + \Delta H_{sub}$

B. $\Delta H_{vap} = \Delta H_{fus} + \Delta H_{sub}$

C. $\Delta H_{sub} = \Delta H_{vap} + \Delta H_{fus}$

D. $\Delta H_{sub} = \Delta H_{vap} - \Delta H_{fus}$

Answer: C

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162. Enthalpy change for reaction

$1/2H_2(g) + 1/2Cl_2(g) \rightarrow HCl(g)$ is called :-

A. Enthalpy of combination

B. Enthalpy of reaction

C. Enthalpy of formation

D. Enthalpy of fusion

Answer: C

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163. The enthalpy of neutralization is about 57.3 kJ for the pair

A. HCl and NH_4OH

B. NH_4OH and HNO_3

C. HCl and NaOH

D. CH_3COOH and $NaOH$

Answer: C

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164. Heat of combustion of CH_4, C_2H_6, C_2H_4 and C_2H_2 gases are -212.8, -212.8, -373.0, -337.0 and -310.5 Kcal respectively at the same temperature. The best fuel among these gases is :

A. CH_4

B. C_2H_6

C. C_2H_4

D. C_2H_2

Answer: A

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165. Heat of formation of $CO_2(g), H_2O(l)$ and $CH_4(g)$ are $-94, -68.4$ and -17.9 kCal mol^{-1} respectively, the heat of combustion of $CH_4(g)$ is :-

A. -212.9 kcal

B. -136.8 kcal

C. -304.3 kcal

D. -105.2 kcal

Answer: A

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166. The heat change ΔH for the reaction

$2CO + O_2 \rightarrow 2CO_2, \Delta H = -135$ kcal is called _____ .

A. Heat of formation

B. Heat of reaction

C. Heat of combustion

D. Heat of solution

Answer: B

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167. The heat of formation of $H_2O(l)$ is -68.0 kcal, the heat of formation of $H_2O(g)$ can logically be

A. -68.0 kcal

B. -67.4 kcal

C. 80.0 kcal

D. -58.3 kcal

Answer: D

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168. The heat of combustion of carbon is -94 kcal at 1 atm pressure. The intrinsic energy of CO_2 is

A. $+94$ kcal

B. -94 kcal

C. $+47$ kcal

D. -47 kcal

Answer: B

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169. The heat of combustion of benzene determined in a bomb calorimeter is - 870 kcal mol^{-1} at $25^{\circ}\mathrm{C}$. The value of ΔE for the reaction is

A. -1740 kcal

B. -870 kcal

C. -872 kcal

D. -874 kcal

Answer: B

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170. The standard heats of formation in Kcal mol^{-1} of $NO_2(g)$ and $N_2O_4(g)$ are 8.0 and 2.0 respectively. The heat of dimerization of NO_2 in Kcal is. Given : $2NO_2(g) \Leftrightarrow N_2O_4(g)$

A. 10

B. -6.0

C. -12.0

D. -14.0

Answer: D

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171. Calculate the heat of combustion of benzene form the following data:

a. $6C(s) + 3H_2(g) \rightarrow C_6H_6(l), \Delta H = 49.0 kJ$

b. $H_2(g) + 1/2O_2(g) \rightarrow H_2O(l), \Delta H = -285.8 kJ$

c. $C(s) + O_2(g) \rightarrow CO_2(g), \Delta H = -389.3 kJ$

A. $+3172.8$ kJ

B. -1549.2 kJ

C. -3172.8 kJ

D. -3264.6 kJ

Answer: D

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172. Assertion:The enthalpies of neutralised of strong acids and strong bases are always same.

Reason:Neutralisation is heat of formation of water.

A. If the assertion and reason are true and the reason is the correct explanation of the assertion

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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173. Assertion (A): The heat of neutralisation of perchloric acid, $HCIO_4$, with $NaOH$ is same as that of HCI with $NaOH$.

Reason (R) : Both HCI and $HCIO_4$ are strong acids.

A. If the assertion and reason are true and the reason is the correct explanation of the assertion

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: A

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174. The bond dissociation energies of X_2, Y_2 and XY are in the ratio of $1:0.5:1$. ΔH for the formation of XY is -200kJmol^{-1}.The bond dissociation energy of X_2will be

A. 200 kJ mol^{-1}

B. 100 kJ mol^{-1}

C. 800 kJ mol^{-1}

D. 400 kJ mol^{-1}

Answer: C

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ORDINARY THINKING (Objective Questions) Bond energy

1. If the end energies of H-H, Br-Br and H-Br are 433, 192 and 364 kJ mol^{-1} respectively, then ΔH° for the reaction, $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$ is

A. $+261$ kJ

B. -103 kJ

C. -261 kJ

D. $+103$ kJ

Answer: B

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2. Given the bond energies of $H-H$ and $Cl-Cl$ are $430 kJmol^{-1}$ and $240 kJmol^{-1}$, respectively, and $\Delta_f H^\circ$ for HCl is $-90 kJmol^{-1}$. Bond enthalpy of HCl is

A. 290 kJ mol^{-1}

B. 380 kJ mol^{-1}

C. 425 kJ mol^{-1}

D. 245 kJ mol^{-1}

Answer: C

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3. Bond dissociation enthalpy of H_2, Cl_2 and HCl are $434, 242$ and $431 kJ mol^{-1}$ respectively. Enthalpy of formation of HCl is :

A. $-91 kJ mol^{-1}$

B. 245 kJ mol^{-1}

C. 93 kJ mol^{-1}

D. -245 kJ mol^{-1}

Answer: A

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4. From the following bond energies

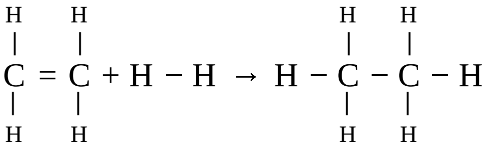
$H - H$ bond energy $431.37 kJ mol^{-1}$

$C = C$ bond energy $606.10 kJ mol^{-1}$

$C - C$ bond energy $336.49 kJ mol^{-1}$

$C - H$ bond energy $410.5 kJ mol^{-1}$

Enthalpy for the reaction



$$\mathrm{H_2C=CH_2 + H-H \rightarrow H_3C-CH_3}$$

will be

A. 1523.6 kJ mol^{-1}

B. $-243.6\mathrm{kJmol}^{-1}$

C. $-120.0\mathrm{kJmol}^{-1}$

D. 553.0 kJ mol^{-1}

Answer: C

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5. Energy required to dissociate $4g$ of gaseous hydrogen into free gaseous atoms is $208\mathrm{Kcal}$ at $25^{\circ}\mathrm{C}$

The bond energy of $\mathrm{H}-\mathrm{H}$ bond will be

A. 104 kcal

B. 10.4 kcal

C. 1040 kcal

D. 104 cal

Answer: A

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6. Which of the following bonds has the highest bond energy?

A. S=O

B. $C \equiv C$

C. $C \equiv N$

D. $N \equiv N$

Answer: b

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7. Given that $\Delta h_f(H) = 218 kJ / mol$. Express the $H - H$ bond energy in $Kcal / mol$

A. 52.15

B. 911

C. 104

D. 52153

Answer: C

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8. Given that, $C(g) + 4H(g) \rightarrow CH_4(g), \Delta H = -166 kJ$. The bond energy C-H will be

A. 208 kJ/mole

B. -41.6 kJ/mole

C. 832 kJ/mole

D. None of these

Answer: B

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9. The first ionization energy for Li is 5.4 eV and electron affinity of Cl is 3.61eV. The ΔH (in kJ/mol) for the reaction $Li(g) + Cl(g) \rightarrow Li^{+} + Cl^{-}$ is (if resulting ions do not combine with each other) (1eV=$1.6 \times 10^{-19}J$)

A. 70

B. 100

C. 170

D. 270

Answer: C

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10. The heat of atomisation of $PH_{3(g)}$ is $228 kcal mol^{-1}$ and that of P_2H_4 is $355 kcal mol^{-1}$. Calculate the average bond energy of $P - P$ bond.

A. 102 k cal mol^{-1}

B. 51 k cal mol^{-1}

C. 26 k cal mol^{-1}

D. 204 k cal mol^{-1}

Answer: B

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11. If the bond dissociation energies of XY, X_2 and Y_2(all diatomic molecules) are in the ratio $1:1:0.5$ and $\Delta_f H$ of XY is $-200 kJ mol^{-1}$. The bond dissociation energy of X_2 will be :

A. 100 kJ mol^{-1}

B. 800 kJ mol^{-1}

C. 300 kJ mol^{-1}

D. 400 kJ mol^{-1}

Answer: B

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12. The standard enthalpy of formation of NH_3 is -46.0KJmol^{-1} . If the enthalpy of formation of H_2 from its atoms is -436KJmol^{-1} and that of N_2 is -712KJmol^{-1} , the average bond enthalpy of $N-H$ bond in NH_3 is

A. -1102kJmol^{-1}

B. -964kJmol^{-1}

C. $+352\text{kJmol}^{-1}$

D. $+1056\text{kJmol}^{-1}$

Answer: C

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13. For the reaction:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g), \Delta H = -571 \text{kJ}$

bond enegry of $(H - H) = 435 \text{kJ}$ and of $(O = O) = 498 \text{kJ}$. Then, calculate the average bond enegry of $(O - H)$ bond using the above data.

A. 484

B. -484

C. 271

D. -271

Answer: A

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14. Given : $C_2H_{6(g)} \rightarrow 2C_{(g)} + 6H_{(g)}, \Delta H = 712 \text{kcal}$. The C - C bond energy is 112kcal, what is the C-H bond energy

A. 88 kcal

B. 12 kcal

C. 50 kcal

D. 600 kcal

Answer: D

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15. If enthalpies of methane and ethane are respectively 320 and 360 calories then the bond energy of C - C bond is

A. 80 calories

B. 40 calories

C. 60 calories

D. 120 calories

Answer: D

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ORDINARY THINKING (Objective Questions) Free energy and Work function

1. When enthalpy and entropy change for a chemical reaction are -2.5×10^3 cals and 7.4 cals $\deg^{-1}$ respectively. Predict that reaction at 298 K is

A. Spontaneous

B. Reversible

C. Irreversible

D. Non-spontaneous

Answer: A

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2. The densities of graphite and diamond at $298K$ are 2.25 and $3.31gcm^{-3}$, respectively. If the standard free energy difference (ΔG^0) is equal to $1895Jmol^{-1}$, the pressure at which graphite will be transformed into diamond at $298K$ is

A. $9.92 \times 10^5 Pa$

B. $9.92 \times 10^8 Pa$

C. $9.92 \times 10^7 Pa$

D. $9.92 \times 10^6 Pa$

Answer: B

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3. Standard enthalpy and standard entropy changes for the oxidation of ammonia at $298K$ are $-382.64kJmol^{-1}$ and $-145.6jK^{-1}mol^{-1}$ respectively. Standard Gibbs energy change for the same reaction at $298K$ is

A. $-439.3 \text{kJ mol}^{-1}$

B. $-523.2 \text{kJ mol}^{-1}$

C. $-221.1 \text{kJ mol}^{-1}$

D. $-339.3 \text{kJ mol}^{-1}$

Answer: D

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4. Identify the correct statement for change of Gibbs energy for a system $(\Delta G_{\text{system}})$ at constant temperature and pressure.

A. If $\Delta G_{\text{system}} = 0$, the system is still moving in a particular

B. If $\Delta G_{\text{system}} < 0$, the process is not spontaneous

C. If $\Delta G_{\text{system}} > 0$, the process is spontaneous

D. If $\Delta G_{\text{system}} = 0$, the system has attained equilibrium

Answer: D

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5. For vaporization of water at 1 atmospheric pressure the values of ΔH and ΔS are 40.63KJmol^{-1} and $108 \text{JK}^{-1} \text{mol}^{-1}$, respectively. The temperature when Gibbs energy change (ΔG) for this transformation will be zero is

A. 273.4 K

B. 393.4 K

C. 373.4 K

D. 293.4 K

Answer: C

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6. In which of the following reactions,standard reaction entropy change $(\Delta S^{\circ})$is positive and standard Gibb,s energy change(ΔG°)decreases sharply with increasing temperature?

A. $C\quad \text{graphite} + \frac{1}{2}O_2(g) \rightarrow CO(g)$

B. $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

C. $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$

D. $\frac{1}{2}C\quad \text{graphite} + \frac{1}{2}O_2(g) \rightarrow \frac{1}{2}CO_2(g)$

Answer: A

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7. Standard enthalpy of vaporisation$\Delta V_{vap}.H^{\Theta}$ for water at $100^\circ C$is $40.66 kJ mol^{-1}$.The internal energy of Vaporization of water at $100^\circ C(\text{in kJ mol}^{-1})$is

A. $+37.56$

B. -43.76

C. $+43.76$

D. $+40.66$

Answer: A

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8. Using the Gibbs energy change, $\Delta G^\circ = +63.3\text{kJ}$, for the following reaction,

$Ag_2CO_3 \Leftrightarrow 2Ag^+(aq) + CO_3^{2-}$

the K_{sp} of $Ag_2CO_3(s)$ in water at $25^\circ C$ is

$(R = 8.314 JK^{-1} mol^{-1})$

A. 2.9×10^{-3}

B. 7.9×10^{-2}

C. 3.2×10^{-26}

D. 8.0×10^{-12}

Answer: D

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9. For the reaction:

$X_2O_4(l) \rightarrow 2XO_2(g)$

$\Delta U = 2.1 \text{kcal}, \Delta S = 20 \text{calK}^{-1} \text{at} 300 \text{K}$

Hence ΔG is

A. 9.3 kcal

B. -9.3 kcal

C. 2.7 kcal

D. -2.7 kcal

Answer: D

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10. Consider the following liquid-vapour equilibrium.

$\text{Liquid} \Leftrightarrow \text{Vapour}$

Which of the following relations is correct?

A. $\frac{d \ln G}{dT^2} = \frac{\Delta H_v}{RT^2}$

B. $\frac{d \ln P}{dT} = \frac{-\Delta H_v}{RT}$

C. $\frac{d \ln P}{dT^2} = \frac{-\Delta H_v}{T}$

D. $\frac{d \ln P}{dT} = \frac{\Delta H_v}{RT^2}$

Answer: D

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11. Which one of the following characteristics is associated with adsorption ?

A. ΔG is negative but ΔH and ΔS are positive

B. ΔG, ΔH and ΔS all are negative

C. ΔG and ΔH are negative but ΔS is positive

D. ΔG and ΔS are negative but ΔH is positive

Answer: B

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12. The correct thermodynamic conditions for the spontaneous reaction at all temperature is

A. $\Delta H < 0$ and $\Delta S = 0$

B. $\Delta H > 0$ and $\Delta S < 0$

C. $\Delta H < 0$ and $\Delta S > 0$

D. $\Delta H < 0$ and $\Delta S < 0$

Answer: C

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13. The occurrence of a reaction of impossible if

A. ΔH is $+$ ve, ΔS is also $+$ ve but $\Delta H < T\Delta S$

B. ΔH is - ve , ΔS is also - ve but $\Delta H > T\Delta S$

C. ΔH is - ve , ΔS is $+$ ve

D. ΔH is + ve , ΔS is $-$ ve

Answer: D

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14. Equilibrium constant of a reaction is related to

A. Standard free energy change ΔG°

B. Free energy change ΔG

C. Temperature T

D. None

Answer: A::C

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15. The standard enthalpy or the decomposition of $N_2O_5$to NO_2 is 58.04 kJ and standard entropy of this reaction is 176.7 J/K. The standard free energy change for this reaction at 25° C is___________.

A. 539 kJ

B. -539kJ

C. -5.39kJ

D. 5.39kJ

Answer: D

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16. For the equilibrium $H_2O(l) \Leftrightarrow H_2O(g)$ at 1 atm and 298 K

A. Standard free energy change is equal to zero $(\Delta G^\circ = 0)$

B. Free energy change is less than zero $(\Delta G < 0)$

C. Standard free energy change is less than zero $(\Delta G^\circ < 0)$

D. Standard free energy change is greater than zero $(\Delta G^{\circ} > 0)$

Answer: C

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17. For a chemical reaction, ΔG will always be negative if,

A. ΔH and $T\Delta S$ both are positive

B. ΔH and $T\Delta S$ both are negative

C. ΔH is negative and $T\Delta S$ is positive

D. ΔH is positive and $T\Delta S$ is negative

Answer: B

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18. For a spontaneous chemical process, the free energy change is

A. Positive

B. Negative

C. Zero

D. Can be positive or negative

Answer: B

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19. For a reaction at 25°C, enthalpy and entropy change are $-11.7\times10^{3}\text{J}\quad\text{mol}^{-1}$ and $-105\text{J}\quad\text{mol}^{-1}\text{K}^{-1}$ respectively. What is the Gibbs free energy?

A. 15.05 kJ

B. 19.59 kJ

C. 2.55 Kj

D. 22.55 kJ

Answer: B

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20. For the percipitation reaction of $\mathrm{Ag}^{\oplus}$ ions with NaCI, which of the following statements is true?

A. $\Delta\mathrm{H}$ for the reaction is zero

B. $\Delta\mathrm{G}$ for the reaction is zero

C. $\Delta\mathrm{G}$ for the reaction is negative

D. $[\Delta\mathrm{G}] = [\Delta\mathrm{H}]$

Answer: C

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21. The relation between $\Delta\mathrm{E}$ and $\Delta\mathrm{H}$ is

A. $\Delta H = \Delta G - T\Delta S$

B. $\Delta G = \Delta H + P\Delta V$

C. $T\Delta S - \Delta G = \Delta H$

D. $\Delta H = T\Delta S + \Delta S$

Answer: B

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22. The free energy change for the following reactions are given below

$C_2H_2(g) + \frac{5}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l), \Delta G^\circ = -1234kJ$

$C(s) + O_2(g) \rightarrow CO_2(g), \Delta G^\circ = -394kJ$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta G^\circ = -237kJ$

What is the standard free energy change for the reaction

$H_2(g) + 2C(s) \rightarrow C_2H_2(g)$?

A. $-209kJ$

B. $-2259kJ$

C. $+2259\text{kJ}$

D. 209 kJ

Answer: D

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23. The correct relation between equilibrium constant (K), standard free energy (ΔG°) and temperature (T) is

A. $\Delta G^\circ = RT \ln K$

B. $K = e^{-\Delta G^\circ/2.303RT}$

C. $\Delta G^\circ = -RT \log_{10} K$

D. $K = 10^{-\Delta G^\circ/2.303RT}$

Answer: D

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24. Consider the following reaction at $1000\,^{\circ}\mathrm{C}$

$(A)\mathrm{Zn}_{(s)} + \frac{1}{2}\mathrm{O}_{2(s)} + \mathrm{ZnO}_s, \Delta G^0 = -360\mathrm{kJmole}^{-1}$

(B) $(B)\mathrm{Cn}_{(s)} + \frac{1}{2}\mathrm{O}_{2(g)} \rightarrow \mathrm{CO}_s, \Delta G^0 = -460\mathrm{kJmole}^{-1}$

choose the correct statement at $1000^0\mathrm{C}$

A. Zinc can be oxidized by carbon monoxide

B. Zinc oxide can be reduced by graphite

C. Both statements (A) and (B) are true

D. Both statements (A) and (B) are false

Answer: B

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25. At the sublimation temperature, for the process $\mathrm{CO}_2(S) \rightarrow \mathrm{CO}_2(g)$

A. $\Delta H, \Delta S$ and ΔG are all positive

B. $\Delta H > 0, \Delta S > 0$ and $\Delta G < 0$

C. $\Delta H < 0, \Delta S > 0 \text{ and } \Delta G < 0$

D. $\Delta H > 0, \Delta S > 0 \text{ and } \Delta G = 0$

Answer: D

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26. A chemical reaction is spontancous at $298K$ but non spontaneous at $350K$. Which one of the following is true for the reaction ?

A. $\begin{array}{ccc} \Delta G & \Delta H & \Delta S \\ - & - & + \end{array}$

B. $\begin{array}{ccc} \Delta G & \Delta H & \Delta S \\ + & + & + \end{array}$

C. $\begin{array}{ccc} \Delta G & \Delta H & \Delta S \\ - & + & - \end{array}$

D. $\begin{array}{ccc} \Delta G & \Delta H & \Delta S \\ - & - & - \end{array}$

Answer: D

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27. The free energy change for a reversible reaction at equilibrium is

A. Large positive

B. Small negative

C. Small positive

D. 0

Answer: D

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28. In which of the following conditions a chemical reaction can not occur

A. ΔH and ΔS increase and $T\Delta S > \Delta H$

B. ΔH and ΔS decrease and $\Delta H > T\Delta S$

C. ΔH increase and ΔS Decreases

D. ΔH decrease and ΔS increase

Answer: C

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29. For the reaction at 298K, $A_{(g)} + B_{(g)} \rightarrow C_{(g)}$

$\Delta E = -5\text{cal}$ and $\Delta S = -10\text{calK}^{-1}$

A. $\Delta G = +2612\text{cal}$

B. $\Delta G = -2612\text{cal}$

C. $\Delta G = +261.2\text{cal}$

D. $\Delta G = 2379\text{cal}$

Answer: D

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30. What is the free energy change (ΔG) when 1.0mole of water at $100^\circ C$ and atm pressure is converted into steam at $100^\circ C$ and 1 atm pressure?

A. 540 cal

B. -9800 cal

C. 9800 cal

D. 0 cal

Answer: D

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31. The standard Gibb's free energy change, ΔG° is related to equilibrium constant, kp as

A. $K_p = -RT \ln \Delta G^\circ$

B. $K_p = \left(\frac{e}{RT}\right)^{\Delta G^\circ}$

C. $K_p = -\frac{\Delta G^\circ}{RT}$

D. $K_p = e^{-\frac{\Delta G^\circ}{RT}}$

Answer: D

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32. The relation $\Delta G = \Delta H - T\Delta S$ was given by

A. Boltzmann

B. Faraday

C. Gibbs-Helmholtz

D. Thomson

Answer: C

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33. In a chemical reaction ΔH is 150 kJ and ΔS is $100 JK^{-1}$ at 300 K then ΔG is :-

A. 200 k J

B. 333 k J

C. 300 k J

D. 120 k J

Answer: D

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34. The dependence of Gibbs free energy on pressure for an isothermal process of an ideal gas is given by

A. $\Delta G_T = nRT \ln. \frac{P_2}{P_1}$

B. $\Delta G_T = nRT \ln. \frac{V_2}{V_1}$

C. $\Delta G_T = nRT \log. \frac{P_1}{P_2}$

D. $\Delta G_T = nRT \log. \frac{V_2}{V_1}$

Answer: A

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35. If ΔG is negative, the reaction will be

A. At equilibrium

B. Not possible

C. Both (a) and (b)

D. Possible

Answer: D

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36. The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K_c is:

A. $\Delta G = RT \ln K_c$

B. $-\Delta G = RT \ln K_c$

C. $\Delta G^{\circ} = RT \ln K_c$

D. $-\Delta G^{\circ} = RT \ln K_c$

Answer: D

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37. In an irreversible process taking place at constant T and P and in which only pressure-volume work is being done, the change in Gibbs free energy (dG) and the change in entropy (dS) satisfy the criteria

A. $(dS)_{V,E} < 0, (dG)_{T,P} < 0$

B. $(dS)_{V,E} > 0, (dG)_{T,P} < 0$

C. $(dS)_{V,E} = 0, (dG)_{T,P} = 0$

D. $(dS)_{V,E} = 0, (dG)_{T,P} > 0$

Answer: B

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38. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is :

$$CH_3OH_{(l)} + \frac{3}{2}O_{2(g)} \rightarrow CO_2((g)) + 2H_2O_{(l)}$$

At $298K$ standard Gibb's energies of formation for $CH_3OH(l)$, $H_2O(l)$ and $CO_2(g)$ are -166.2, -237.2 and $-394.4 kJ mol^{-1}$ respectively. If standard enthalpy of combustion of methanol is $-726 kJ mol^{-1}$, efficiency of the fuel cell will be :

A. 0.8

B. 0.87

C. 0.9

D. 97

Answer: D

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39. For a particular reversible reaction at temperature T, ΔH and ΔS were found to be both +ve. If T_e is the temperature at equilibrium, the reaction would be spontaneous when

A. $T = T_e$

B. $T_e > T$

C. $T > T_e$

D. T_e is 5 time T

Answer: C

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40. A spontaneous change is one in which a system under goes

A. No energy change

B. A lowering of free energy

C. A lowering of entropy

D. An increase in internal energy

Answer: B

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41. The equilibrium constant for the reaction

$A + B \Leftrightarrow C + D$

is 10. ΔG° for the reaction at 300 K is

A. 13.81

B. -1381.8

C. -138.18

D. 1391.6

Answer: B

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42. ΔG° vs$T$ plot in the Ellingham diagram slopes down for the reaction.

A. $Mg + \frac{1}{2}O_2 \rightarrow MgO$

B. $2Ag + \frac{1}{2}O_2 \rightarrow Ag_2O$

C. $C + \frac{1}{2}O_2 \rightarrow CO$

D. $CO + \frac{1}{2}O_2 \rightarrow CO_2$

Answer: c

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43. For reversible reaction : $X_{(g)} + 3Y_{(g)} \Leftrightarrow 2Z_{(g)}, \Delta H = -40$ kJ

Standard entropies of X, Y and Z are 60, 40and 50 J K^{-1},ol^{-1} respectively.

The temperature at which the above reaction is in equilibrium is

A. 400 K

B. 500 K

C. 273 K

D. 373 K

Answer: B

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44. For the reversible reaction :

$$A(s) + B(g) \Leftrightarrow C(g) + D(g) : \Delta G^{\circ} = -350 kj.$$

Which one of the following statements is true

A. The entropy change is negative

B. Equilibrium constant is greater than one

C. The reaction should be instantaneous

D. The reaction is thermodynamically nto feasible

Answer: B

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45. Identify the correct statement from the following in a chemical reaction

A. The entropy always increases

B. The change in entropy along with suitable change in enthalpy decides the fate of a reaction

C. The enthalpy always decreases

D. Both the enthalpy and the entropy remains constant

Answer: B

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46. The standard Gibbs free energy change (ΔG°) at 25° C for the dissociation of $N_2O_4(g)$ to $NO_2(g)$ is (given, equilibrium constant = 0.15, R=8.314 $JK^{-}mol^{-1}$)

A. 1.1 KJ

B. 4.7 KJ

C. 8.1 KJ

D. 38.2 KJ

Answer: B

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47. Which is correct for spontaneity of an electrochemical cell ?

A. $\Delta G = 0, E^{\circ} = 0$

B. $\Delta G = -ve, E^{\circ} = 0$

C. $\Delta G = +ve, E^{\circ} = +ve$

D. $\Delta G = -ve, E^{\circ} = +ve$

Answer: D

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48. The free energy for a reaction having $\Delta H = 31400$ cal, $\Delta S = 32 \text{ cal } K^{-1} \text{mol}^{-1}$ at 1000° C is:

A. -9336 cal

B. -7386 cal

C. -1936 cal

D. $+9336$ cal

Answer: A

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49. For the reaction,

$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$ partial pressure of CO_2 at 1000 K is 0.003 atm. $\Delta G^{\circ} = 27.2$ kcal. Calculate the value of ΔG

A. 12.6 kcal

B. 15.6 kcal

C. 13.4 kcal

D. 14.2 kcal

Answer: B

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50. The free energy of formation of NO is 78kJmol^{-1} at the temperature of an authomobile engine (1000K). What is the equilibrium constant for this reaction at 1000K?

$$\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \Leftrightarrow NO(g)$$

A. 8.4×10^{-5}

B. 7.1×10^{-19}

C. 4.2×10^{-10}

D. 1.7×10^{-19}

Answer: A

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51. Born-Haber cycle is used to determine

A. Crystal energy

B. Electron affinity

C. Lattice energy

D. All of these

Answer: c

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52. The essential condition for the feasibility of a reaction is that ________ .

A. The reaction should be exothermic

B. The entropy of products must be larger than that of reactants

C. The reaction is to be accompanied with free energy decrease

D. The reaction has to possess high activation energy

Answer: C

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53. ΔH and ΔS for a reaction are $+30.558\text{kJmol}^{-1}$ and 0.066kJmol^{-1} at 1 atm pressure. The temperature at which free energy is equal to zero and the nature of the reaction below this temperature are

A. 483 K, spontaneous

B. 443 K, non-spontaneous

C. 443 K, spontaneous

D. 463 K, spontaneous

Answer: D

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54. If $K < 1.0$, what will be the value of ΔG° of the following

A. 1.0

B. Zero

C. Negative

D. Positive

Answer: D

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55. When the value of entropy is greater then the ability for useful work is :

A. Is maximum

B. Is minimum

C. Is medium

D. None of these

Answer: b

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56. Assertion (A): There is no reaction known for which ΔG is positive, yet it is spontaneous.

Reason (R) : For photochemical reaction, ΔG is negative.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If the assertion and reason both are false.

Answer: D

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57. Assertion : Heat absorbed in a reaction at constant temperature and constant volume is -ΔG.

Reason : ΔG should be negative for the reaction to be spontaneous.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion

C. If assertion is true but reason is false

D. If assertion is false but reason is true.

Answer: D

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Critical Thinking (Objective Questions)

1. Following reaction occurring in an automobile $2C_8H_{18}(g) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$. The sign of $\triangle H$, $\triangle S$ and $\triangle G$ would be-

A. $+, -, +$

B. $-, +, -$

C. $-, +, +$

D. $+, +, -$

Answer: B

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2. Which of the following statement is correct for the spontaneous adsorption of a gas?

A. ΔS is positive and, therefore, ΔH should be negative

B. ΔS is positive and, therefore, ΔH should also be highly positive

C. ΔS is negative and, therefore, ΔH should be highly positive

D. ΔS is negative and therefore, ΔH should be highly negative

Answer: D

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3. For a hypothetic reaction $A \rightarrow B$, the activation energies for forward and backward reactions are 19 kJ/mole and 9 kJ/mole respectively. The heat of reaction is

A. 28 kJ

B. 19 kJ

C. 10 kJ

D. 9 kJ

Answer: C

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4. Enthalpy of formation of two compounds x and y are -84kJ and -156kJ respectively. Which of the following statement is CORRECT?

A. x is more stable than y

B. x is less stable than y

C. Both x and y are unstable

D. x and y are endothermic compounds

Answer: B

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5. Match List -I (Equations) with List -II (Type of processes) and select the correct option.

	List -I Equation		List -II Type of processes
(a)	$K_p > Q$	(i)	Non spontaneous
(b)	$\Delta G^\circ < RT \ln Q$	(ii)	Equilibrium
(c)	$Kp = Q$	(iii)	Spontaneous and endothermic
(d)	$T > \frac{\Delta H}{\Delta S}$	(iv)	Spontaneous

A. 1(i), 2(ii), 3(iii), 4(iv)

B. 1(iii), 2(iv), 3(ii), 4(i)

C. 1(iv), 2(i), 3(ii), 4(iii)

D. 1(ii), 2(i), 3(iv), 4(iii)

Answer: C

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6. Enthalpy change for the reaction

$2H(2)(g) \rightarrow 4H(g)$ is $-869.6kJ$

The dissociation energy of $H - - H$bond is:

A. $+217.4$ kJ

B. -434.8 kJ

C. -869.6 kJ

D. $+434.8$ kJ

Answer: D

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7. Equal volumes of two monoatomic gases,A, B, at the same temperature and pressure are mixed.The ratio of specific heats$(C_p/C_v)$of the mixture will be

A. 0.83

B. 1.5

C. 3.3

D. 1.67

Answer: D

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8. The heat of a reaction is measured in a bomb calorimeter . This heat is equal to which thermodynamic quantity?

A. ΔG

B. ΔH

C. ΔE

D. $P \Delta V$

Answer: C

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9. In thermodynamics, a process is called reversible when

A. Surroundings and system change into each other

B. There is no boundary between system and surroundings

C. The surroundings are always in equilibrium with the system

D. The system changes into the surroundings spontaneously

Answer: A::C

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10. One molee of methanol when burnt in O_2, gives out 723 kJ mol^{-1} of heat. If one mole of O_2 is used, what will be the amount of heat evovled?

A. 723 kJ

B. 924 kJ

C. 482 kJ

D. 241 kJ

Answer: C

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11. The calorific value of fat is

A. Less than that of carbohydrate and protein

B. Less than that of protein but more than carbohydrate

C. Less than that of carbohydrate but more than that of protein

D. More than that of carbohydrate and protein

Answer: D

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12. The enthalpy of neutralization of HCN by NaOH is $-12.13\mathrm{kJmol}^{-1}$. The enthalpy of ionisation of HCN will be

A. 4.519 kJ

B. 54.10 kJ

C. 451.9 kJ

D. 45.19 kJ

Answer: D

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13. Heat of neutralization of strong acid against strong base is constant and is equal to

A. 13.7 kcal

B. 57 kcal

C. 5.7×10^4 J

D. All of the above

Answer: C

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14. The heat liberated when $1.89g$ of benzoic acid is burnt in a bomb calorimeter at $25^\circ C$ increases the temperture of $18.94kg$ of water by $0.632^\circ C$. If the specific heat of water at $25^\circ C$ is $0.998cal/gdeg$, the value of the heat of combustion of benzoic acid is

A. 771.1 kcal

B. 871.2 kcal

C. 881.1 kcal

D. 981.1 kcal

Answer: A

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15. In which of the following entropy decreases

A. Crystallization of sucrose from the solution

B. Rusting of iron

C. Melting of ice

D. Vaporisation of Camphor

Answer: A

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16. In an isobaric process, the ratio of heat supplied to the system (dQ) and work done by the system (dW) for diatomic gas is

A. $1:1$

B. $7:2$

C. $7:5$

D. $5:7$

Answer: B

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17. The equilibrium constant of a reaction at 298 K is 5×10^{-3} and at 1000 K is 2×10^{-5} What is the sign of $\triangle \mathrm{H}$ for the reaction.

A. $\Delta \mathrm{H} = 0$

B. $\Delta \mathrm{H}$ is negative

C. ΔH is positive

D. None of these

Answer: B

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18. Mechanical work is specially important in system that contain

A. Solid-liquid

B. Liquid-liquid

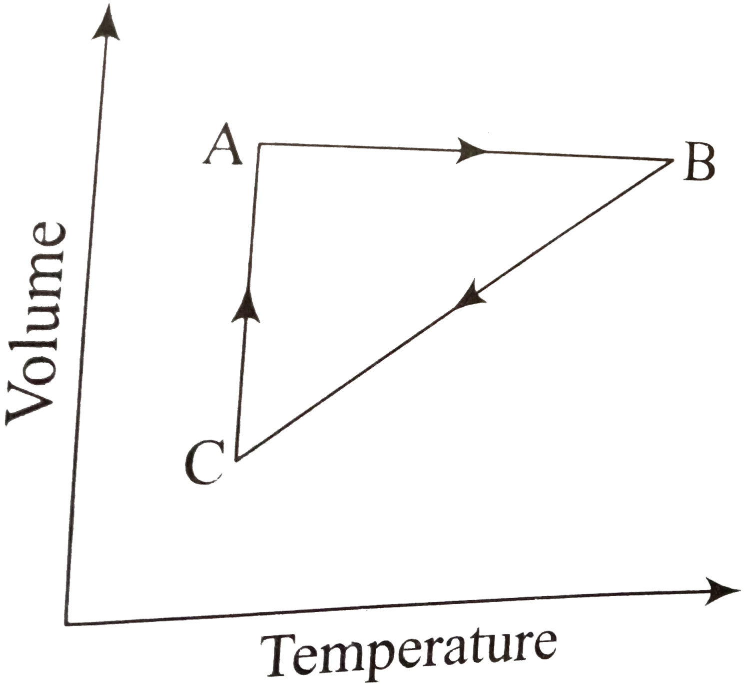
C. Solid-solid

D. Gases

Answer: D

Watch Video Solution

19. Five mole of a gas put through a series of change as shown below graphically in a cyclic process. The processes $A \rightarrow B, B \rightarrow C$ and $C \rightarrow A$, respectively, are



A. Isochoric, Isobaric, Isothermal

B. Isobaric, Isochoric, Isothermal

C. Isothemal, Isobaric, Isochoric

D. Isochoric, Isothermal, Isobaric

Answer: B

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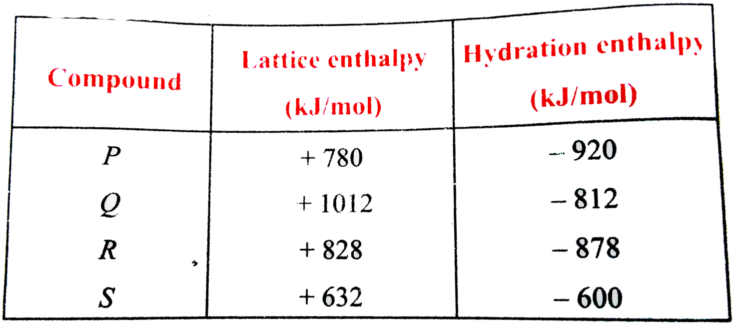
20. The lattice enthalpy and hydration enthalpy of four compounds are given below:



Compound	Lattice enthalpy (kJ/mol)	Hydration enthalpy (kJ/mol)
P	$+780$	-920
Q	$+1012$	-812
R	$+828$	-878
S	$+632$	-600

the pair of compounds which is soluble in water is:

A. P and Q

B. Q and R

C. R and S

D. P and R

Answer: D

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21. Molar heat capacity of aluminium is $25 \text{J K}^{-1} \text{mol}^{-1}$.The heat necessary to raise the temperature of 54 g of aluminium (Atomic mass 27 g mol^{-1}) from 30°C to 50°C is

A. 1.5 kJ

B. 0.5 kJ

C. 1.0 kJ

D. 2.5 kJ

Answer: C

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22. $C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g), \Delta H = -94.05 \text{kcal mol}^{-1}$

$C_{(\text{diamond})} + O_2(g) \rightarrow CO_2(g), \Delta H = -94.50 \text{kcal mol}^{-1}$ therefore

A. $C_{(\text{graphite})} \rightarrow C_{(\text{diamond})}, \Delta H^{\circ}_{298K} = -450\text{calmol}^{-1}$

B. $C_{(\text{diamond})} \rightarrow C_{(\text{graphite})}, \Delta H^{\circ}_{298K} = +450\text{calmol}^{-1}$

C. Graphite is the stabler allotrope

D. Diamond is harder than graphite

Answer: C

View Text Solution

23. The enhtaply change for the reaction of 50ml of ethylene with 50.0 mL if H_2 at 1.5 atm pressure is $\Delta H = -0.31KJ$. What is the ΔE?

A. -0.3024 kJ

B. 0.3024 kJ

C. 2.567 kJ

D. -0.0076 kJ

Answer: A

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24. Given the bond energies $N \equiv N$, H-H and N-H bonds are 945,436 and 391 kJ mole^{-1} respectively, the enthalpy of the following reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ is

A. -93 kJ

B. 102 kJ

C. 90 kJ

D. 105 kJ

Answer: A

View Text Solution

25. The total amount of energy in the universe is fixed, but

A. Disorder is increasing

B. Lightning is increasing

C. Matter is increasing

D. Gravitation is decreasing

Answer: A

Watch Video Solution

26. For a reaction, ΔH= 9.08 kJmol^{-1} and ΔS=35.7 J $K^{-1} \text{mol}^{-1}$ at 298 K. Which of the following is CORRECT for the reaction at 298 K?

A. Reversible and Isothermal

B. Reversible and Exothermic

C. Spontaneous and Endothermic

D. Spontaneous and Exothermic

Answer: C

Watch Video Solution

27. Which of the following is not a correct statement

A. When ΔG is negative, the process is spontaneous

B. When ΔG is zero, the process is in a state of equilibrium

C. When ΔG is positive, the process is non-spontaneous

D. None of these

Answer: D

Watch Video Solution

28. Sodium chloride is soluble in water but not in benzene because

A. $\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in water}}$ and

$\Delta H_{\text{hydration}} > \Delta H_{\text{lattice energy in benzene}}$

B. $\Delta H_{\text{hydration}} > \Delta H_{\text{lattice energy in water}}$ and

$\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in benzene}}$

C. $\Delta H_{\text{hydration}} = \Delta H_{\text{lattice energy in water}}$ and

$\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in benzene}}$

D. $\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in water}} \mathrm{d}$

$\Delta H_{\text{hydration}} = \Delta H_{\text{lattice energy in benzene}}$

Answer: B

Watch Video Solution

29. The change of energy on vaporizing 1.00 kg of liquid water at $0^\circ \mathrm{C}$ and 1 atm is

A. 2367 kJ kg^{-1}

B. $-2367\mathrm{kJkg}^{-1}$

C. $-2367\mathrm{kJmol}^{-1}$

D. $-2367\mathrm{kJg}^{-1}$

Answer: A

View Text Solution

30. A sample of liquid in a thermally insulated container is stirred for 1 hr by a mechanical attachment to a motor in the surroundings, which of the following thermodynamic quantity for the system is zero

A. Work (W)

B. Change in internal energy (ΔE)

C. Change in enthalpy (ΔH)

D. None of these

Answer: D

View Text Solution

31. For conversion C (graphite) $\rightarrow$ C (diamond) the ΔS is

A. Zero

B. Positive

C. Negative

D. Unknown

Answer: C

Watch Video Solution

32. For melting of 3 moles of water at 0°C, the ΔG is ______ .

A. Zero

B. $+\text{ve}$

C. $-\text{ve}$

D. Unpredictable

Answer: A

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33. Which of the following would be expected to have the largest antropy per mole

A. $SO_2Cl_2(s)$

B. $SO_2Cl_2(g)$

C. $SO_2Cl_2(l)$

D. $SO_2(g)$

Answer: D

Watch Video Solution

34. The relation between ΔG and E for a cell is ΔG=-nFE, the cel reaction will be spontaneous if

A. G is negative

B. G is positive

C. E is negative

D. E is positive

Answer: D

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35. Which of the follwing has lowest fusion temperature ?

A. Naphthalene

B. Diamond

C. NaCl

D. Mn

Answer: A

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36. Among the following for spontaneity of chemical reaction there should be

A. Decrease in entropy and increase in free energy

B. Decrease in entropy and free energy both

C. Increase in entropy and decrease in free energy

D. Increase in entropy and free energy both

Answer: C

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37. The heat required to raise the temperature of a body by $1\mathrm{K}$ is called

A. Specific heat

B. Thermal capacity

C. Water equivalent

D. None of these

Answer: B

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38. The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of 10dm^3 to a volume of 100dm^3 at 27°C is

A. 38.3 J $\text{mol}^{-1}\text{K}^{-1}$

B. 35.8 J $\text{mol}^{-1}\text{K}^{-}$

C. 32.3 J $\text{mol}^{-1}\text{K}^{-1}$

D. $42.3\text{J}\,\text{mol}^{-1}\text{K}^{-1}$

Answer: A

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39. The incorrect expression among the following is

A. $\frac{\Delta G_{\text{system}}}{\Delta S_{\text{total}}} = -T$

B. In isothermal process, $W_{\text{reversible}} = -nRT \ln. \frac{V_f}{V_i}$

C. $\ln K = \frac{\Delta H^\circ - T\Delta S^\circ}{RT}$

D. $K = e^{-\Delta G^\circ / RT}$

Answer: C

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40. A thermometer is used to measure

A. High temperature

B. Low temperature

C. Normal temperature

D. ALL temperature

Answer: D

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41. The standard enthalpies of formation of $A(NH_3), B(CO_2), C(HI)$ and $D(SO_2)$ are respectively -46.19,-393.4, +24.94 and -296.9 kJ mol^{-1}. The increasing order of their stability is

A. $B < D < A < C$

B. $C < A < D < B$

C. $D < B < C < A$

D. $A < C < D < B$

Answer: B

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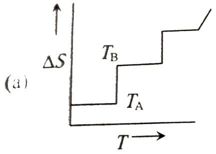
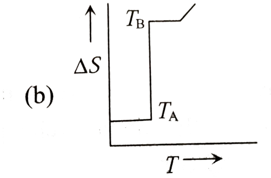
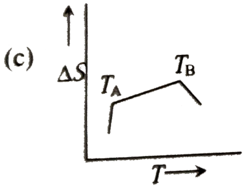
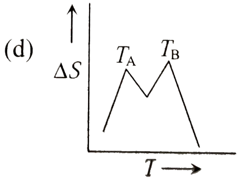
42. If for a given substance, melting point is T_B and freezing point is T_A then correct variation of entropy is by graph between entropy change and temperature is

A. 

B. 

C. 

D. 

Answer: A

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43. When a gas is subjected to adiabatic expansion, it gets cooled due to :

A. Loss of kinetic energy

B. Fall in temperature

C. Decrease in velocity

D. Energy used in doing work

Answer: B

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44. For the reaction

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta H = -285.8 \text{kJmol}^{-1}$

$\Delta S = -0.163 \text{kJmol}^{-1}\text{K}^{-1}$. What is the value of free energy change at 27°C for the reaction

A. -236.9kJmol^{-1}

B. -281.4kJmol^{-1}

C. -334.7kJmol^{-1}

D. $+334.7 \text{kJmol}^{-1}$

Answer: A

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45. For the process

Dry ice $\rightarrow$ $CO_2(g)$

A. ΔH is positive while $\Delta \rho$ is negative

B. Both ΔH and $\Delta \rho$ are negative

C. Both ΔH and $\Delta \rho$ are positive

D. ΔH is negative while $\Delta \rho$ is positive

Answer: C

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46. To calculate the amount of work done in joules during reversible isothermal expansion of an ideal gas, the volume must be expressed in

A. m^3 only

B. dm^3 only

C. cm^3 only

D. Any one of them

Answer: D

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47. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are $-1596KJ$ and $-1134KJ$ respectively. ΔH for the reaction

$2Al + Cr_2O_2 \rightarrow 2Cr + Al_2O_3$ is

A. -2730 kJ

B. -462 kJ

C. -1365 kJ

D. $+2730$ kJ

Answer: B

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48. When 50cm^3 of $0.2\text{N}\,\text{H}_2\text{SO}_4$ is mixed with 50cm^3 of $1\text{N}\,\text{KOH}$, the heat liberated is

A. 11.46 kJ

B. 57.3 kJ

C. 573 kJ

D. 573 J

Answer: D

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49. The amount of heat evolved when $500\text{cm}^3 0.1\text{M}\,\text{HCl}$ is mixed with 200cm^3 of $0.2\text{M}\,\text{NaOH}$ is

A. 2.292 kJ

B. 1.292 kJ

C. 0.292 kJ

D. 3.392 kJ

Answer: A

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50. Which of the following statements is true

A. The total entropy of the universe remains constant

B. The total entropy of the universe is continuously decreasing

C. The total entropy of the universe is continuously decreasing

D. The total energy of the universe remains constant

Answer: D

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51. Which of the following thermodynamic relation is correct?

A. dG=VdP-SdT

B. dE=PdV+TdS

C. dH=VdP+TdS

D. dG=VdP+SdT

Answer: A

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52. ΔG in $Ag_2O \rightarrow 2Ag + 1/2O_2$ at a certain temperature is $-10 \text{kJ} \text{mol}^{-1}$. Pick the correct statement.

A. Ag_2O decomposes to Ag and O_2

B. Ag and O_2 combines to form Ag_2O

C. Reaction is in equilibrium

D. Reaction does not take place

Answer: A

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53. Which of the following salt on dissolution in water absorbs heat

A. NH_4Cl

B. CaO

C. Na_2SO_4

D. Na_2CO_3

Answer: A

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54. A $1.0g$ sample of substance A at $100^\circ C$ is added to $100mL$ of H_2O at $25^\circ C$. Using separate $100mL$ portions of H_2O, the procedure is repeated with substance B and then with substance C. How will the final temperatures of the water compare ?

Substance	Specific heat
A	$0.60 J g^{-1}$^(@)C^(-1)),(B,0.40 J g^(-1) $^\circ C^{-1}$
C	$0.20 J g^{-1}\,^\circ C^{-1}$

A. $T_C > T_B > T_A$

B. $T_B > T_A > T_C$

C. $T_A > T_B > T_C$

D. $T_A = T_B = T_C$

Answer: C

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55. As O_2 (l) is cooled at 1 atm pressure , it freezes to form solid I at 54.5 K. At a lower temperature , solid rearrange to solid II, which has a different crystal that for the phase transition solid to slid II , $\Delta H = -743.1 \text{J mol}^{-1}$ and $\Delta S = -17.0 \text{J K}^{-1} \text{mol}^{-1}$. At what temperature are solids I and II in equilibrium ?

A. 2.06 K

B. 31.5 K

C. 43.7 K

D. 53.4 K

Answer: C

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56. The enthalpy of solution of $NaOH(s)$ in water is $-41.6 \text{kJ}/\text{mole}$ When $NaOH$ is dissolved in water then the temperature of water:

A. Increase

B. Decrease

C. Does not change

D. Fluctuates indefinitely

Answer: A

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57. Consider the reactions :

$C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)}, \Delta H = -X kcal$

$C_{(g)} + 4H_{(g)} \rightarrow CH_{4(g)}, \Delta H - X_1 kcal$

$CH_{4(g)} \rightarrow CH_{3(g)} + H_{(g)}, \Delta H = +Y kcal$

The average bond energy of $C - H$ bond is :

A. y kcal mol^{-1}

B. x_1 kcal mol^{-1}

C. $x/4$ kcal mol^{-1}

D. $x_1/4$ kcal mol^{-1}

Answer: D

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58. Total heat content of a system is

A. Internal energy

B. Entropy

C. Free energy

D. Enthalpy

Answer: D

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59. Heat of reaction at constant volume is measured in the apparatus

A. Bomb calorimeter

B. Calorimeter

C. Pyknometer

D. Pyrometer

Answer: A

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60. Which of the following gas has the highest heat of combustion ?

A. Methane

B. Ethane

C. Ethylene

D. Acetylene

Answer: B

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61. The $H_2O_{(g)}$ molecule dissociates as

(i) $H_2O_{(g)} \rightarrow H_{(g)} + OH_{(g)}, \Delta H = 490 kJ$

(ii) $OH_{(g)} \rightarrow H_{(g)} + O_{(g)}, \Delta H = 424 kJ$

The average bond energy (in kJ) for water is __________ .

A. 490

B. 424

C. 914

D. $914/2$

Answer: D

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62. In case of an ideal gas, Joule Thomson coefficient is -

A. Zero

B. $+ve$

C. $-\text{ve}$

D. Infinite

Answer: A

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63. Decreasing order of calorific value is

A. $C_2H_2 > C_4H_{10} > C_3H_8 > C_2H_4$

B. $C_4H_{10} > C_3H_8 > C_2H_4 > C_2H_2$

C. $C_2H_4 > C_3H_8 > C_4H_{10} > C_2H_2$

D. $C_3H_8 > C_2H_4 > C_4H_{10} > C_2H_2$

Answer: B

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JEE section (Only one correct answer)

1. The standard molar heat of formation of ethane $\mathrm{CO_2}$ and water (l) are respectively -21.1 ,-94.1 and -68.3 kcal .the standard molar heat of combustion of ethane will be

A. -372 kcal

B. 162 kcal

C. -240 kcal

D. 183.5 kcal

Answer: A

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2. Which of the following is an endothermic reaction

A. $2H_2 + O_2 \rightarrow 2H_2O$

B. $N_2 + O_2 \rightarrow 2NO$

C. $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

D. $3O_2 + C_2H_5OH \rightarrow 2CO_2 + 3H_2O$

Answer: B

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3. Calculate the standard heat of formation of carbon disulphide (l). Given that the standard heats of combustion of carbon (s), sulphur (s) and carbon disulphide (l) are -393.3, -293.72 and -1108.76 kJ mol^{-1} respectively.

A. $-128.02 kJ mol^{-1}$

B. $+12.802 kJ mol^{-1}$

C. $+128.02 kJ mol^{-1}$

D. $-12.802 kJ mol^{-1}$

Answer: C

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4. The difference between the heats of reaction at constant pressure and a constant volume for the reaction $2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$ at $25^\circ C$ in kJ is

A. -7.43

B. $+3.72$

C. -3.72

D. $+7.43$

Answer: A

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5. Which of the following equations correctly represents the standard heat of formation(ΔH_f°) of methane?

A. C(diamond)$+2H_2(g) \rightarrow CH_4(g)$

B. $C(\text{graphite}) + 2H_2(g) \rightarrow CH_4(l)$

C. $C(\text{graphite}) + 2H_2(g) \rightarrow CH_4(g)$

D. $C(\text{graphite}) + 4H \rightarrow CH_4(g)$

Answer: C

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6. For an endothermic reaction, where ΔH represents the enthalpy of reaction in $kJ mol^{-1}$, the minimum value for the energy of activation will be

A. Less than ΔH

B. Zero

C. More than ΔH

D. Equal to ΔH

Answer: C

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7. The bond dissociation energy needed to form the benzyl radical from toluence is.......... Than the formation of the methyl radical from methane.

A. Less

B. Much

C. Equal

D. None of the above

Answer: B

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8. For which change $\Delta H \neq \Delta E$:-

A. $H_2 + I_2 \rightarrow 2HI$

B. $HCl + NaOH \rightarrow NaCl$

C. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

D. $N_2 + 3H_2 \rightarrow 2NH_3$

Answer: D

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9. Standard molar enthalpy of formation of CO_2 is equal to :

A. Zero

B. The standard molar enthalpy of combustion of gaseous carbon

C. The sum of standard molar enthalpies of formation of CO and O_2

D. The standard molar enthalpy of combustion of carbon (graphite)

Answer: D

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10. Molar heat capacity of water in equilibrium with ice at constant pressure is

A. Zero

B. Infinite (∞)

C. 40.45 kJ $K^{-1}mol^{-1}$

D. $75.48JK^{-1}$

Answer: B

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11. For the reaction

$A(g) + 2B(g) \rightarrow 2C(g) + 3D(g)$,

the value of ΔH at $27^{\circ}C$ is $19.0kcal$. The value of ΔE for the reaction would be

$(R = 2.0calH^{-1}mol^{-1})$

A. 20.8 kcal

B. 19.8 kcal

C. 17.8 kcal

D. 20.2 kcal

Answer: C

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12. The enthalpy of dissolution of $BaCl_2(s)$ and $BaCl_2.2H_2O$ are -20.6 and 8.8 KJ mol^{-1} respectively . Calculate enthalpy of hydration forgiven reaction:

$BaCl_2(s) + 2H_2O \rightarrow BaCl_2.2H_2O(s)$

A. 29.4 kJ

B. $-11.8kJ$

C. $-20.6kJ$

D. $-29.4kJ$

Answer: D

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13. ΔG° for the reaction $X + Y \Leftrightarrow Z$ is -4.606 kcal. The value of equilibrium constant of the reaction at $227^{\circ}C$ is (R = 2 Cal/mol K)

A. 100

B. 10

C. 2

D. 0.01

Answer: A

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14. The ΔH_f° for $CO_2(g)$, CO(g) and $H_2O(g)$ are -395.5, -110.5 and $-241.8 \quad kJmol^{-1}$ respectively. The standard enthalpy change in (in kJ) for the reaction

$CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$ is

A. 524.1

B. 41.2

C. -262.5

D. -41.2

Answer: B

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15. For the reaction $N_2 + 3H_2 \Leftrightarrow 2NH_3, \Delta H = ?$

A. $\Delta E - RT$

B. $\Delta E - 2RT$

C. $\Delta E + RT$

D. $\Delta E + 2RT$

Answer: B

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16. In thermodynamics, a process is called reversible when

A. Surroundings and system change into each other

B. There is no boundary between system and surroundings

C. The surroundings are always in equilibrium with the system

D. The system changes into the surroundings spontaneously

Answer: C

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17. Which one of the following statements is false

A. Work is a state function

B. Temperature is a state function

C. Change in the state is completely defined when the initial and final states are specified

D. Work appears at the boundary of the system

Answer: A

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18. One mole of non - ideal gas undergoes a change of state (2.0 atm , 3 .0 L , 95 K → (4.0 atm , 5.0 L , 245 K) with a change in internal energy , $\Delta U = 30.0 L$ atm . The change in enthalpy (ΔH) of the process in L atm is

A. 40

B. 42.3

C. 44

D. Not defined, because pressure is not constant

Answer: C

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19. Which of the following defines ΔH_f° ?

A. $C_{(diamond)} + O_{2(g)} \rightarrow CO_{2(g)}$

B. $\frac{1}{2}H_{2(g)} + \frac{1}{2}F_{2(g)} \rightarrow HF_{(g)}$

C. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

D. $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$

Answer: B

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20. The enthalpy of vaporisation of a liquid is 30kJmol^{-1} and entropy of vaporisation is $75 \text{Jmol}^{-1}\text{K}^{-1}$. The boiling point of the liquid at 1atm is :

A. 250 K

B. 400 K

C. 450 K

D. 600 K

Answer: B

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21. Adsorpton of gases on solid surface is generally exothermic because :

A. Enthalpy is positive

B. Entropy decreases

C. Entropy increases

D. Free energy increase

Answer: B

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22. Two moles of an ideal gas is expanded isothermally and reversibly from 2 litre to 20 litre at 300 K. The enthalpy change (in kJ) for the process is

A. 11.4

B. -11.4 kJ

C. 0 kJ

D. 4.8 kJ

Answer: C

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23. The rusting of iron takes place as follows :

$$2H^{\oplus} + 2e^{-} + \frac{1}{2}O_2 \rightarrow H_2O(l), \qquad E^{c-} = +1.23V$$

$$Fe^{2+} + 2e^{-} \rightarrow Fe(s), \qquad E^{c-} = -0.44V$$

Calculae ΔG^{c-} for the net process.

A. -322kJmol^{-1}

B. -161kJmol^{-1}

C. -152kJmol^{-1}

D. -76kJmol^{-1}

Answer: A

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24. When 1mol of a monoatomic ideal gas at TK undergoes adiabatic change under a constant external pressure of 1atm, changes volume from $1\text{L} \rightarrow 2\text{L}$. The final temperature (in K) would be

A. $\dfrac{\text{T}}{2^{(2/3)}}$

B. $\text{T} + \dfrac{2}{3 \times 0.0821}$

C. T

D. $\text{T} - \dfrac{2}{3 \times 0.0821}$

Answer: D

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25. For the reaction, $2CO + O_2 \rightarrow 2CO_2, \Delta H = -560 kJ$. Two moles of CO and one mole of O_2 are taken in a container of volume 1 L. They completely form two moles of CO_2, the gases deviate appreciably from ideal behaviour. If the pressure in the vessel changes from 70 to 40 atm, find the magnitude (absolute value) of ΔU at 500 K.

A. -557

B. 575

C. 585

D. 595

Answer: A

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26. The direct conversion of A to B is difficult. Hence it is carried out by the following shown path:

$\Delta S(A \rightarrow C) = 50 e.u.$, $\Delta S(C \rightarrow D) = 30 e.u$,

$\Delta S(B \rightarrow D) = 20 e.u$ where e.u is entropy unit.

Then $\Delta S(A \rightarrow B)$,

A. $+100 e.u.$

B. $+60 e.u.$

C. $-100 e.u.$

D. $-60 e.u.$

Answer: B

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27. For the process $H_2O(l)(1 bar, 373 K) \rightarrow H_2O(g)(1 bar, 373 K)$ the correct set of thermodynamic parameters is

A. $\Delta G = 0, \Delta S = +ve$

B. $\Delta G = 0, \Delta S = -\text{ve}$

C. $\Delta G = +\text{ve}, \Delta S = 0$

D. $\Delta G = -\text{ve}, \Delta S = +\text{ve}$

Answer: A

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28. The value of $\log_{10} K$ for a reaction $A \Leftrightarrow B$ is:

(Given,

$\Delta_r H^\circ_{298K} = -54.07 \text{kJ} \quad \text{mol}^{-1}, \Delta_r S^\circ_{298K} = 10 \text{JK}^{-1} \quad \text{mol}^{-1}$ and $R = 8.314 \text{JK}$

)

A. 5

B. 10

C. 95

D. 100

Answer: B

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29. The species which by definition has zero standard molar enthalpy of formation at 298 K is

A. $Br_2(g)$

B. $Cl_2(g)$

C. $H_2O(g)$

D. $CH_4(g)$

Answer: B

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30. The bond energy (in kcal mol^{-1}) of a $C-c$ single bond is approximately

A. 1

B. 10

C. 100

D. 1000

Answer: C

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31. Using the data provided, calculate the multiple bond energy (kJmol^{-1}) of a $C \equiv C$ bond in C_2H_2. That energy is (take the bond energy of a $C-H$ bond as 350kJmol^{-1}).

$2C_{(s)} + H_{2(g)} \rightarrow C_2H_{2(g)}, \Delta = 225\text{kJmol}^{-1}$

$2C_{(s)} \rightarrow 2C_g), \Delta H = 1410\text{kJmol}^{-1}$

$H_{2(g)} \rightarrow 2H_{(g)}, \Delta H = 330\text{kJmol}^{-1}$

A. 1165

B. 837

C. 865

D. 815

Answer: D

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32. A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0mL to 375mL at a constant temperature of 37.0°C. As it does so, it absorbs 208J of heat. The value of q and w for the process will be:

$(R = 8.314\text{J}/\text{molK})(\ln 7.5 = 2.01)$

A. q=+208 J, w=-208 J

B. q=-208 J, w=-208 J

C. q=-208 J, w=+208 J

D. q=+208 J, w=+208 J

Answer: A

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33. The standard enthalpies fo formation of $CO_2(g)$, $H_2O(1)$, and glucose (s) at $25^\circ C$ are $-400 kJ mol^{-1}$, $-300 kJ mol^{-}$, and $-1300 kJ mol^{-1}$, respectively. The standard enthalply of combustion per gram of glucose at $25^\circ C$ is

A. $+2900 kJ$

B. $-2900 kJ$

C. $-16.11 kJ$

D. $+16.11 kJ$

Answer: C

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34. For complete combustion of ethaol,

$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(L)$

the amount of heat produced as measured in bomb calorimeter, is $1364.47 \text{ kJ mol}^{-1}$ at 25°C. Assuming ideality the enthalpy of combustion, $\Delta_c H$, for the reaction will be $(R = 8.314 \text{kJmol}^{-1})$

A. $-1366.95 \text{kJmol}^{-1}$

B. $-1361.95 \text{kJmol}^{-1}$

C. $-1460.50 \text{kJmol}^{-1}$

D. $-1350.50 \text{kJmol}^{-1}$

Answer: A

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35. For the process $H_2O(l) \rightarrow H_2O(g)$ at $T = 100^\circ \text{C}$ and 1 atmosphere pressure, the correct choice is

A. $\Delta S_{\text{system}} > 0 \text{ and } \Delta S_{\text{surroundin gs}} > 0$

B. $\Delta S_{\text{system}} > 0 \text{ and } \Delta S_{\text{surroundin gs}} < 0$

C. $\Delta S_{\text{system}} < 0 \text{ and } \Delta S_{\text{surroundin gs}} > 0$

D. $\Delta S_{system} < 0$ and $\Delta S_{surroundin\ gs} < 0$

Answer: B

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36. The following reaction is performed at 298 K ?

$2NO(g) + O_2(g) \Leftrightarrow 2NO_2(g)$

The standard free energy of formation of NO(g) is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $NO_2(g)$ at 298 K ?

$(K_p = 1.6 \times 10^{12})$

A. $R(298)\ln(1.6 \times 10^{12}) - 86600$

B. $86600 + R(298)\ln(1.6 \times 10^{12})$

C. $86600 - \dfrac{\ln(1.6 \times 10^{12})}{R(298)}$

D. $0.5[2 \times 86,600 - R(298)\ln(1.6 \times 10^{12})]$

Answer: D

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37. The heats of combustion of carbon and carbon monoxide are -393.5 and -283.5kJmol^{-1} respectively. The heat of formation (in kJ) of carbon monoxide per mole is:

A. 676.5

B. -676.5

C. -110.5

D. 110.5

Answer: C

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38. one mole of an ideal gas at 300k in thermal contact with surroundings expands isothermally from 1.0 L to 2.0 L against a constant presses of 3.0 atm. In this process. The change in entropy of surrroundings (ΔS) in J^{-1}

is

(1 L atm = 101.3 J)

A. 5.763

B. 1.013

C. -1.013

D. -5.763

Answer: C

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39. Given $C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g)$,

$\Delta_r H^0 = -393.5 \text{kJ} \quad \text{mol}^{-1}$

$H_2(g) = +\frac{1}{2}O_2(g) \rightarrow H_2O(1)$,

$\Delta_r H^0 = -285.8 \ \text{kJ} \ \ \text{mol}^{-1}$

$CO_2(g) + 2H_2O(1) \rightarrow CH_4(g) + 2O_2(g)$,

$\Delta_r H^0 = +890.3 \text{kJ} \quad \text{mol}^{-1}$

Based on the above thermochemical equations, the value of $\Delta_r H^0$ at at

298 K for the reaction

$C_{(\text{graphite})} + 2H_2(g) \rightarrow CH_4(g)$ will be:

A. $+144.0 \text{kJ mol}^1$

B. -74.8kJ mol^1

C. -144.0kJ mol^1

D. $+74.8 \text{kJ mol}^1$

Answer: B

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40. δU is equal to

A. Isobaric work

B. Adiabatic work

C. Isothermal work

D. Isochoric work

Answer: B

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41. The standard state Gibbs free energies of formation of) C(graphite and C(diamond) at T = 298 K are

$\Delta_f G^\circ [C(\text{graphite})] = 0 \text{kJmol}^{-1}$

$\Delta_f G^\circ [C(\text{diamond})] = 2.9 \text{kJmol}^{-1}$

The standard state means that the pressure should be 1 bar, and substance should be pure at a given temperature. The conversion of graphite [ ) C(graphite] to diamond [C(diamond)] reduces its volume by $2 \times 10^{-6} \text{m}^3 \text{mol}^{-1}$. If) C(graphite is converted to C(diamond) isothermally at T = 298 K, the pressure at which) C(graphite is in equilibrium with C(diamond), is

$[\text{Useful information:} 1\text{J} = 1\text{kgm}^2\text{s}^{-2}, 1\text{Pa} = 1\text{kgm}^{-1}\text{s}^{-2}, 1\text{bar} = 10^5\text{Pa}]$

A. 58001 bar

B. 1450 bar

C. 14501 bar

D. 29001 bar

Answer: C

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42. The combustion of benzene (l) gives $CO_2(g)$ and $H_2O(l)$. Given that heat of combustion of benzene at constant volume is $-3263.9 kJ mol^{-1}$ at $25^{\circ} C$, heat of combustion (in kJmol^{-1}) of benzene at constant pressure will be

(R = 8.314 JK–1 mol–1)

A. -452.46

B. 3260

C. -3267.6

D. 4152.6

Answer: C

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JEE section (More than one choice correct answer)

1. The following is (are) endothermic reaction (s)

A. Combustion of methane

B. Decomposition of water

C. Dehydrogenation of ethane to ethylene

D. Conversion of graphite to diamond

Answer: B::C::D

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2. Identify the intensive quantities from the following :

A. Enthalpy

B. Temperature

C. Volume

D. Refractive index

Answer: B::D

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3. The enthalpy of neutralization of which of the following acid & base is nearly $-13.6\text{kcal}.$

A. HCN and NaOH

B. HCl and KOH

C. HCl and NaOH

D. HCl and NH_4OH

Answer: b

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4. At 300 K, the reaction with which of the following values of thermodynamics parameters indicates non-spontaniety?

A. $\Delta G^\circ = -400 \text{kJmol}^{-1}$

B. $\Delta H^\circ = 200 \text{kJmol}^{-1}, \Delta S^\circ = -4 \text{JK}^{-1} \text{mol}^{-1}$

C. $\Delta H^\circ = -200 \text{kJmol}^{-1}, \Delta S^\circ = 4 \text{JK}^{-1} \text{mol}^{-1}$

D. $\Delta H^\circ = 200 \text{Jmol}^{-1}, \Delta S^\circ = 40 \text{JK}^{-1} \text{mol}^{-1}$

Answer: A::C::D

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5. Which one of the following statement is false

A. Work is a state function

B. Temperature is a state function

C. Change in the state is completely defined when the initial and final states are specified

D. Work appears at the boundary of the system

Answer: A::B

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6. Among the following , the state funcation (s) is (are)

A. Internal energy

B. Irreversible expansion work

C. Reversible expansion work

D. Molar enthalpy

Answer: A::D

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7. Among the following, the intensive property is (properties are):

A. Molar conductivity

B. Electromotive force

C. Resistance

D. Heat capacity

Answer: A::B

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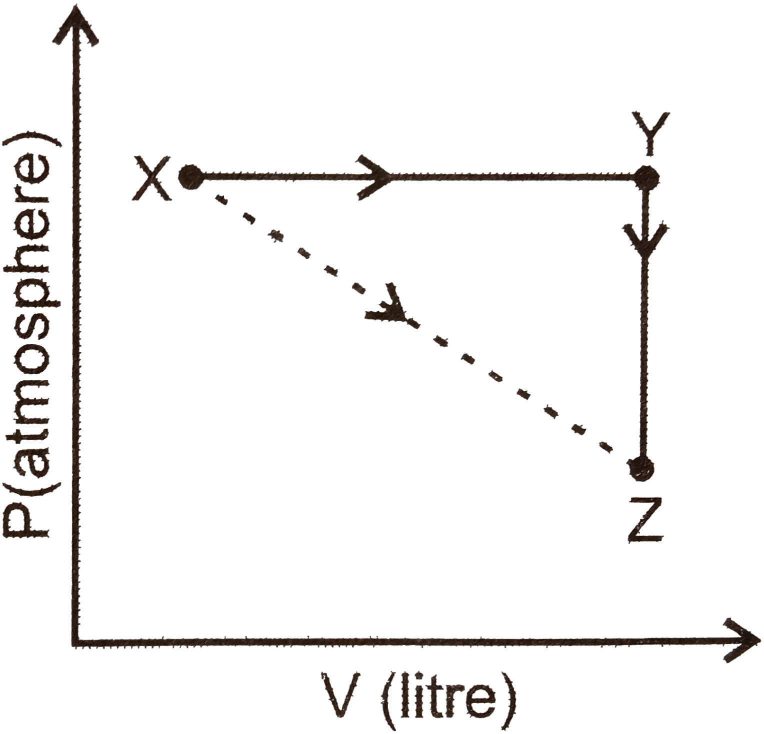
8. For an ideal gas, consider only $P - V$ work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is (are) correct? [Take ΔS as change in entropy and w as work done]



A. $\Delta S_{x \to z} = \Delta S_{x \to y} + \Delta S_{y \to z}$

B. $w_{x \to z} = w_{x \to y} + \Delta S_{y \to z}$

C. $w_{x \to y \to z} = w_{x \to y}$

D. $\Delta S_{x \to y \to z} = \Delta S_{x \to y}$

Answer: A::C

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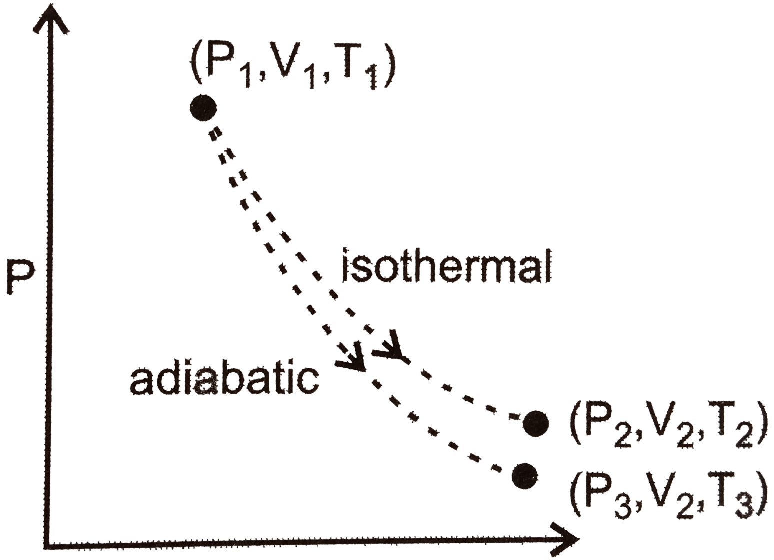
9. The reversible expansion of an ideal gas under adiabatic and isothermal conditions is shown in the figure. Which of the following statement(s) is (are) correct?



A. $T_1 = T_2$

B. $T_3 > T_1$

C. $w_{\text{isothermal}} > w_{\text{adiabatic}}$

D. $\Delta U_{\text{isothermal}} > \Delta U_{\text{adiabatic}}$

Answer: A::D

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10. An ideal gas in a thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irreversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of the gas are P_2, V_2 and T_2, respectively. For this expansion.

A. q=0

B. $T_2 = T_1$

C. $P_2V_2 = P_1V_1$

D. $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

Answer: A::B::C

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11. An ideal gas is expand from (p_1, V_1, T_1) to (p_2, V_2, T_2) under different conditions. The correct statement(s) among the following is (are):

A. The work done by the gas is less when it is expanded reversibly from V_1 to V_2 under adiabatic conditions as compared to that when expanded reversibly from V_1 to V_2 under isothermal conditions

B. The change in internal energy of the gas is (i) zero, if it is expanded reversibly with $T_1 = T_2$, and (ii) positive, if it is expanded reversibly under adiabatic conditions with $T_1 \neq T_2$

C. If the expansion is carried out freely, it is simultaneously both isothermal as well as adiabatic

D. The work done on the gas is maximum when it is compressed irreversibly from (P_2, V_2) to (P_1, V_1) against constant pressure P_1

Answer: A::C::D

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12. For a reaction taking place in a container in equilibrium with its surroundings, the effect of temperature on its equilibrium constant Kin terms of change in entropy is described by

A. With increase in temperature, the value of K for endothermic reaction increases because unfavourable change in entropy of the surroundings decreases

B. With increase in temperature, the value of K for exothermic reaction decreases because favourable change in entropy of the surroundings decreases

C. With increase in temperature, the value of K for endothermic reaction increases because the entropy change of the system is negative

D. With increase in temperature, the value of K for exothermic reaction decreases because the entropy change of the system is positive

Answer: A::B

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13. One mole of an ideal gas is subjected to a two step reversible process (A-B and B-C). The pressure at A and C is same. Mark the correct statement(s) ltbgt

A. Work involved in the path AB is zero

B. In the path AB work will be done on the gas by the surrounding

C. Volume of gas at C = $3 \times$ volume of gas at A

D. Volume of gas at B is 16.42 litres

Answer: C::D

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14. If separate samples of argon, methane, nitrogen and ammonia, all at the same initial temperature and pressure and expanded adiabatically to double their original volumes, then which one of these gases will require the greatest quantity of heat to restore the original temperature?

A.

B.

C.

D.

Answer: ammonia

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15. Which of the following is/are correct

A. $\Delta H = \Delta U + \Delta(PV)$ when P and V both changes

B. $\Delta H = \Delta U + P\Delta V$ when pressure is constant

C. $\Delta H = \Delta U + V\Delta P$ when volume is constant

D. $\Delta H = \Delta U + P\Delta V + V\Delta P$ when P and V both changes

Answer: A::B::C

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JEE section (Reasoning type questions)

1. Assertion (A): The endothermic reactions are favoured at lower temperature and the exothermic reactions are favoured at higher temperature.

Reason (R) : when a system in equilibrium is disturbed by changing the temperature, it will tend to adjust itself so as to overcome the effect of the change.

A. Statement 1 is true, statement-2 is true, statement 2 is a correct explanation for statement 1

B. Statement 1 is true, statement 2 is true, statement 2 is not a correct explanation for statement 1

C. Statement 1 is true, statement 2 is false

D. Statement 1 is false, statement 2 is true

Answer: D

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2. Staement -1: The heat absorbed during the isothermal expansion of an ideal gas againt vacuum is zero .

Statement -2: The volume occupied by the molecules of an ideal gas is zero.

A. Statement 1 is true, statement-2 is true, statement 2 is a correct explanation for statement 2

B. Statement 1 is true, statement 2 is true, statement 2 is not a correct explanation for statement 2

C. Statement 1 is true, statement 2 is false

D. Statement 1 is false, statement 2 is true

Answer: C

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3. Statement -1: For every chmical reaction at equilibrium , standard Gidds energy of reaction is zero

Statement-2: At constant temperature and pressure , chemical reactions are spontaneious in the direction of decreasing gibbs energy.

A. Statement 1 is true, statement-2 is true, statement 2 is a correct explanation for statement 3

B. Statement 1 is true, statement 2 is true, statement 2 is not a correct explanation for statement 3

C. Statement 1 is true, statement 2 is false

D. Statement 1 is false, statement 2 is true

Answer: D

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4. Statement-1: There is a natural asymmetry between work to heat and converting heat to work .

Statement-2: No process is possible in which the sole result is the absorption of heat from a reservoir and its complaete conversion into work .

A. Statement 1 is true, statement-2 is true, statement 2 is a correct explanation for statement 4

B. Statement 1 is true, statement 2 is true, statement 2 is not a correct explanation for statement 4

C. Statement 1 is true, statement 2 is false

D. Statement 1 is false, statement 2 is true

Answer: A

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5. Statement-1: The enthalpy of formation of H_(2)O(l)is greater than of H_(2)O(g) in magnitude.

Statement -2: Enthalpy chnge Is negative for the condensation reaction

$H_2O(g) \rightarrow H_2O(l)$

A. Statement 1 is true, statement-2 is true, statement 2 is a correct explanation for statement 5

B. Statement 1 is true, statement 2 is true, statement 2 is not a correct explanation for statement 5

C. Statement 1 is true, statement 2 is false

D. Statement 1 is false, statement 2 is true

Answer: A

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6. Assertion: $C_P - C_V = R$ for an ideal gas.

Reason: $\left(\frac{\partial E}{\partial V}\right)_T = 0$ for an ideal gas.

A. Statement 1 is true, statement-2 is true, statement 2 is a correct explanation for statement 6

B. Statement 1 is true, statement 2 is true, statement 2 is not a correct explanation for statement 6

C. Statement 1 is true, statement 2 is false

D. Statement 1 is false, statement 2 is true

Answer: B

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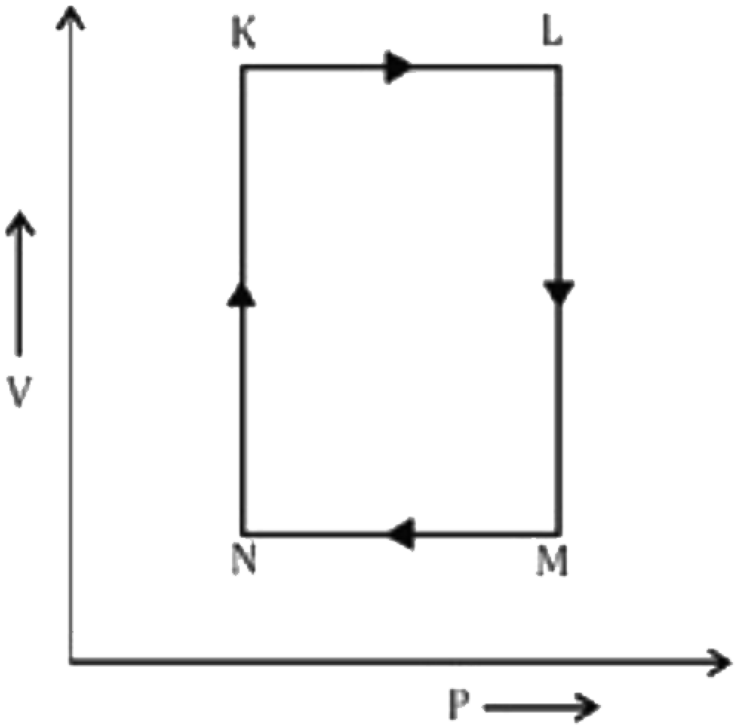
JEE section (Comprehension type questions)

1. A fixed mass m of a gas is subjected to transformation of states from K to L to M to N and back to K as shown in the figure.



The succeeding operation that enable this transformation of state are

A. Heating, cooling, heating, cooling

B. Cooling, heating, cooling, heating

C. Heating, cooling, cooling, heating

D. Cooling, heating, heating, cooling

Answer: C

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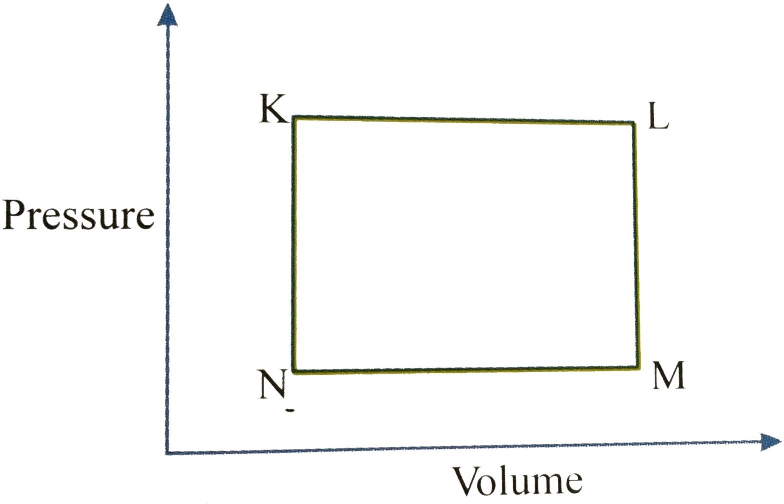
2. A fixed mass 'm' of a gas is subjected to transformation of states from K to L to M to N and back to K as shown in the figure



The pair of isochoric process among the tranformation of states is

A. K to L and L to M

B. L to M and N to K

C. L to M and M to N

D. M to N and N to K

Answer: B

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3. When 100 mL of 1.0 M HCl was mixed 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increase $5.7^\circ C$ was measured for the beaker and its contents (Expt. 1). Because the enthalpy of neutralization of a strong acid with a strong base is a constant $(-57.0 \text{kJmol}^{-1})$, this experiment could be used to measure the calorimeter constant. In a second experiment (Expt.2) 100 mL of 2.0 M acetic acid $(K_a = 2.0 \times 10^{-5})$ was mixed with 100 mL of 1.0 M NaOH (under indentical conditions to Expt. 1) where a temperature rise of $5.6^\circ C$ was measured

(Consider heat capacity of all solutions as $4.2 \text{Jg}^{-1}\text{K}^{-1}$ and density of al solutions as 1.0 gmL^{-1})

Enthalpy of dissociation (in KJmol^{-1}) of acetic acid obtained from the Expt.2 is

A. 1.0

B. 10.0

C. 24.5

D. 51.4

Answer: A

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4. When 100 mL of 1.0 M HCl was mixed 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increase 5.7°C was measured for the beaker and its contents (Expt. 1). Because the enthalpy of neutralization of a strong acid with a strong base is a constant (-57.0kJmol^{-1}), this experiment could be used to measure the calorimeter constant. In a second experiment (Expt.2) 100 mL of 2.0 M acetic acid ($K_a = 2.0 \times 10^{-5}$) was mixed with 100 mL of 1.0 M NaOH (under indentical conditions to Expt. 1) where a temperature rise of $5.6^\circ C$ was measured

(Consider heat capacity of all solutions as $4.2 J g^{-1} K^{-1}$ and density of al solutions as 1.0 gmL^{-1})

The pH of the solution after Expt. 2 is

A. 2.8

B. 4.7

C. 5.0

D. 7.0

Answer: B

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5. Standard Gibb's energy of reaction ($\Delta_r G^\circ$) at a certain temperature can be computed as $\Delta_r G^\circ = \Delta_r H^\circ - T . \Delta_r S^\circ$ and the change in the value of $\Delta_r H^\circ$ and $\Delta_r S^\circ$ for a reaction with temperature can be computed as follows

$$\Delta_r H^\circ_{T_2} - \Delta_r H^\circ_{T_1} = \Delta_r C_p^\circ (T_2 - T_1)$$

$$\Delta_r S^\circ_{T_2} - \Delta_r S^\circ_{T_1} = \Delta_r C_p^\circ \ln(\frac{T_2}{T_1})$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$$

and by $\Delta_r G^\circ = -RT\ln K_{eq}$

Consider the following reaction :

$CO(g) + 2H_2(g) \subset CH_3OH(g)$

Given : $\Delta_f H^\circ (CH_3OH), g = -201 kJ/mol$

$\Delta_f H^\circ (CO, g) = -114 kJ/mol$

$S^\circ (CH_3OH, g) = 240 J/K - mol, S^\circ (H_2, g) = 29 JK^{-1} mol^{-1}$

$S^\circ (CO, g) = 198 J/mol - K, C_{p,m}^\circ (H_2) = 28.8 J/mol - K$

$C_{p,m}^\circ (CO) = 29.4 J/mol - K, C_{p,m}^\circ (CH_3OH) = 44 J/mol - K$

and $\ln(\frac{320}{300})0.06$, all data at 300 K

$\Delta_r S^\circ$ at 320 K is

A. 155.18 J/mol - K

B. 150.02 J/mol - K

C. 172 J/mol - K

D. None of these

Answer: D

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6. Standard Gibb's energy of reaction $(\Delta_r G^\circ)$ at a certain temperature can be computed as $\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$ and the change in the value of $\Delta_r H^\circ$ and $\Delta_r S^\circ$ for a reaction with temperature can be computed as follows

$$\Delta_r H^\circ_{T_2} - \Delta_r H^\circ_{T_1} = \Delta_r C_p^\circ (T_2 - T_1)$$

$$\Delta_r S^\circ_{T_2} - \Delta_r S^\circ_{T_1} = \Delta_r C_p^\circ \ln\left(\frac{T_2}{T_1}\right)$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$$

and by $\Delta_r G^\circ = -RT\ln K_{eq}$

Consider the following reaction :

$$CO(g) + 2H_2(g) \subset CH_3OH(g)$$

Given : $\Delta_f H^\circ (CH_3OH), g = -201 kJ/mol$

$\Delta_f H^\circ (CO, g) = -114 kJ/mol$

$S^\circ (CH_3OH, g) = 240 J/K - mol, S^\circ (H_2, g) = 29 JK^{-1} mol^{-1}$

$S^\circ (CO, g) = 198 J/mol - K, C^\circ_{p,m}(H_2) = 28.8 J/mol - K$

$C_{p,m}^{\circ}(CO) = 29.4J/mol - K, C_{p,m}^{\circ}(CH_3OH) = 44J/mol - K$

and $\ln(\frac{320}{300})0.06$, all data at 300 K

$\Delta_r S^{\circ}$ at 300 K for the reaction is

A. 152.6 J/K - mol

B. 181.6 J/K - mol

C. $-16J/K - mol$

D. None of these

Answer: C

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7. Standard Gibb's energy of reaction $(\Delta_r G^{\circ})$ at a certain temperature can be computed as $\Delta_r G^{\circ} = \Delta_r H^{\circ} - T . \Delta_r S^{\circ}$ and the change in the value of $\Delta_r H^{\circ}$ and $\Delta_r S^{\circ}$ for a reaction with temperature can be computed as follows

$$\Delta_r H_{T_2}^{\circ} - \Delta_r H_{T_1}^{\circ} = \Delta_r C_p^{\circ} (T_2 - T_1)$$

$$\Delta_r S_{T_2}^{\circ} - \Delta_r S_{T_1}^{\circ} = \Delta_r C_p^{\circ} \ln(\frac{T_2}{T_1})$$

$\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$

and by $\Delta_r G^\circ = -RT \ln K_{eq}$

Consider the following reaction :

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$C^\circ_{p,m}(CO) = 29.4 J/mol - K, C^\circ_{p,m}(CH_3OH) = 44 J/mol - K$

and $\ln(\frac{320}{300})0.06$, all data at 300 K

$\Delta_r H^\circ$ at 320 K is

A. $-288.86 kJ/mol$

B. $-289.1 kJ/mol$

C. $-87.86 kJ/mol$

D. None of these

Answer: C

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8. Standard Gibb's energy of reaction ($\Delta_r G^\circ$) at a certain temperature can be computed as $\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$ and the change in the value of $\Delta_r H^\circ$ and $\Delta_r S^\circ$ for a reaction with temperature can be computed as follows

$\Delta_r H^\circ_{T_2} - \Delta_r H^\circ_{T_1} = \Delta_r C_p^\circ (T_2 - T_1)$

$\Delta_r S^\circ_{T_2} - \Delta_r S^\circ_{T_1} = \Delta_r C_p^\circ \ln(\frac{T_2}{T_1})$

$\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$

and by $\Delta_r G^\circ = -RT \ln K_{eq}$

Consider the following reaction :

$CO(g) + 2H_2(g) \subset CH_3OH(g)$

Given : $\Delta_f H^\circ (CH_3OH), g = -201 kJ/mol$

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$C_{p,m}^\circ (CO) = 29.4 J/mol - K, C_{p,m}^\circ (CH_3OH) = 44 J/mol - K$

and $\ln(\frac{320}{300})0.06$, all data at 300 K

$\Delta_r H^\circ$ at 300 K for the reaction is

A. $-87\text{kJ}/\text{mol}$

B. $87\text{kJ}/\text{mol}$

C. $-315\text{kJ}/\text{mol}$

D. $-288\text{kJ}/\text{mol}$

Answer: A

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9. Standard Gibb's energy of reaction $(\Delta_r G^\circ)$ at a certain temperature can be computed as $\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$ and the change in the value of $\Delta_r H^\circ$ and $\Delta_r S^\circ$ for a reaction with temperature can be computed as follows

$$\Delta_r H^\circ_{T_2} - \Delta_r H^\circ_{T_1} = \Delta_r C_p^\circ (T_2 - T_1)$$

$$\Delta_r S^\circ_{T_2} - \Delta_r S^\circ_{T_1} = \Delta_r C_p^\circ \ln\left(\frac{T_2}{T_1}\right)$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T.\Delta_r S^\circ$$

and by $\Delta_r G^\circ = -RT\ln K_{eq}$

Consider the following reaction :

$CO(g) + 2H_2(g) \subset CH_3OH(g)$

Given : $\Delta_f H^\circ (CH_3OH), g = -201 kJ/mol$

$\Delta_f H^\circ (CO, g) = -114 kJ/mol$

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$C^\circ_{p,m}(CO) = 29.4 J/mol - K, C^\circ_{p,m}(CH_3OH) = 44 J/mol - K$

and $\ln(\frac{320}{300})0.06$, all data at 300 K

$\Delta_r G^\circ$ at 320 K is

A. $-48295.2 kJ/mol$

B. $-240.85 kJ/mol$

C. $240.85 kJ/mol$

D. $-81.91 kJ/mol$

Answer: D

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JEE section (Integer type questions)

1. In a constant volume calorimeter, 3.5g of a gas with molecular weight 28 was burnt in excess oxygen at 298.0K. The temperature of the calorimeter was found to increase from $298.0\text{K} \rightarrow 298.45\text{K}$ due to the combustion process. Given that the heat capacity of the calorimeter is 2.5kJK^{-1}, find the numerical value for the enthalpy of combustion of the gas in kJmol^{-1}

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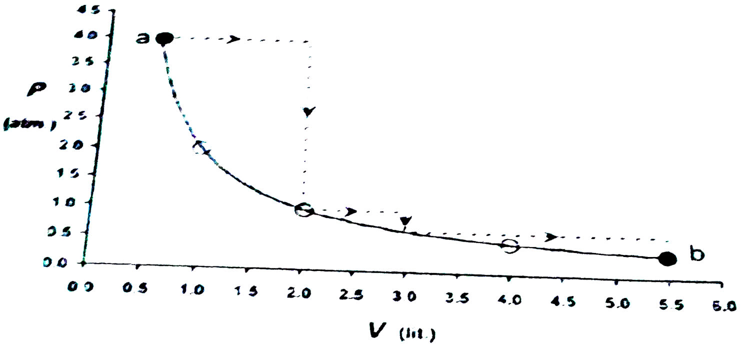
2. One mole of an ideal gas is taken from a to b along two paths denoted by the solid and the dashed lines as shown In the graph below. If the work done along the solid line path is W_s and that along the the dotted line path is w_d, then the integer closest to the ratio w_d / w_s is



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3. All the energy released from the reaction $X \rightarrow Y, \Delta_r G^\circ = -193 \text{kJmol}^{-1}$ is used for oxidising M° as $M^+ \rightarrow M^{3+} + 2e^-, E^\circ = -0.25V$.

Under standard conditions, the number of moles of M^+ oxidised when one mole of X is converted to Y is $[F = 96500 \text{Cmol}^{-1}]$

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4. $\Delta_f H^\Theta$ of Cyclohexene (l) and benzene at $25^\circ C$ is -156 and $+46 \text{kJmol}^{-1}$, respectively. $\Delta_{\text{hydrogenation}} H^\Theta$ of cyclohexene $(l) \text{at} 25^\circ C \text{is} -119 \text{kJmol}^{-1}$.

Reasonance energy of benzene is found to be $-38x \text{kJmol}^{-1}$. Find the value of x.

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5. Calculate the entropy change accompanying the following change of state

$H_2O(s, -10^\circ C, 1atm) \rightarrow H_2O(l, 10^\circ C, 1atm)$

C_P for ice $= 9cladeg^{-1}mol^{-1}$

C_P for $H_2O = 18caldeg^{-1}mol^{-1}$

Latent heat of fustion of ice $= 1440calmol^{-1}at0^\circ C.$

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JEE section (Matrix Match type questions)

1. Match the transformation in colums I with appropriate options in column II.

Column I	Column II
(A)$CO_2(s) \rightarrow CO_2(g)$	(p)phase transition
(B)$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$	(q)allotropic change
(C)$2H. \rightarrow H_2(g)$	(r)$\Delta H$is positive
(D)$P_{(\text{white, solid})} \rightarrow P_{(\text{red,solid})}$	(s)$\Delta S$is positive
	(t)$\Delta S$is negative

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2. Match the thermodynamic processes given under Column I with the expressions given under Column II

	Column I
(A)	Freezing of water at 273 K and 1 atm
(B)	Expansion of 1 mole of an ideal gas into a vacuum under isolated conditi
(C)	Mixing of equal volumes of two ideal gases at constant temperature and p
(D)	Reversible heating of $H_2(g)$ at 1 atm from 300 K to 600 K, followed by

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3. Match the entries listed in Column I with appropriate entries listed in Column II.

	Column I		Column II
(A)	Hess' law	(p)	$2.303 \log. \frac{P_2}{P_1} = \frac{\Delta_{vap} H}{R}(\frac{T_2 - T_1}{T_1 T_2})$
(B)	Combustion reaction	(q)	$\Delta_{vap}H = 88 JK^{-1} mol^{-1} \times$ Boiling p
(C)	Trouton's law	(r)	Exothermic
(D)	Clausius-Cal-peyron equation	(s)	ΔH remains the same irrespective s

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4. Match the entries listed in Column I with appropriate entries listed in Column II.

	Column I		Column II
(A)	Isothermal process	(p)	$\left(\frac{\partial U}{\partial V}\right)_T = 0$
(B)	$-nF\overset{\Theta}{E}$	(q)	$W = -\Delta U$
(C)	Adiabatic reaction	(r)	$\Delta U = 0$
(D)	van der waals gas	(s)	ΔG^{Θ}
(E)	Ideal gas	(t)	$\left(\frac{\partial T}{\partial P}\right)_H \neq 0$

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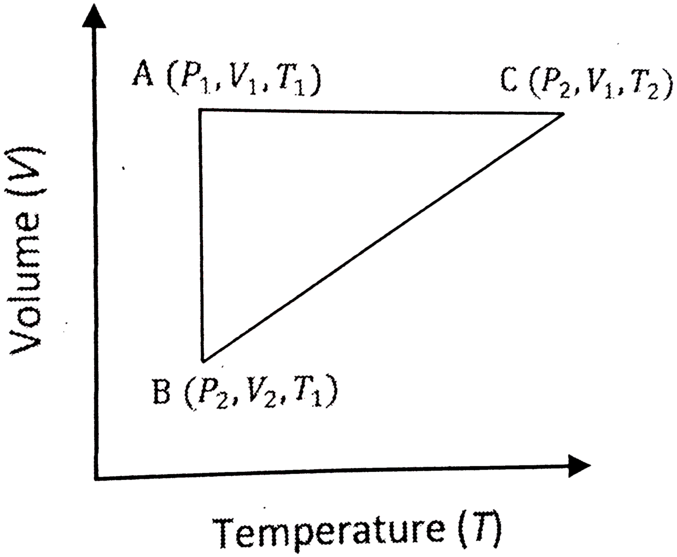
JEE section (JEE (Advanced) 2018) More than one choice correct answer

1. A reversible cyclic process for an ideal gas is shown below. Here, P, V, and T are pressure, volume and temperature, respectively. The thermodynamic parameters q, w, H and U are heat, work, enthalpy and internal energy, respectively.



The correct option (s) is (are)

A. $q_{AC} = \Delta U_{BC}$ and $W_{AB} = P_2(V_2 - V_1)$

B. $W_{BC} = P_2(V_2 - V_1)$ and $q_{BC} = \Delta H_{AC}$

C. $\Delta H_{CA} < \Delta U_{CA}$ and $q_{AC} = \Delta U_{BC}$

D. $q_{BC} = \Delta H_{AC}$ and $\Delta H_{CA} > \Delta U_{CA}$

Answer: B::C

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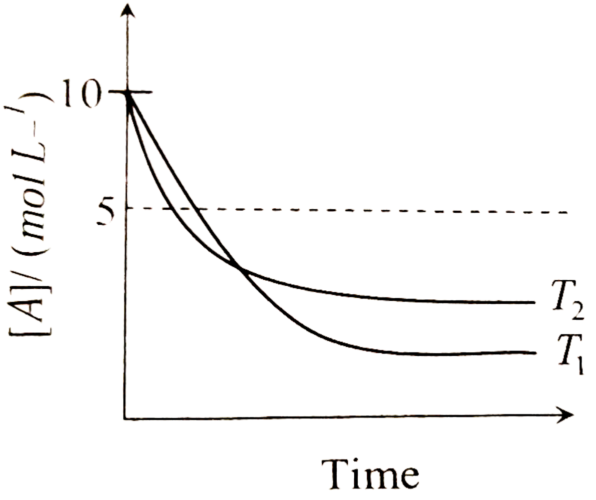
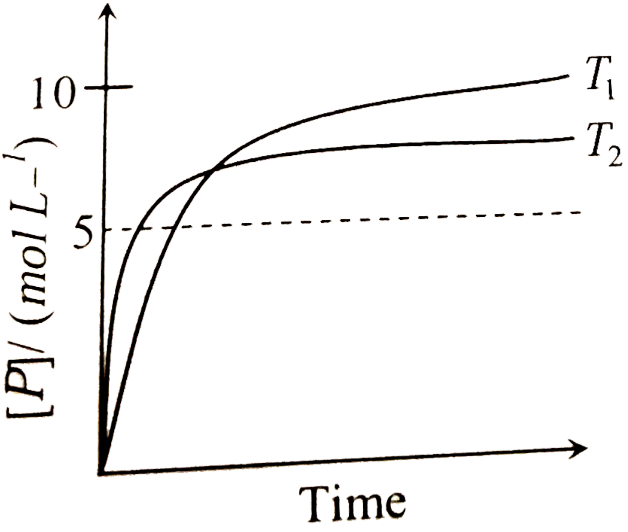
2. For a reaction A P, the plots of [A] and [P] with time at temperature T_1 and T_2 are given below





If $T_2 > T_1$, the correct statement(s) is (are)

(Assume ΔH^{θ} and ΔS^{theat} are independent of temperature and ratio of lnK at T_1 to lnK at T_2 is greater than T_2/T_1. Here H, S, G and K are enthalpy, entropy, Gibbs energy and equilibrium constant, respectively.)

A. $\Delta H^{\theta} < 0, \Delta S^{\theta} < 0$

B. $\Delta G^{\theta} < 0, \Delta H^{\theta} > 0$

C. $\Delta G^{\theta} < 0, \Delta S^{\theta} < 0$

D. $\Delta G^{\theta} < 0, \Delta S^{\theta} > 0$

Answer: A::C

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JEE section (JEE (Advanced) 2018) Numeric answer type questions

1. The surface of copper gets tarnished by the formation of copper oxide. N_2 gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the N_2 gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below: $2Cu(s) + H_2O(g) \rightarrow Cu_2O(s) + H_2(g)$ is the minimum partial pressure of H2 (in bar) needed to prevent the oxidation at 1250 K. The value of ln is ____. (Given: total pressure = 1 bar, R (universal gas constant) = $8JK - 1mol^{-1}$, $\ln(10) = 2.3$. $Cu(s)$ and $Cu_2O(s)$ are mutually immiscible. At $1250\ K : 2Cu(s) + 1/2O_2(g) \rightarrow Cu_2O(s)$

$\triangle H^{\theta} = -78,000 Jmol^{-1}$

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(g)$, $\triangle G^{\theta} = -1,78,000 Jmol^{-1}$, G is the Gibbs energy

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2. Consider the following reversible reaction, $AgBg \rightarrow ABg$. The activation energy of the backward reaction exceeds that of the forward reaction by 2($\in Jmol^{1}$). If the pre-exponential factor of the forward reaction is 4 times that of the reverse reaction, the absolute value of $\triangle G^{\theta}(\in Jmol^{-1})$ for the reaction at 300 K is ____. (Given, ln(2) = 0.7, $= 2500 Jmol^{-1}$ at 300 K and G is the Gibbs energy)

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