PHYSICS

BOOKS - HC VERMA

CALORIMETRY

Example

1. What is the kinetic energy of a $10kg$ mass moving at a speed of $30kmh^{-1}$ in calorie?

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2. A copper block of mass $60kg$ is heated till its temperature is increased by $20^\circ C$. Find the heat supplied to the block. Specific heat capacity of $= 0.09calg^{-1} - C.$

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3. A piece of ice of mass of $100g$ and at temperature $0^\circ C$ is put in $200g$ of water of 25° How much ice will melt as the temperature of the water reaches $0^\circ C$? The specific heat capacity of

water $= 4200 Jkg^{-1}K^{-1}$ and the latent heat of ice $= 3.36 \times 10^5 Jkg^{-1}$

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4. A calorimeter of water equivalent $15g$ contains $165g$ of water at $25^\circ C$. Steam at $100^\circ C$is passed through the water for some time .The temperature is increased to $30^\circ C$ and the mass of the calorimeter and its contents is increased by $1.5g$ Calculate the specific latent heat of vaporization of water. Specific head capacity of water is $1\frac{cal}{g^\circ C}$.

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Short Answer

1. Is head a coserved quantity?

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2. The calorie is defined as $1cal = 4.86$joule Why as $1cal = 4J$ to make the conversions easy?

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3. A calorimater is kept in a wooden box to insulate it thermally from the surroundings .Why is it neccessery?

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4. In a calorimeter, the beat given by the bot object is assumed to be equal to the beat taken by the cold object. Does it mean that beat of the two object taken togather remain constant?

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5. In Regnault's apparatus for measuring specific beat capcity of a solied, there is an intel and an inlet and an outlet in the sterm chamber .The intel is near the top and the outlet is near the bottom .Why is it better than the opposite choice where the inlet is near bottom and the outlet is near the top ?

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6. When a solid melts or a liquir boils, the temperature does not increase even when head is

supplied .Where does not the energy go ?

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7. What is the specific head capacity of (a) melting ice (b) boling water?

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8. A person's skin is more selveely burnet when put in contact with $1g$ of steam at 100° then when put inn contact with $1g$ of water at 100° Explain

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9. The atmospheric teperature in the cities on sea- coast change very little Explain

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10. Should a thermometer bulb have large heat capacity or small heat capacity?

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Objetive I

1. The heat capacity of a body depends on

A. the heat given

B. the temperature released

C. the mass of the body

D. the material of the body

Answer: D

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2. Water equivalent of a body is measured in

A. kg

B. calorie

C. kelvin

D. m^3

Answer: A

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3. When a hot liquid is mixed with a cold liquid, the temperature of the mixture

A. first decreases then becomes constant

B. first increases then becomes constant

C. continously increases

D. is undefined for some time and then becomes nearly constant

Answer: D

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4. Which of the following pairs represent of the same physical quantities?

A. Kelvin and joule

B. Kelvin and calorie

C. Newton and calorie

D. joule and calorie

Answer: D

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5. Which of the following pairsof physical ququantities may be represented in the same unit?

A. Heat and temperature

B. temperature and mole

C. Heat and work

D. Specific heat and heat

Answer: C

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

A. Sum of the temperature 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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7. The mechanical equivalent of heat

A. has the same dimension as heat

B. has the same dimension as work

C. has the same dimension as energy

D. is dimensionless

Answer: D

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Objetive Ii

1. The heat capacity of a body depends on

A. the heat given

B. the temperature released

C. tha mass of the body

D. the material of the body

Answer: C::D

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2. The ratio of specific to molar heat capacity of a body

A. is a universal constant

B. depends on the mass of the body

C. depends on the molecular weight of the body

D. is dimensionless

Answer: C

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3. If heat a supplied to a solid, its temperature

A. must increase

B. may increase

C. may remain constant

D. may decrease

Answer: B::C

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

A. heat may have supplied to the body

B. heat may have been extracted from the body

C. no heat is supplied to the body

D. no heat is extracted from the body

Answer: A::B

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5. 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. heat is certainly supplied to it

B. heat is certainly not supplied to it

C. heat may have been supplied to it

D. work may have been done on it

Answer: C::D

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6. Head and work are equivalent.This means

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 at rest may be can be set into motion along a line by suppliying heat to it

Answer: C

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Exercises

1. An aluminium vessel of mass $0.5kg$ contains $0.2kg$ of water at $20^\circ C$ A block of iron of mass $0.2kgat100^\circ C$ is gently put into the water .Find the equilibrium temperature of the mixture, Specific heat capacities of aluminium , iron and water are $910Jkg^{-1}K^{-1}470Jkg^{-1}K^{-1}$ and $4200Jkg^{-1}K^{-1}$ respectively

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2. A piece of iron of mass $100g$ is kept inside a furnace for a long time 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 $= 470 Jkg^{-1}C^{-1}$

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3. The temperature of equal masses of three different liquids A ,B and C are $12^\circ, 19^\circ \text{ and } 28^\circ$

respectively. The temperature when A and B are mixed is16° and when Band C are mixed it is 23° what will be the temperature when A and C are mixed?

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

Find the temperature of the drink when thermal equilibrium is attained in it.Density of ice $= 900kgm^{-8}$, 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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5. Indian style of cooling drinking water is to keep it in a pitcher having porous walls. Water comes to the outer surface very slowly and evaporates .Most of the energy needed for evaporation is taken from the water itself and the water is cooled down. Assume that a pitcher contains $10kg$ water and $0.2g$ of water comes out per

second. Assuming no backward heat transfer from the atmosphere to the water, calculate the time in which the temperature decreases by $5^{\circ}C$. Specific heat capacity of water $= 4200 Jkg^{-1}.^{\circ} C^{-1}$ and latent heat of vaporization of water $= 2.27 \times 10^{6} Jkg^{-1}$

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6. A cube of iron (density $= 8000 kgm^{-1}$, specific heat capacity $= 470 gJkg^{-1}K^{-1}$) is heated to a high temperature and is placed on a larger block of ice at $0^{\circ}C$. The cube melts the ice below it,

displaces the water and sinks in the final equilibrium position its upper surface is just inside the ice. Calculate the initial temperature of the cube. Neglect any loss of heat outside the ice and the cube .The density of ice $= 900 kgm^{-1}$ and the latent heat of fusion of ice $= 3.36 \times 10^5 Jkg^{-1}$

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7. $1kg$ 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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8. Calculate the time required to heat $20kg$ of water from $10^\circ C \rightarrow 35^\circ C$ using an immersion heater $1000W$ Assume that $80\,\%$ of the power input is used to heat the water. Specific heat capacity of water $= 4200 Jkg^{-1}K^{-1}$

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9. The number of molecules in a drop of water (0.0018 ml) at room temperature is

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10. A bullet of mass $20g$ enters into a fixed wooden block with a speed of $40ms^{-1}$ and stops in it .Find the change in internal energy during the process

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11. A $50kg$ man is running at a speed of $18kmh^{-1}$ If all the kinetic energy of the man can be used to increase the temperature of water from $20^{\circ}C$ to $30^{\circ}C$.How much water can be heated with this energy?

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12. A brick weighing $4.0kg$is dropped into a $1.0m$ deep river from a height of $2.0m$ Assuming that $80\,\%$ of the gravitational potential energy is

finally converted into thermal energy, find this thermal energy in calorie.

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13. A van of mass $1500kg$ travelling at a speed of 15 m/s is stopped in $10s$ Assuming that all the mechanical energy lost appears as thermal energy in the brakes find the average rate of production of thermal energy in cal s^{-1}

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14. A block of mass $100g$ slides on a rough horizontal surface .If the speed of the block decreases from $10ms^{-1} \rightarrow 5ms^{-1}$, find the thermal energy developed in the process

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15. A 10kg ball and 20kg ball approach each other with velocities $20ms^{-1}$ and $10ms^{-1}$ respectively. What are their velocities after collision if the collision is perfectly elastic?

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16. 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 specific heat capacity of the ball is $800Jkg^{-1}K^{-1}$

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17. A copper cube of mass $200g$ slides down an a rough inclined plane of inclination 37° at a constant speed Assume that any loss in mechanical energy goes into the copper block as thermal energy .Find the increase in the temperature of the block as if slides down through $60cm$ Specific head capacity of copper $= 420Jkg^{-1}K^{-1}$

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18. A metal block of density $6000 kgm^{-3}$ and mass $1.2 kg$ is suspended through a spring of spring constant $200 Nm^{-1}$ .The spring - block system is dipped in water kept in a vessel .The water has a mass of $250 g$ and the block is at a height $40 cm$ above the bottom of the vessel .If the support to the spring is broken , what will be the rise in the temperature of the water specific heat capacity of the block is $250 Jkg^{-1}K^{-1}$ and that of water is $4200 Jkg^{-1}K^{-1}$ .Heat capacities of the vessel and the spring are negligible .

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