



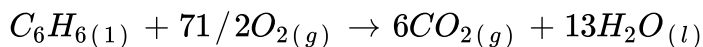
CHEMISTRY

NCERT - FULL MARKS CHEMISTRY(TAMIL)

THERMODYNAMICS

Example

1. From the following data at constant volume for combustion of benzene, calculate the heat of this reaction at constant pressure condition.

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2. Calculate the enthalpy of combustion of ethylene at 300K at constant pressure if its enthalpy of combustion at constant volume is $-1406 \text{ kJ mol}^{-1}$.



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3. (a) The measured heats of neutralization of acetic acid, formic acid, hydrocyanic acid, and hydrogen sulphide are 13.20, 13.40, 2.90 and 3.80 KCal per g.equiv. respectively. Arrange these acids in a decreasing order of strength.

(b) Heat of neutralization of formic acid by NH_4OH is 11.9 KCal per g.equiv. What is the heat of ionization of NH_4OH ?



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Questions A Choose The Correct Answer

1. Which of the following is not a statement ?

A. q

B. $q + w$

C. ΔH

D. $V + PV$

Answer:



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2. Which one of the following is not an extensive property ?

A. volume

B. density

C. refractive index

D. molar volume

Answer:



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3. Which of the following is not an endothermic reaction?

- A. melting of ice
- B. combustion reactions
- C. hydrolysis
- D. boiling of water

Answer:



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4. Which of the following process is reversible ?

- A. Diffusion
- B. melting
- C. neutralization

D. combustion

Answer:



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5. In which process, work is maximum?

- A. reversible
- B. irreversible
- C. exothermic
- D. cyclic

Answer:



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Questions B Fill In The Blanks

1. Translational energy of molecules is a part of _____ energy of the system.



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2. Specific heat of a liquid system is _____ property.



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3. Work done in the reversible expansion is



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4. Combustion is an _____ process.



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5. Heat of neutralisation of a strong acid is ____ than that of a weak acid.



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6. Name the equipment using which heat of combustion of compounds are determined?



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7. Energy can be created and be destroyed. State whether this is true or false.



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8. State Zeroth law of thermodynamic .



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9. Give the relation between ΔU and ΔH .



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10. Define an adiabatic process.



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11. Write the differences between an exothermic and an endothermic process.



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12. What are intensive and extensive properties?.



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13. Define first law of thermodynamics.



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14. Explain thermal and mechanical equilibrium processes.



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Questions D Explain Briefly On The Following

1. Describe a bomb calorimeter and explain how heat of formation of an organic compound is determined.



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2. Compare the enthalpy changes that occur between the neutralisation of a strong acid and a weak acid by sodium hydroxide. Explain the

differences seen.



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Questions Miscellaneous

1. Calculate the enthalpy of combustion of acetic (1) when burnt in excess of O_2 in a bomb calorimeter. Given that $\Delta H_f^\circ, H_2O_{(l)} = -285.84 \text{ KJ mol}^{-1}$ and $\Delta_f H^\circ, CO_{2(g)} = -393.52 \text{ KJ mol}^{-1}$.



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2. Heat of neutralisation of a strong acid is ___ than that of a weak acid.



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3. ΔH for the reaction at 298 K $CO(g) + 1/2O_2(g)$ is $282.85 \text{ KJ mol}^{-1}$.

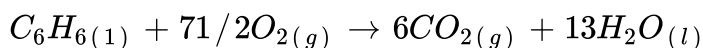
Calculate ΔU of the reaction.



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Question

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2. Calculate the enthalpy of combustion of ethylene at 300K at constant pressure if its enthalpy of combustion at constant volume is $-1406 \text{ kJ mol}^{-1}$.





3. (a) The measured heats of neutralization of acetic acid, formic acid, hydrocyanic acid, and hydrogen sulphide are 13.20, 13.40, 2.90 and 3.80 KCal per g.equiv. respectively. Arrange these acids in a decreasing order of strength.

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4. Which of the following is an exothermic reaction?

- A. melting of ice
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- C. hydrolysis
- D. boiling of water

Answer:



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- A. Diffusion
- B. melting
- C. neutralization
- D. combustion

Answer:



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B. irreversible

C. exothermic

D. cyclic

Answer:



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19. Define first law of thermodynamics.



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20. Explain thermal and mechanical equilibrium processes.



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21. Describe a bomb calorimeter and explain how heat of formation of an organic compound is determined.



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22. Compare the enthalpy changes that occur between the neutralisation of a strong acid and a weak acid by sodium hydroxide. Explain the differences seen.



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23. Calculate the enthalpy of combustion of acetic (1) when burnt in excess of O_2 in a bomb calorimeter. Given that $\Delta H_f^\circ, H_2O(l) = -285.84 \text{ KJ mol}^{-1}$ and $\Delta_f H^\circ, CO_{2(g)} = -393.52 \text{ KJ mol}^{-1}$.



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24. Heat of neutralisation of a weak acid HA by $NaOH$ is $-12.13 \text{ kJ mol}^{-1}$. Calculate the enthalpy of ionization of HA.



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25. ΔH for the reaction at 298 K $CO(g) + 1/2O_2(g)$ is $282.85 \text{ KJ mol}^{-1}$.

Calculate ΔU of the reaction.



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Problem

1. A gas contained in a cylinder fitted with a frictionless piston expands against a constant external pressure of 1 atm from a volume of 5 litres to a volume of 10 litres. In doing so it absorbs 400 J of thermal energy from its surroundings. Determine the change in internal energy of system.



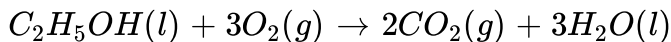
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2. The standard enthalpies of formation of

$C_2H_5(OH)(l)$, $CO_2(g)$ and $H_2O(l)$ are

-277 , -393.5 and $-285.5 \text{ kJ mol}^{-1}$ respectively.

Calculate the standard enthalpy change for the reaction



The enthalpy of formation of $O_2(g)$ in the standard state is Zero, by definition



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3. Calculate the value of ΔU and ΔH on heating 128.0 g of oxygen from $0^\circ C$ to $100^\circ C$. C_V and C_P on an average are 21 and 29 $J\ mol^{-1}\ K^{-1}$. (The difference is 8 $J\ mol^{-1}\ K^{-1}$ which is approximately equal to R)



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4. Calculate the enthalpy of combustion of ethylene at 300 K at constant pressure, if its heat of combustion at constant volume (ΔU) is -1406 kJ.



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5. If an automobile engine burns petrol at a temperature of 816°C and if the surrounding temperature is 21°C , calculate its maximum possible efficiency.



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6. Calculate the standard entropy change for the following reaction (ΔS_f^0), given the standard entropies of $\text{CO}_2(g)$, $\text{C}(s)$, $\text{O}_2(g)$ as 213.6, 5.740 and 205 JK^{-1} respectively.



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7. Calculate the entropy change during the melting of one mole of ice into water at 0°C and 1 atm pressure. Enthalpy of fusion of ice is 6008 J mol^{-1}



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8. Show that the reaction $CO + \left(\frac{1}{2}\right)O_2 \rightarrow CO_2$ at 300K is spontaneous. The standard Gibbs free energies of formation of CO_2 and CO are -394.4 and $-137.2\text{kJ mole}^{-1}$ respectively.



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9. Calculate ΔG^0 for conversion of oxygen to ozone $3/2O_2 \rightleftharpoons O_{3(g)}$ at 298 K, if K_p for this conversion is 2.47×10^{-29} in standard pressure units.



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Evaluate Yourself

1. Calculate ΔH_f^0 for the reaction $CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$ given that ΔH_f^0 for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are -393.5 , -111.31 and -242 kJ mol^{-1} respectively.



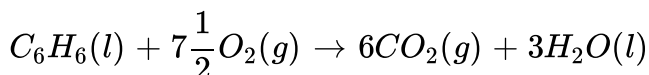
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2. Calculate the amount of heat necessary to raise 180 g of water from 25°C to 100°C . Molar heat capacity of water is $75.3 \text{ J mol}^{-1}\text{K}^{-1}$



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3. From the following data at constant volume for combustion of benzene, calculate the heat of this reaction at constant pressure condition.



$$\Delta U \text{ at } 25^{\circ}\text{C} = -3268.12\text{KJ}$$



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4. When a mole of magnesium bromide is prepared from 1 mole of magnesium and 1 mole of liquid bromine, 524 kJ of energy is released.

The heat of sublimation of Mg metal is 148 kJ mol^{-1} . The heat of dissociation of bromine gas into atoms is 193 kJ mol^{-1} . The heat of

vapourisation of liquid bromine is 31 kJ mol^{-1} . The ionisation energy of magnesium is 2187 kJ mol^{-1} and the electron affinity of bromine is -662 kJ mol^{-1} . Calculate the lattice energy of magnesium bromide.

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5. An engine operating between 127°C and 47°C takes some specified amount of heat from a high temperature reservoir. Assuming that there are no frictional losses, calculate the percentage efficiency of an engine.

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6. Urea on hydrolysis produces ammonia and carbon dioxide. The standard entropies of urea, H_2O , CO_2 , NH_3 are 173.8 , 70 , 213.5 and $192.5 \text{ J mole}^{-1} \text{K}^{-1}$ respectively. Calculate the entropy change for this reaction.

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7. Calculate the entropy change when 1 mole of ethanol is evaporated at 351 K. The molar heat of vaporisation of ethanol is $39.84 \text{ kJ mol}^{-1}$

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8. For a chemical reaction the values of ΔH and ΔS at 300K are -10 kJ mole^{-1} and $-20 \text{ J deg}^{-1}\text{mole}^{-1}$ respectively. What is the value of ΔG of the reaction? Calculate the ΔG of a reaction at 600 K assuming ΔH and ΔS values are constant. Predict the nature of the reaction.

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Evaluation Choose The Best Answer

1. The amount of heat exchanged with the surrounding at constant temperature and pressure is given by the quantity

A. ΔE

B. ΔH

C. ΔS

D. ΔG

Answer: B



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2. All the naturally occurring processes proceed spontaneously in a direction which leads to

A. decrease in entropy

B. increase in enthalpy

C. increase in free energy

D. decrease in free energy

Answer: D

3. In an adiabatic process, which of the following is true ?

A. $q = w$

B. $q = 0$

C. $\Delta E = q$

D. $P\Delta V = 0$

Answer: B

4. In a reversible process, the change in entropy of the universe is

A. > 0

B. ≥ 0

C. < 0

D. $d = 0$

Answer: D



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5. In an adiabatic expansion of an ideal gas

A. $w = -\Delta u$

B. $w = \Delta u + \Delta H$

C. $\Delta u = 0$

D. $w = 0$

Answer: A



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6. The intensive property among the quantities below is

A. mass

B. volume

C. enthalpy

D. $\frac{\text{mass}}{\text{volume}}$

Answer: D



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7. An ideal gas expands from the volume of $1 \times 10^{-3} m^3$ to $1 \times 10^{-2} m^3$ at 300 K against a constant pressure at $1 \times 10^5 Nm^{-2}$. The work done is

A. $-900J$

B. $900kJ$

C. $270kJ$

D. $-900kJ$

Answer: A



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8. Heat of combustion is always

- A. positive
- B. negative
- C. zero
- D. either positive or negative

Answer: B



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9. The heat of formation of CO and CO_2 are -26.4 kCal and -94 kCal, respectively. Heat of combustion of carbon monoxide will be

A. $+26.4\text{kcal}$

B. -67.6kcal

C. -120.6kcal

D. $+52.8\text{kcal}$

Answer: B



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10. $\text{C(diamond)} \rightarrow \text{C(graphite)}, \Delta H = -ve$, this indicates that

A. graphite is more stable than diamond

B. graphite has more energy than diamond

C. both are equally stable

D. stability cannot be predicted

Answer: A



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11. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are - 1596 kJ and -1134 kJ, respectively.

ΔH for the reaction $2Al + Cr_2O_3 \rightarrow 2Cr + Al_2O_3$ is

A. $-1365kJ$

B. 2730 kJ

C. $-2730kJ$

D. $-462kJ$

Answer: D



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12. Which of the following is not a thermodynamic function ?

A. internal energy

B. enthalpy

C. entropy

D. frictional energy

Answer: D



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

A. $\Delta H > \Delta U$

B. $\Delta H - \Delta U = 0$

C. $\Delta H + \Delta U = 0$

D. $\Delta H < \Delta U$

Answer: D



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

A. $+1\text{kJ}$

B. -5kJ

C. $+3\text{kJ}$

D. -3kJ

Answer: C



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

A. -2.48kJ

B. -2.22kJ

C. $+2.22\text{kJ}$

D. $+2.48kJ$

Answer: A



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16. The value of ΔH for cooling 2 moles of an ideal monatomic gas from $125^{\circ}C$ to $25^{\circ}C$ at constant pressure will be $\left[\text{given } C_P = \frac{5}{2}R \right]$

A. $-250R$

B. $-500R$

C. $500R$

D. $+250R$

Answer: B

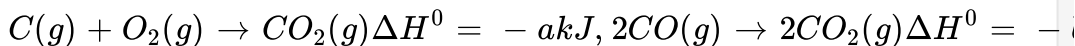


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17.

Given

that



Calculate the ΔH^0 for the reaction $C(g) + \frac{1}{2}O_2(g) \rightarrow CO(g)$

A. $\frac{b + 2a}{2}$

B. $2a - b$

C. $\frac{2a - b}{2}$

D. $\frac{b - 2a}{2}$

Answer: D



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18. When 15.68 litres of a gas mixture of methane and propane are fully combusted at $0^\circ C$ and 1 atmosphere, 32 litres of oxygen at the same temperature and pressure are consumed. The amount of heat released from this combustion in kJ is

$$(\Delta H_C(CH_4) = -890 \text{ kJ mol}^{-1} \text{ and } \Delta H_C(C_3H_8) = -2220 \text{ kJ mol}^{-1})$$

A. -889kJ

B. -1390kJ

C. -3180kJ

D. -653.66kJ

Answer: D



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19. The bond dissociation energy of methane and ethane are 360 kJ mol^{-1} and 620 kJ mol^{-1} respectively. Then, the bond dissociation energy of C-C bond is

A. 170 kJ mol^{-1}

B. 50 kJ mol^{-1}

C. 80 kJ mol^{-1}

D. 220 kJ mol^{-1}

Answer: C



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20. The correct thermodynamic conditions for the spontaneous reaction at all temperature is (NEET Phase - I)

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: A



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21. The temperature of the system, decreases in an _____

- A. Isothermal expansion
- B. Isothermal Compression
- C. adiabatic expansion
- D. adiabatic compression

Answer: C



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22. In an isothermal reversible compression of an ideal gas the sign of q , ΔS and w are respectively

- A. $+$, $-$, $-$
- B. $-$, $+$, $-$
- C. $+$, $-$, $+$
- D. $-$, $-$, $+$

Answer: D

23. Molar heat of vapourisation of a liquid is 4.8 kJ mol^{-1} . If the entropy change is $16 \text{ J mol}^{-1} \text{ K}^{-1}$, the boiling point of the liquid is

A. 323 K

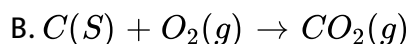
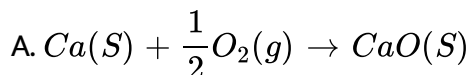
B. 27°C

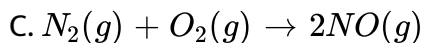
C. 164 K

D. 0.3 K

Answer: B

24. ΔS is expected to be maximum for the reaction





Answer: D



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25. The values of ΔH and ΔS for a reaction are respectively 30 kJ mol^{-1} and $100 \text{ JK}^{-1} \text{ mol}^{-1}$. Then the temperature above which the reaction will become spontaneous is

A. 300 K

B. 30 K

C. 100 K

D. 20°C

Answer: A



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Evaluation

1. Calculate the work done when 2 moles of an ideal gas expands reversibly and isothermally from a volume of 500 ml to a volume of 2 L at 25°C and normal pressure.



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2. In a constant volume calorimeter, 3.5 g of a gas with molecular weight 28 was burnt in excess oxygen at 298 K. The temperature of the calorimeter was found to increase from 298 K to 298.45 K due to the combustion process. Given that the calorimeter constant is 2.5kJK^{-1} . Calculate the enthalpy of combustion of the gas in kJ mol^{-1} .



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3. Calculate the entropy change in the system, and surroundings, and the total entropy change in the universe during a process in which 245 J of heat flow out of the system at 77°C to the surrounding at 33°C .



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4. 1 mole of an ideal gas, maintained at 4.1 atm and at a certain temperature, absorbs heat 3710J and expands to 2 litres. Calculate the entropy change in expansion process.



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5. 30.4 kJ is required to melt one mole of sodium chloride. The entropy change during melting is $28.4\text{JK}^{-1}\text{mol}^{-1}$. Calculate the melting point of sodium chloride.



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6. Calculate the standard heat of formation of propane, if its heat of combustion is $-2220.2 \text{ kJ mol}^{-1}$. the heats of formation of $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$ are -393.5 and $-285.8 \text{ kJ mol}^{-1}$ respectively.

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7. You are given normal boiling points and standard enthalpies of vapourisation. Calculate the entropy of vapourisation of liquids listed below.

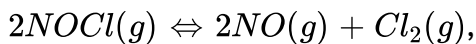
S. No	Liquid	Boiling points ($^{\circ}\text{C}$)	ΔH (kJ mol^{-1})
1.	Ethanol	78.4	+ 42.4
2.	Toluene	110.6	+ 35.2

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8. For the reaction $Ag_2O(S) \rightarrow 2Ag(s) + \frac{1}{2}O_2(g)$: $\Delta H = 30.56 \text{ kJ mol}^{-1}$ and $\Delta S = 6.66J$ (at 1 atm). Calculate the temperature at which ΔG is equal to zero. Also predict the direction of the reaction (i) at this temperature and (ii) below this temperature.

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9. What is the equilibrium constant K_{eq} for the following reaction at 400K

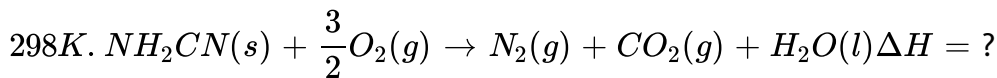


given that $\Delta H^0 = 77.2 \text{ kJ mol}^{-1}$, and $\Delta S^0 = 122JK^{-1} \text{ mol}^{-1}$.

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10. Cyanamide (NH_2CN) is completely burnt in excess oxygen in a bomb calorimeter, ΔU was found to be $-742.4 \text{ kJ mol}^{-1}$, calculate the

enthalpy change of the reaction at

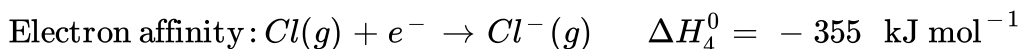
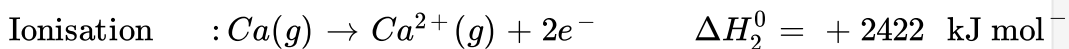
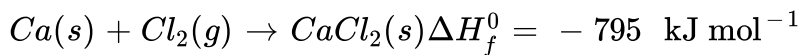


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11. Calculate the enthalpy of hydrogenation of ethylene from the following data. Bond energies of $C-H$, $C-C$, $C=C$ and $H-H$ are 414, 347, 618 and $435 kJ mol^{-1}$.

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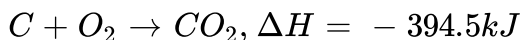
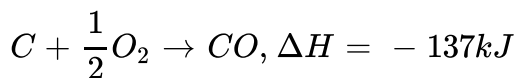
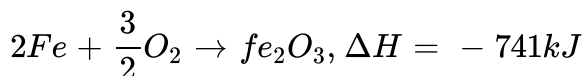
12. Calculate the lattice energy of $CaCl_2$ from the given data



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13. Calculate the enthalpy change for the reaction

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ from the following data.



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14. When 1-pentyne (A) is treated with 4N alcoholic KOH at $175^\circ C$, it is converted slowly into an equilibrium mixture of 1.3% 1-pentyne(A) , 95.2% 2-pentyne(B) and 3.5% of 1,2 pentadiene (C) the equilibrium was maintained at $175^\circ C$, calculate ΔG_0 for the following equilibria.



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15. At $33K$, N_2O_4 is fifty percent dissociated. Calculate the standard free energy change at this temperature and at one atmosphere.

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16. The standard enthalpies of formation of SO_2 and SO_3 are -297 kJ mol^{-1} and -396 kJ mol^{-1} respectively. Calculate the standard enthalpy of reaction for the reaction: $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$

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17. For the reaction at 298 K: $2A + B \rightarrow C$

$\Delta H = 400 \text{ J mol}^{-1}$, $\Delta S = 0.2 \text{ JK}^{-1} \text{ mol}^{-1}$ Determine the temperature at which the reaction would be spontaneous.

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18. Find out the value of equilibrium constant for the following reaction at 298K, $2NH_3(g) + CO_2(g) \rightleftharpoons NH_2CONH_2(aq) + H_2O(l)$ Standard Gibbs energy change, ΔG_r^0 at the given temperature is $-13.6 \text{ kJ mol}^{-1}$.

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19. A gas mixture of 3.67 lit of ethylene and methane on complete combustion at 25°C and at 1 atm pressure produce 6.11 lit of carbondioxide. Find out the amount of heat evolved in kJ, during this combustion.

$$\left(\Delta H_C(\text{CH}_4) = -890 \text{ kJ mol}^{-1} \text{ and } \left(\Delta H_C(\text{C}_2\text{H}_4) = -1423 \text{ kJ mol}^{-1}\right.\right.$$

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