PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

HEAT AND CALORIMETRY

Example

1. When 300 J of heat is added to $25 gm$ of sample of a material its temperature rises from $25^\circ C$ to $45^\circ C$. The thermal capacity of the sample and specific heat of the material are respectively given by

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2. The temperature of equal masses of three different liquids A,B and C are $12^{\circ}C, 19^{\circ}C$ and $28^{\circ}C$ respectively. The temperature when A and B are mixed is $16^{\circ}C$ and when B and C are mixed it is $23^{\circ}C$. What should be the temperature when A and C are mixed?

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3. A lead bullet penetrates into a solid object and melts. Assuming that 50% of its kinetic energy was used to heat it, calculate the initial speed of the bullet. The initial temperature of the bullet is $27^\circ C$ and its melting point is $327^\circ C$. Latent heat of fusion of lead $= 2.5 \times 10^4 J/kg$ and specific heat capacity of lead $= 125 J/kg. K.$

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4. A lead ball at $30^{\circ} C$ is dropped from a height of $6.2 km$. The ball is heated due to the air resestance and it completely melts just before reaching the ground. The molten substance falls slowly on the ground. Calculate the latent heat of fusion of lead. Specific heat capacity of lead $= 126 J / Kg -^{\circ} C$ and the melting point of lead $= 330^{\circ} C$. Assume that any mechanical energy lost is used to heat the ball.

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5. A piece of iron of mass $100g$ is kept inside a furnace for a long time and then put in a calorimeter of water equivalent $10g$ containing $240g$ of water at $20^\circ C$. The mixture attains an equilibrium temperature of $60^\circ C$. Find the temperature of the furnace.

Specific heat capacity of iron $= 470 J kg^{-1} .^\circ C^{-1}$

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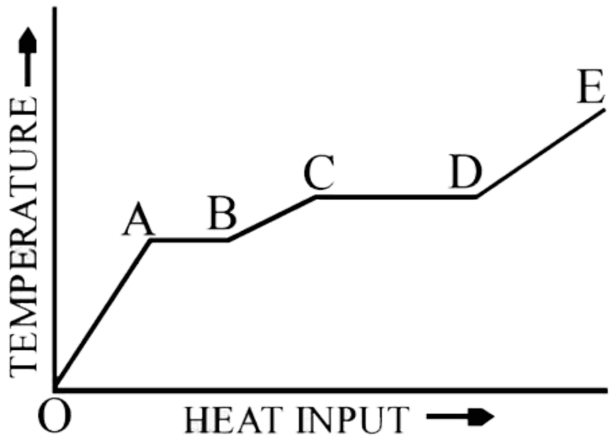
6. A solid material is supplied with heat at a constant rate. The temperature of the material is changing with the heat input as shown in the graph in figure. Study the graph carefully and answer the following questions:



(i) What do the horizontal regions AB and CD represent?

If CD is equal to 2AB, what do you infer?

What does the slope of DE represents?

The slope of OAgtthe slope of BC. What does this indicate?

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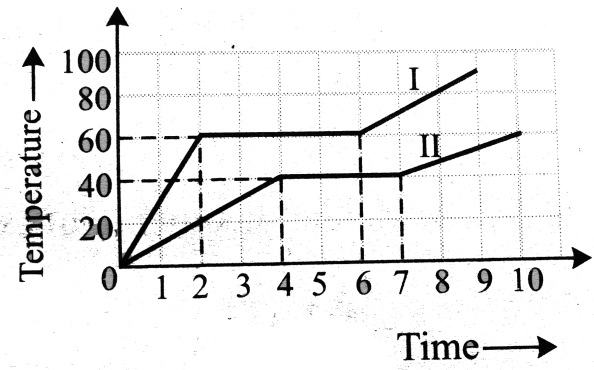

7.

Two bodies of equal masses are heated at a uniform rate under identical conditions. The change in temperature in the two cases in shown graphically. What are their melting points?

Find the ratio of their specific heats and latent heats.

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8. Calculate the amount of heat required to convert 10 g ice at $-10^{\circ} C$ into steam at $120^{\circ} C$ at normal pressure. If heat is supplied uniformly at the rate $50 cal / s$, sketch variation temperature with time

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9. A 5 g piece of ice at $-20^\circ C$ is put into 10 g of water at $30^\circ C$. Assuming that heat is exchanged only between the ice and water. The final temperature of the mixture.

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10. Four $2cm \times 2cm \times 2cm$ cubes of ice are taken from a refrigerator and put in $200ml$ of a drink at $10^\circ C$

(a) Find the temperature of the drink when thermal equilibrium is attained in it.

(b) If the ice cubes do not melt completely, find the amount melted.

Assume that no heat is lost to the outside of the drink and that the container has negligible heat capacity. Density of ice $= 900 kgm^{-8}$, density of the drink $= 1000 kgm^{-8}$, specific heat capacity of the drink $= 4200 Jkg^{-1}K^{-1}$,latent heat of fusion of ice $= 3.4 \times 10^6 Jkg^{-1}$

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11. (a) The temperature of 100 g of water is to be raised form $10^\circ C$ to $40^\circ C$ by adding steam at $100^\circ C$ to it. Determine the mass of the steam required for this purpose.

(b) How much steam at $100^\circ C$ will just melt 2700 g of ice at $-10^\circ C$?

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12. Steam at $100^\circ C$ is allowed to pass into a vessel containing $10g$ of ice and 100 g of water at $0^\circ C$ until all the ice is melted and the temperature is raised to $50^{\circ}C$. Neglecting water equivalent of the vessel and the loss due to radiation etc. Calculate how much steam is condensed.

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13. $1kg$ ice at $0^{\circ}C$ is mixed with $1kg$ of steam at $100^{\circ}C$. What will be the composition of the system when thermal equilibrium is reached ? Latent heat of fusion of ice $= 3.36 \times 10^{6} Jkg^{-1}$ and latent heat of vaporization of water $= 2.26 \times 10^{6} Jkg^{-1}$

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14. A mixture of 250 g of water and 200 g of ice at $0^{\circ}C$ is kept in a calorimeter which has a water equivalent of 50 g. If 200 g of steam at $100^{\circ}C$ is passed through this mixture, calculate the final temperature and the weight of the contents of the calorimeter.

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15. An ice cube of mass 0.1 kg at $0^\circ C$ is placed in an isolated container which is at $227^\circ C$. The specific heat s of the container varies with temperature T according to the empirical relation $s = A + BT$, where $A = 100 cal/kg.K$ and $B = 2 \times 10^{-2} cal/kg.K^2$. If the final temperature of the container is $27^\circ C$, determine the mass of the container.

(Latent heat of fusion for water = $8 \times 10^4 cal/kg$, specific heat of water $= 10^3 cal/kg.K$).

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Exercise

1. Heat and work are equivalent i.e.,

A. when we supply heat to a body we do work on it

B. when we do work on a body we supply heat to it

C. the temperature of a body can be increased by doing work on it.

D. a body kept at rest may be set into motion by supplying heat on it

Answer: C

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2. The temperature of an object is observed to rise in a period. In this period

(i) Heat is certainly supplied to it

(ii) Heat is certainly not supplied to it

(iii) heat may have been supplied to it

(iv) work may have been done on it.

A. (i),(iii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: C

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3. If heat is supplied to s solid its temperature

(i) must increase

(ii) may increase

(iii) may remain same

(iv) may decrease

A. (i),(iii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: B

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4. The temperature of a solid object is observed to be constant during a priod. In the period

(i) Heat may have been supplied to the body

(ii) heat may have been extracted from the body

(iii) no heat is supplied to the body

(iv) no heat is extracted from the body

A. (i),(iii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: A

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5. If specific heat of a substance is infinite, it means

A. heat is give out

B. heat is taken in

C. no change in temperature takes place whether heat is taken in or given out

D. all of the above

Answer: C

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6. Boiling water is changing into steam. Under this condition the specific heat of water is

A. zero

B. one

C. infinite

D. less than one

Answer: C

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7. Calorie is defined as the amount of heat required to raise temperature of 1 g of water by $1^\circ C$ and it is defined under which of the following conditions?

A. from $14.5^{\circ} C$ to $15.5^{\circ} C$ at 760 mm of Hg

B. from $98.5^{\circ} C$ to $99.5^{\circ} C$ to 760 mm of Hg

C. from $13.5^{\circ} C$ to $14.5^{\circ} C$ at 76 mm of Hg

D. from $3.5^{\circ} C$ to $4.5^{\circ} C$ at 76 mm of Hg

Answer: A

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8. A metallic ball and highly stretched spring are made of the same material and have the same mass. They are heated so that they melt. The latent heat required

A. are the same for both

B. is greater for the ball

C. is greater for the spring

D. for the two may or may not be the same depending upon the metal

Answer: A

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9. A $50kg$ man is running at a speed of $18kmH^{-1}$ If all the kinetic energy of the man be uses to increase the temperature of water from $30^{\circ}C$.How much water can be heated with this energy?

A. 5 g

B. 10 g

C. 15 g

D. 20 g

Answer: C

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10. A ball is dropped on a floor from a height of $2.0m$. After the collision it rises up to a height of $1.5m$. Assume that 40% of the mechanical energy lost goes as thermal energy into the ball.Calculate the rise in the temperature of the ball in the collision. Heat capacity of the ball is $800JK^{-1}$

A. $10^{-3\circ}C$

B. $1.5 \times 10^{-3\circ}C$

C. $2 \times 10^{-3\circ}C$

D. $2.5 \times 10^{-3} {}^{\circ}C$

Answer: D

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11. A lead bullet strikes against a steel plate with a velocity $200ms^{-1}$. If the impact is perfectly inelastic and the heat produced is equally shared between the bullet and the target, thent he rise in temperature of the bullet is (specific heat capacity of lead $= 125Jkg^{-1}K^{-1}$)

A. $80^\circ C$

B. $60^\circ C$

C. $160^\circ C$

D. $40^\circ C$

Answer: A

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12. A lead bullet penetrates into a solid object and melts. Assuming that 50% of its kinetic energy was used to heat it, calculate the initial speed of the bullet. The initial temperature of the bullet is $27^{\circ} C$ and its melting point is $327^{\circ} C$. Latent heat of fusion of lead $= 2.5 \times 10^{4} J / kg$ and specific heat capacity of lead $= 125 J / kg. K$.

A. $100 m / s$

B. $500 m / s$

C. $800 m / s$

D. $1000 m / s$

Answer: B

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13. An electric kettle takes $4A$ current at $220V$. How much time will it take to boil $1kg$ of wate from temperature $20^\circ C$? The temperature of boiling water is $100^\circ C$

A. 12.6 min

B. 4.2 min

C. 6.3 min

D. 8.4 min

Answer: C

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14. Hailstone at $0^{\circ} C$ from a height of 1 km on an insulating surface converting whole of its kinetic energy into heat. What part of it will melt? ($g = 10m / s)$

A. $\frac{1}{33}$

B. $\frac{1}{8}$

C. $\frac{1}{33} \times 10^{-4}$

D. all of it

Answer: A

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15. Two bodies at different temperature are mixed in a calorimeter.Which of the following quantities remain conserved?

A. sum of the temperatures of the two bodies

B. total heat of the two bodies

C. total internal energy of the two bodies

D. internal energy of each body

Answer: C

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16. A liquid of mass m and specific heat c is heated to a temperature 2T. Another liquid of mass m/2 and specific heat 2 c is heated to a temperature T. If these two liquids are mixed, the resulting temperature of the mixture is

A. $(2/3)T$

B. $(8/5)T$

C. $(3/5)T$

D. $(3/2)T$

Answer: D

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17. Two liquids A and B are at $30^\circ C$ and $20^\circ C$, respectively When they are mixied in equal masses, the temperature of the mixture is found to be $26^\circ C$. The ratio of their specific heat is

A. $4:3$

B. $3:4$

C. $2:3$

D. $3:2$

Answer: D

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18. A vessel contains $110g$ of water. The heat capacity of the vessel is equal to $10g$ of water. The initial temperature of water in vessel is

$10^{\circ} C$. If $220 g$ of ho, water at $70^{\circ} C$ is poured in the vessel, the final temperature neglecting radiation loss, will be

A. $70^{\circ} C$

B. $80^{\circ} C$

C. $60^{\circ} C$

D. $50^{\circ} C$

Answer: D

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19. The temperature of equal masses of three different liquids A, B and C are $30^\circ C, 60^\circ C$ and $75^\circ C$ respectively. The temperature when A and B are mixed is $50^\circ C$ and when B and C are mixed, it is $70^\circ C$. The equilibrium temeprature when A and C are mixed will be

A. $56^\circ C$

B. $66^\circ C$

C. $50^\circ C$

D. $60^\circ C$

Answer: B

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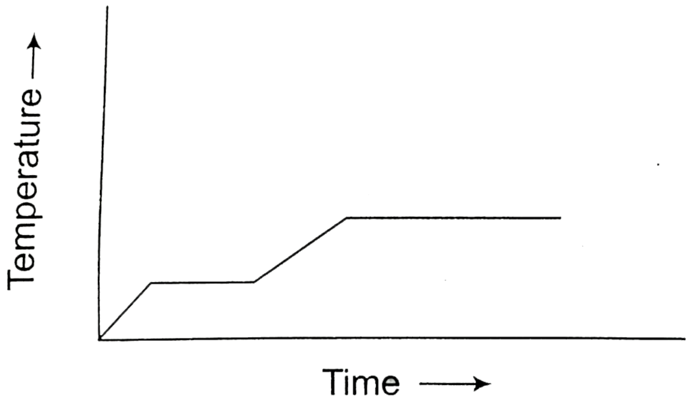
20.



Heat is supplied to a certain homogeneous sample of matter, at a uniform rate. Its temperature is plotted against time, as shown Which of the following conclusions can be drawn?

(i) Its specific heat capacity is greater in the solid state than the liquid state.

(ii) Its specific heat capacity is greater in the liquid state than in the solid state.

(iii) Its latent heat of vaporization is greater than its latent heat of fusion.

(iv) Its latent heat of vaporization is smaller than its latent heat of fusion

A. (i),(iii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: B

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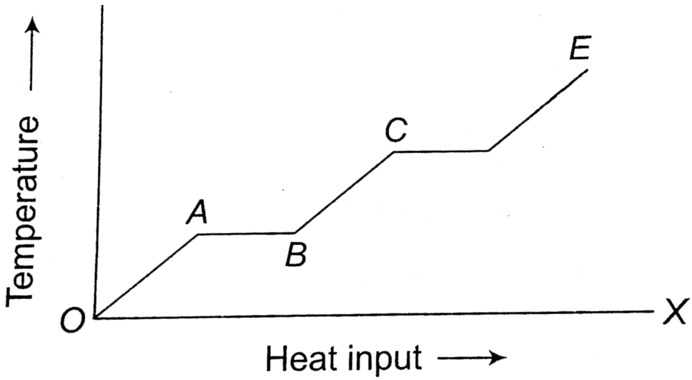
21.



A solid material is supplied with heat at a constant rate. The temperature of the material is changing with heat input as shown

(i) AB: change of state from solid to liquid.

CD: change of state from liquid to vapour

(ii) When $CD = 2AB$, i.e., latent heat of vapourization is twice the latent heat of fusion of the substance.

(iii) The reciprocal of slope of DE represents the heat capacity of vapour state of substance .

(iv) If slope of $OA >$ slope of BC, i.e., specific heat of liquid state is greater than specific heat that of solid state.

A. (i),(iii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: D

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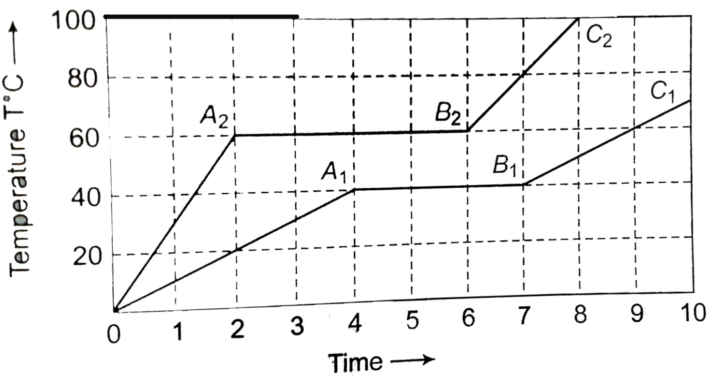
22. 

Two bodies of equal mass m are heated at a uniform rate under identical condition. Their change in temperature are shown. Then

(i) The ratio of melting point of the substances is 1.5

(ii) the ratio of their latent heats is 0.75

(iii) the ratio of specific heat of two substances is 0.33 in solid state

(iv) the ratio of specific heat of two substances is 2 in liquid state.

A. (i),(iii)

B. (ii),(iii)

C. (iii),(iv)

D. all

Answer: D

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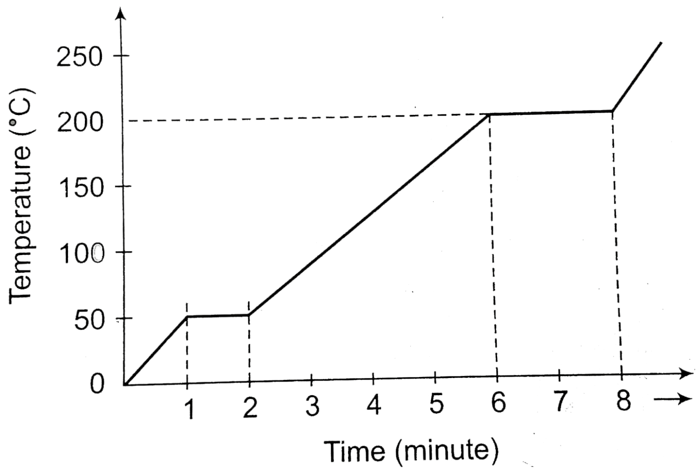
23.



A student takes 50 g wax (specific heat $= 0.6 kcal / kg^{\circ} C$) and heats it till it boils. The graph between temperature and time is as follows. Heat supplied to the wax per minute and boiling point are respectively.

A. $500cal, 50^\circ C$

B. $1000cal, 100^\circ C$

C. $1500cal, 200^\circ C$

D. $1000cal, 200^\circ C$

Answer: C

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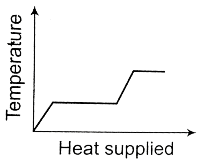
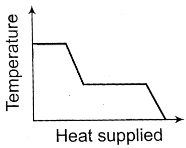
24. A block of ice at $-10^\circ C$ is slowly heated and converted to steam at $100^\circ C$. Which of the following curves represents the phenomenon qualitatively?

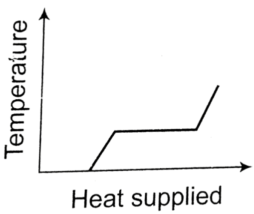
A. (1)

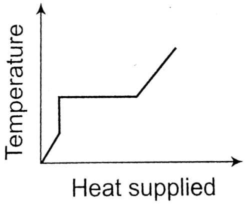


B. (2)



C.



D. 

Answer: C

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25. A substance of mass M kg requires a power input of P wants to remain in the molten state at its melting point. When the power source is turned off, the sample completely solidifies in time t seconds. The latent heat of fusion of the substance is ....

A. $\frac{Pm}{t}$

B. $\frac{Pt}{m}$

C. $\frac{m}{Pt}$

D. $\frac{t}{Pm}$

Answer: B

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26. 80 g of water at $30^\circ C$ are poured on a large block of ice at $0^\circ C$. The mass of ice that melts is

A. $30g$

B. $80g$

C. $1600g$

D. $150g$

Answer: A

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27. 10 g of ice at $0^\circ C$ is mixed with 100 g of water at $50^\circ C$. What is the resultant temperature of mixture

A. $31.2^{\circ} C$

B. $32.8^{\circ} C$

C. $36.8^{\circ} C$

D. $38.2^{\circ} C$

Answer: D

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28. A piece of ice of mass of $100g$ and at temperature $0^{\circ} C$ is put in $200g$ of water of $25^{\circ} C$ .How much ice will melt as the temperature of the water reaches $0^{\circ}C$? The specific heat capacity of water $= 2400 J kg^{-1} K^{-1}$ and the specific latent heat of ice $= 3.4 \times 10^{3} J kg^{-1}$

A. 20 g

B. 30 g

C. 40 g

D. 50 g

Answer: D

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29. A 5 g piece of ice at $-20^{\circ}C$ is put into 10 g of water at $30^{\circ}C$. Assuming that heat is exchanged only between the ice and water. The final temperature of the mixture.

A. $10^{\circ}C$

B. $20^{\circ}C$

C. $0^{\circ}C$

D. $15^{\circ}C$

Answer: C

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30. 19 g of water at $30^{\circ}C$ and 5 g of ice at $-20^{\circ}C$ are mixed together in a calorimeter. What is the final temperature of the mixture? Given specific heat of ice $= 0.5 cal g^{-1} (.^{\circ} C)^{-1}$ and latent heat of fusion of ice $= 80 cal g^{-1}$

A. $0^{\circ}C$

B. $-5^{\circ}C$

C. $5^{\circ}C$

D. $10^{\circ}C$

Answer: C

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31. 2kg of ice at $20^{\circ} C$ is mixed with 5kg of water at $20^{\circ} C$ in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water & ice are $1kcal / kg /^{\circ} C$ and 0.5 $kcal / kg /^{\circ} C$ while the latent heat of fusion of ice is $80kcal / kg$

A. 7 kg

B. 6 kg

C. 4 kg

D. 2 kg

Answer: B

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32. 1 kg of ice at $0^\circ C$ is mixed with 1 kg of steam at $100^\circ C$

(i) The equilibrium temperature is $100^\circ C$

(ii) The equilibrium temperature is $0^\circ C$

(iii) The contents of mixture are : 665 g steam, 1335 g water

(iv) The contents of mixture are 800 g steam, 1200 g water

A. (i),(iii)

B. (ii),(iii)

C. (i),(iv)

D. (ii),(iv)

Answer: A

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33. How much steam at $100^{\circ}C$ will just melt 64 gm of ice at $-10^{\circ}C$?

A. 8.5 g

B. 6.5 g

C. 4.5 g

D. 2.5 g

Answer: A

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34. Steam at $100^{\circ} C$ is allowed to pass into a vessel containing 10 g of ice and 100 g of water at $0^{\circ} C$, until all the ice is melted and the temperature is raised to $40^{\circ} C$. Neglecting water equivalent of the vessel and the loss due to radiation etc. The approximate amount of steam condensed is

A. 9 g

B. 18 g

C. 15 g

D. 21 g

Answer: A

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35. Steam is passes into 22 g of water at $20^\circ C$. The mass of water that will be present when the water acquires a temperature of $90^\circ C$ (Latent heat of steam is $540 cal / g$) is

A. 24.8 g

B. 24 g

C. 36.6 g

D. 30 g

Answer: A

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36. If water at $0^{\circ}C$ kept in a container with an open top, is placed a large evacuated chamber,

A. all the water will vaporize

B. all the water will freeze

C. part of the water will vaporize and the rest will freeze

D. ice, water and water vapour will be formed and reach equilibrium at the triple point

Answer: C

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37. In the previous question, if the specific latent heat of vaporization of water at $0^\circ C$ is η times the specific latent heat of freezing of water at

$0^\circ C$, the fraction of water that will ultimately freeze is

A. $\frac{1}{\eta}$

B. $\frac{\eta}{\eta+1}$

C. $\frac{\eta-1}{\eta}$

D. $\frac{\eta-1}{\eta+1}$

Answer: B

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