PHYSICS

BOOKS - SELINA PHYSICS (ENGLISH)

CALORIMETRY

Examples

1. (a) An iron ball requires 5000 J heat energy to raise its temperature by 10° C. Calculate the heat capacity of the iron ball.

(b) If mass of ball is 1.1 kg, find the specific heat capacity of iron.

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2. Calculate the heat energy required to raise the temperature of 2 kg of water from 10° C to 50° C. Specific heat capacity of water is 4200 J $kg^{-1}K^{-1}$.

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3. A metal piece of mass 50 g at 27°C requires 2400 J of heat energy in order to raise its temperature to 327°C. Calculate the specific heat capacity of the metal.

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4. Some heat energy is given to 120 g of water and its temperature rises by 10 K. When the same amount of heat energy is given to 60 g of oil, its temperature rises by 40 K. The

specific heat capacity of water is 4200 J kg-K^{-1}. Calculate : (i) the amount of heat energy in joule given to water, and (ii) the specific heat capacity of oil.

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5. An electric heater of power 1000 W raises the temperature of 5 kg of a liquid from 25°C to 31°C in 2 minutes. Calculate : (i) the heat capacity, and (ii) the specific heat capacity of liquid.

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6. A bucket contains 8 kg of water at 25°C. 2 kg of water at 80°C is poured into it. Neglecting the heat energy absorbed by the bucket, calculate the final temperature of water.

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7. 40 g of water at 60°C is poured into a vessel containing 50 g of water at 20°C. The final

temperature of mixture is 30°C. Taking the specific heat capacity of water as 4.2 J g-K-1, calculate the heat capacity of the vessel.

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8. A metal piece of mass 20 g is heated to a constant temperature of 100°C. Then it is added in a calorimeter of mass 50 g and specific heat capacity 0.42 J $g^{-1}K^{-1}$, containing 50 g of water at 20°C. After stirring the water, the highest temperature

recorded is 22°C. Calculate the specific heat capacity of metal.

Specific heat capacity of water = $4.2Jg^{-1}K^{-1}$

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9. A hot iron ball of mass 0.2 kg is added into 0.5 kg of water at 10°C. The resulting temperature is 30°C. Calculate the temperature of hot ball. Specific heat capacity of iron = 336 J $kg^{-1}K^{-1}$ and specific heat capacity of water = $4.2 \times 10^3 \quad J \quad kg^{-1}K^{-1}$.

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10. What mass of a liquid A of specific heat capacity 0.84 J $g^{-1}K^{-1}$ at a temperature 40° C must be mixed with 100 g of a liquid B of specific heat capacity 2.1 J $g^{-1}K^{-1}$ at 20° C, so that the final temperature of mixture becomes 32° C ?

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11. Water initially at 20°C at a height of 1.68 km above the ground, falls down on ground. Taking the specific heat capacity of water to be 4200 J $kg^{-1}K^{-1}$, find the final temperature of water on reaching the ground. Take g = 10 m s^{-2}.

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12. A slab of ice at 0°C is constantly heated till the steam is formed at 100°C. Draw a graph

showing the change in temperature with time.

Label the various parts of the graph properly.

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13. A piece of ice is heated at a constant rate. The variation in temperature with time of heating is shown in the graph in Fig. 11.6.

(i) What is represented by the part AB ?

(ii) What does the part CD represent ?

(iii) What conclusion do you draw regarding the nature of ice from the graph ?

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14. A substance initially in solid state at 0°C is heated. The graph showing the variation in temperature with the amount of heat supplied is shown in Fig. 11.7. If the specific heat capacity of the solid substance is 500 J kg^{-1} ^ o C^{-1}, use graph to find : (i) the mass of the substance, and (ii) the specific latent heat of fusion of the substance in the liquid state.

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15. How much heat energy is required to melt 5 kg of ice ? Specific latent heat of ice = 336 J g^{-1}

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16. The temperature of 300 g of water at 40° C is lowered to 0° C by adding ice to it. Find the mass of ice added if specific heat capacity of water is 4.2 J $g^{-1}K^{-1}$ and specific latent heat of ice is 336 J g^{-1}

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17. How much boiling water at 100°C is needed to melt 2 kg of ice so that the mixture, which is all water, is at 0°C ? Given : specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$, specific latent heat of ice = 336 J g^{-1}.

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18. Heat energy is supplied at a constant rate to 400 g of ice at 0°C. The ice is converted into water at 0°C in 5 minutes. How much time will be required to raise the temperature of water from 0°C to 100°C ?

Specific latent heat of ice = 336 J g^{-1}, specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$

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19. Calculate the power of an electric heater required to melt 1 kg of ice at 0°C in 30 s if the efficiency of heater is 40%. Take specific latent heat of ice = 336 J g^{-1}

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20. One kilogram of ice at -10°C is heated at a constant rate until the whole of it vaporises. How much heat is required ? Specific latent heat of fusion of ice = 336×10^{3} J kg^{-1},

specific latent heat of steam = 2268×10^3 J kg^{-1}, specific heat capacity of ice = 2.1×10^3 J $kg^{-1}K^{-1}$, specific heat capacity of water = 4.2×10^3 J $kg^{-1}K^{-1}$.

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21. A cube of ice of mass 30 g at 0°C is added into 200 g of water at 30°C. Calculate the final temperature of water when whole of the ice cube has melted.

Given: specific latent heat of ice = 80 cal g^{-1},

specific heat capacity of water = 1 cal g^{-1} ^ $\circ C^{-1}$

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22. A vessel of mass 100 g contains 150 g of water at 30° C. How much ice is needed to cool it to 5°C ? Take specific heat capacity of material of vessel = 0-4 J $g^{-1}K^{-1}$, specific latent heat of fusion of ice = 336 J g- and specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$.

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23. A vessel of negligible heat capacity contains 5-0 kg of water at 50°C. If 5.0 kg of ice at 0°C is added to it, find : (i) heat energy imparted by water in fall of its temperature from 50°C to 0°C, (ii) mass of ice melted, (iii) final temperature of mixture, and (iv) mass of water at 0°C in mixture. Given : specific heat capacity of water = 4200 J $kg^{-1}K^{-1}$, specific latent heat of ice = 336 kJ kg^{-1}.

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24. What will be the result of mixing 400 g of copper chips at 500°C with 500 g of crushed ice at 0°C ?

Specific heat capacity of copper = 0.42 J $g^{-1}K^{-1}$, specific latent heat of fusion of ice = 340 J g^{-1}.

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25. An electric heater of power 150 W is immersed in 0.75 kg of ice at 0°C in a lagged container of negligible heat capacity. The

temperature remains constant for 27-5 minutes and then rises to $40-0^{\circ}\mathrm{C}$ in a further 14 minutes. Explain why does the temperature remain constant. Calculate : (a) the specific latent heat of ice, and (b) the specific heat capacity of water.

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Exercise 11 A

1. Define the term heat.

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2. Name the S.I. unit of heat. How is it related to the unit calorie?

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3. Define the term calorie. How is it related to joule ?

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4. Define one kilo-calorie of heat.

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5. Define temperature. What is its Sl unit?

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6. Write the difference between heat and temperature .

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7. Define Calorimetry.

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8. Define heat capacity and state its SI unit.

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9. Define heat capacity and state its SI unit.

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10. Specific Heat Capacity

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11. What is the difference between (i) heat capacity (ii) specific heat capacity and (iii) molar specific heat capacity.

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12. Name the liquid which has the highest specific heat capacity.

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13. Write the approximate value of specific heat capacity of water in S.I. unit

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14. What do you mean by the following statements :

(i) the heat capacity of a body is 50 J K^{-1}?

(ii) the specific heat capacity of copper is 0.4 J $g^{-1}K^{-1}$?

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15. Specific heat capacity of substance A is 3.8 J/gK, whereas the specific heat capacity of

substance B is 0.4 J/gK

Which of the two is good conductor of heat ?

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16. Name two factors on which the heat energy liberated by a body depends.

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17. Name three factors on which the heat energy absorbed by a body depends and state

how does it depend on them.

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18. Write the expression for the heat energy Q received by m kg of a substance of specific heat capacity c J $kg^{-1}K^{-1}$ when it is heated through Δt° C.

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19. An equal quantity of heat is supplied to two substances A and B. The substance A shows a greater rise in temperature. What can you say about the heat capacity of A as compared to that of B?

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20. Two metallic blocks P and Q having masses in ratio 2 : 1 are supplied with the same amount of heat. If their temperatures rise by

same degree, compare their specific heat capacities.

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21. What is the principle of method of mixture ? What other name is given to it? Name the law on which this principle is based.

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22. A mass m_1 of a substance of specific heat capacity c_1 at temperature t_1 is mixed with a mass m_2 of other substance of specific heat capacity c_2 at a lower temperature t_2. Deduce the expression for the temperature t of the mixture. State the assumption made, if any.

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23. Why do the farmers fill their fields with water on a cold winter night ?

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24. Discuss the role of high specific heat capacity of water with reference to climate in coastal areas.

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25. Water is used in hot water bottles for fomentation. Give a reason.

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26. Which property of water makes it an effective coolant ?

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27. Give one example each where high specific heat capacity of water is used (i) as coolant, (ii) as heat reservoir.

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28. A liquid X has specific heat capacity higher than the liquid Y. Which liquid is useful as (i) coolant in car radiators, and (ii) heat reservior to keep juice bottles without freezing ?

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29. (a) What is a calorimeter ?

(b) Name the material of which it is made of. Give two reasons for using the material stated by you.

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30. Why is the base of a cooking pan made thick and heavy ?

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Exercise 11 A Multiple Choice Type

1. Write the SI unit of heat capacity.

A. J kg^{-1}

B. J K^{-1}

C. J $kg^{-1}K^{-1}$

D. $cal^{\circ}C^{-1}$

Answer:

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2. The S.I. unit of specific heat capacity is :

A. J kg^{-1}

B. J K^{-1}

C. J $kg^{-1} - K^{-1}$

D. kcal kg^{-1} ^ $\circ C^{-1}$

Answer:

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3. The specific heat capacity of water is :

A. 4200 J $kg^{-1}K^{-1}$

B. 420 J $g^{-1}K^{-1}$

C. 0.42 J $g^{-1}K^{-1}$

D. 4.2 J $kg^{-1}K^{-1}$

Answer:

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Exercise 11 A Numericals

1. By imparting heat to a body, its temperature rises by 15°C. What is the corresponding rise in temperature on kelvin scale ?

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2. (a) Calculate the heat capacity of a copper vessel of mass 150 g if the specific heat capacity of copper is 410 J $kg^{-1}K^{-1}$.

(b) How much heat energy will be required to increase the temperature of the vessel in part (a) from 25° C to 35° C ?

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3. A piece of iron of mass 2.0 kg has a heat capacity of 966 J K^{-1}. Find : (i) heat energy

needed to warm it by 15°C, and (ii) its specific heat capacity in S.I. unit.

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4. Calculate the amount of heat energy required to raise the temperature of 100 g of copper from 20°C to 70°C. Specific heat capacity of copper = 390 J $kg^{-1}K^{-1}$

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5. 1300 J of heat energy is supplied to raise the temperature of 0.5 kg of lead from 20°C to 40°C. Calculate the specific heat capacity of lead.

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6. Find the time taken by a 500 W heater to raise the temperature of 50 kg of material of specific heat capacity 960 J $kg^{-1}K^{-1}$ from

18° C to 38° C. Assume that all the heat energy supplied by heater is given to the material.

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7. An electric heater of power 600 W raises the temperature of 4.0 kg of a liquid from 10.0° C to 15.0° C in 100 s. Calculate : (i) the heat capacity of 4.0 kg of liquid, and (ii) the specific heat capacity of liquid.

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8. 0.5 kg of lemon squash at 30° C is placed in a refrigerator which can remove heat at an average rate of 30 J s^{-1}. How long will it take to cool the lemon squash to 5° C ? Specific heat capacity of squash = 4200 J $kg^{-1}K^{-1}$.

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9. A mass of 50 g of a certain metal at 150° C is immersed in 100 g of water at 11° C. The final temperature is 20° C. Calculate the specific

heat capacity of the metal. Assume that the specific heat capacity of water is 4.2 $g^{-1}K^{-1}$

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10. 45 g of water at 50°C in a beaker is cooled when 50 g of copper at 18°C is added to it. The contents are stirred till a final constant temperature is reached. Calculate the final temperature. The specific heat capacity of copper is 0.39 J $g^{-1}K^{-1}$ and that of water is 4.2 J $g^{-1}K^{-1}$. State the assumption used.

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11. 200 g of hot water at 80° C is added to 300 g of cold water at 10° C. Neglecting the heat taken by the container, calculate the final temperature of the mixture of water. Specific heat capacity of water = 4200 J $kg^{-1}K^{-1}$

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12. The temperature of 600 g of cold water rises by 15° C when 300 g of hot water at 50° C

is added to it. What was the initial temperature of the cold water ?

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13. 1.0 kg of water is contained in a 1.25 kW kettle. Calculate the time taken for the temperature of water to rise from 25°C to its boiling point 100°C. Specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$.

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Exercise 11 B

1. (a) What do you understand by the change of phase of a substance ?

(b) Is there any change in temperature during the change of phase ?

(c) Does the substance absorb or liberate any heat energy during the change of phase ?

(d) What is the name given to the energy absorbed during a phase change ?

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2. A substance changes from its solid state to the liquid state when heat is supplied to it.

(a) Name the process.

(b) What name is given to heat observed by the substance.

(c) How does the average kinetic energy of molecules of the substnace change ?

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3. A substance on heating, undergoes (i) a rise in its temperature, (ii) a change in its phase

without change in its temperature. In each case, state the change in energy of molecules of the substance.

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4. How does the (a) average kinetic energy (b) average potential energy of molecules of a substance change during its change in phase at a constant temperature, on heating ?

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5. State the effect of presence of impurity on the melting point of ice. Give one use of it.

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6. State the effect of increase of pressure on the melting point of ice.

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7. The diagram in Fig. 11.8 below shows the change of phases of a substance on a temperature-time graph on heating the substances at a constant rate.

(a) What do the parts AB, BC, CD and DE represent?

(b) What is the melting point of the substance ?

(c) What is the boiling point of the substance ?

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8. 1 kg of ice at 0°C is heated at a constant rate and its temperature is recorded after every 30 s till steam is formed at 100°C. Draw a temperature-time graph to represent the change of phases.

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9. Explain the terms boiling and boiling point. How is the volume of water affected when it boils at 100°C ?

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10. How is the boiling point of water affected when some salt is added to it ?

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11. What is the effect of increase in pressure on the boiling point of a liquid ?

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12. Water boils at 120°C in a pressure cooker. Explain the reason.

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13. Write down the approximate range of temperature at which water boils in a pressure cooker.

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14. It is difficult to cook vegetables on hills and mountains. Explain the reason.

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15. Complete the following sentences :

When ice melts, its volume.....

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16. Complete the following sentences :

Decrease in pressure over ice ..... its melting point.

Watch Video Solution

17. Complete the following sentences :

Increase in pressure ..... the boiling point of water.

Watch Video Solution

18. Complete the following sentences :

A pressure cooker is based on the principle that boiling point of water increases with the .....

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19. Complete the following sentences :

The boiling point of water is defined as .....

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20. Complete the following sentences :

Water can be made to boil at 115°C by ..... pressure over its surface.

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21. What do you understand by the term latent heat ?

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22. The specific latent heat of fusion of ice is 336×10^3 J/kg. What does this statement mean?

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23. Write the approximate value of specific latent heat of ice.

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24. The specific latent heat of fusion of ice is 336 J g^{-1}. Explain the meaning of this statement.

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25. 1 g ice at 0° C melts to form 1 g water at 0° C. State whether the latent heat is absorbed or given out by ice.

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26. Which has more heat : 1 g of ice at 0° C or 1 g of water at 0° C ? Give reason.

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27. (a) Which requires more heat : 1 g ice at 0° C or 1 g water at 0° C to raise its temperature to 10° C ? (b) Explain your answer in part (a)

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28. Explain, why-one feels ice cream at $0^{\circ} C$ colder than water at $0^{\circ} C$?

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29. Why does a bottle of soft drink cool faster when surrounded by ice cubes than by ice cold water, both at $0^{\circ} C$?

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30. It is generally cold after a hail-storm than during and before the hail-storm. Give reason.

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31. It is observed that the temperature of the surroundings starts falling when the ice in a frozen lake starts melting. Give a reason for the observation.

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32. Water in lakes and ponds do not freeze at once in cold countries. Give a reason in support of your answer.

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33. Explain the following:

(a) The surrounding become pleasantly warm when water in a lake starts freezing in cold countries.

(b) The heat supplied to a substance during its

change of state, does not cause any rise in its temperature.

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Exercise 11 B Multiple Choice Type

1. The SI unit of specific latent heat is:

A. cal g^{-1}

B. cal $g^{-1}K^{-1}$

C. J kg^{-1}

D. J $kg^{-1}K^{-1}$

Answer:

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2. The specific latent heat of fusion of water is

:

A. 80 cal g^{-1}

B. 2260 J g^{-1}

C. 80 J g^{-1}

D. 336 J kg^{-1}

Answer:

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Exercise 11 B Numericals

1. 10 g of ice at 0°C absorbs 5460 J of heat energy to melt and change to water at 50°C. Calculate the specific latent heat of fusion of

ice. Specific heat capacity of water is 4200 J $kg^{-1}K^{-1}$.

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2. How much heat energy is released when 5.0 g of water at 20°C changes into ice at 0°C ? Take specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$, specific latent heat of fusion of ice = 336 J g^{-1}.

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3. A molten metal of mass 150 g is kept at its melting point 800°C. When it is allowed to freeze at the same temperature, it gives out 75,000 J of heat energy.

(a) What is the specific latent heat of the metal ?

(b) If the specific heat capacity of metal is 200 J $kg^{-1}K^{-1}$, how much additional heat energy will the metal give out in cooling to -50°C ?

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4. A solid metal weighing 150 g melts at its melting point of $800^{\circ}C$ by providing heat at the rate of 100 W. The time taken for it to completely melt at the same temperature is 4 min. What is the specific latent heat of fusion of the metal ?

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5. A refrigerator converts 100 g of water at 20°C to ice at -10°C in 73.5 min. Calculate

the average rate of heat extraction in watt. The specific heat capacity of water is 4.2 J $g^{-1}K^{-1}$, specific latent heat of ice is 336 J g^{-1} and the specific heat capacity of ice is 2.1 J $g^{-1}K^{-1}$

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6. In an experiment, 17 g of ice is used to bring down the temperature of 40 g of water at 34° C to its freezing temperature. The specific heat capacity of water is 4.2 J $g^{-1}K^{-1}$. Calculate

the specific latent heat of ice. State one important assumption made in the above calculation.

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7. The temperature of 170 g of water at 50°C is lowered to 5°C by adding certain amount of ice to it. Find the mass of ice added. Given : Specific heat capacity of water = 4200 J kg^{-1} ^ o C^{-1} and specific latent heat of ice = 336000 J kg^{-1}.

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8. Find the result of mixing 10 g of ice at -10° C with 10 g of water at 10°C. Specific heat capacity of ice = 2.1 J $g^{-1}K^{-1}$, specific latent heat of ice = 336 J g^{-1} and specific heat capacity of water = $4.2Jg^{-1}K^{-1}$.

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9. A piece of ice of mass 40 g is added to 200 g of water at 50°C. Calculate the final

temperature of water when all the ice has melted. Specific heat capacity of water = 4200 J $kg^{-1}K^{-1}$ and specific latent heat of fusion of ice = 336 $\times 10^3$ J kg^{-1}.

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10. Calculate the mass of ice needed to cool 150 g of water contained in a calorimeter of mass 50 g at 32°C such that the final temperature is 5°C. Specific heat capacity of calorimeter = 0.4 J g^{-1} ^ $\circ C^{-1}$, specific heat

capacity of water = $4.2\ \text{J}\ g^{-1\circ}C^{-1}$, latent heat capacity of ice = 330 J g^{-1}.

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11. 250 g of water at $30^\circ C$ is present in a copper vessel of mass 50 g. Calculate the mass of ice required to bring down the temperature of the vessel and its contents to $5^\circ C$.

Specific latent heat of fusion of ice = $336 \times 10^3 Jkg^{-1}$

Specific heat capacity of copper vessel =

$400 Jkg^{-1} \circ C^{-1}$

Specific heat capacity of water = $4200 Jkg^{-1} \circ C^{-1}$.

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12. How much boiling water at 100°C is needed to melt 2 kg of ice so that the mixture, which is all water, is at 0°C ? Given : specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$, specific latent heat of ice = 336 J g^{-1}.

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13. Calculate the total amount of heat energy required to convert 100 g of ice at -10°C completely into water at 100°C. Specific heat capacity of ice = 2.1 J $g^{-1}K^{-1}$, specific heat capacity of water = 4.2 J $g^{-1}K^{-1}$, specific latent heat of ice = 336 J g^{-1}

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14. The amount of heat energy required to convert 1 kg of ice at -10°C to water at 100°

C is 7,77,000 J. Calculate the specific latent heat of ice. Specific heat capacity of ice = 2100 J $kg^{-1}K^{-1}$, specific heat capacity of water = 4200 J $kg^{-1}K^{-1}$.

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15. 200 g of ice at 0°C converts into water at 0°C in 1 minute when heat is supplied to it at a constant rate. In how much time 200 g of water at 0°C will change to 20°C ? Take specific latent heat of ice = 336 J g^{-1}.

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