



PHYSICS

BOOKS - HC VERMA PHYSICS (HINGLISH)

CALORIMETRY

Examples

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°C Find the heat supplied to the block specific heat capacity of $= 0.09\text{calg}^{-1} \text{ } ^\circ\text{C}$

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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 $25^\circ C$

is passed through the water for some time. The temperature is increased

and the mass of the calorimeter and its contents is increased by $1.5g$

calculate the specific latent heat of fusion of water Specific heat

capacity of water is $1 calg^{-1} ^\circ C^{-1}$

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1. In head a coserved quantity?

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

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

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4. In a calorimeter, the heat given by the hot object is assumed to be equal to the heat taken by the cold object. Does it mean that heat of the

two object taken together remain constant?

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5. In Regnault's apparatus for measuring specific heat capacity of a solid, there is an inlet and an outlet in the stem chamber. The inlet 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 liquid boils, the temperature does not increase even when heat is supplied. Where does not the energy go?

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



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8. A person's skin is more severely burned when put in contact with 1g of steam at 100° than when put in contact with 1g of water at 100°

Explain



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9. The atmospheric temperature 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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1. The specific 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. continuously 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 pair of physical quantities 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 calorimeter. 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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Objective 2

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: 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 is 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. Heat 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 set into motion along a line by supplying 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°C . A block of iron of mass 0.2kg at 100°C is gently put into the water. Find the equilibrium temperature of the mixture. Specific heat capacities of aluminium, iron and water are $910\text{Jkg}^{-1}\text{K}^{-1}$, $470\text{Jkg}^{-1}\text{K}^{-1}$ and $420\text{Jkg}^{-1}\text{K}^{-1}$ respectively.

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2. A piece of iron of mass 100g is kept in a furnace or along time put in a calorimeter of water containing 240g of water at 20°C . The mixture attains an equilibrium temperature of 60°C . Find the temperature of the furnace. Specific heat capacity of iron = $470\text{Jkg}^{-1}\text{ }^\circ\text{C}^{-1}$

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3. The temperature of equal masses of three different liquids A, B and C are 12° , 18° , 19° and 28° respectively. The temperature when A and B are mixed is 16° and when B and C are mixed it is 23° . What will be the temperature when A and C are mixed?

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4. Four $2\text{cm} \times 2\text{cm} \times 2\text{cm}$ cubes of ice are taken from a refrigerator and put in 200ml of a drink when at 10°C . (a) Find the temperature attained in it. (b) If the ice cubes do not melt completely, find the amount melted.

Assumes that no heat is lost to the outside of the drink and that of ice
 $= 900 \text{ kg m}^{-3}$ density of the drink $= 1000 \text{ kg m}^{-3}$ specific heat capacity
of the drink $= 4200 \text{ J kg}^{-1} \text{ K}^{-1}$ latent heat capacity of drink of ice
 $= 3.4 \times 10^6 \text{ J kg}^{-1}$

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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 heat and the water is cooled down. Assume that a pitcher contains 10 kg water and 0.2 g of water comes from the atmosphere. Decrease by 5°C if $\rho_{\text{ice}} \cap \rho_{\text{water}} = 4200 \text{ J kg}^{-1} \text{ }^\circ \text{C}^{-1}$ and $\leq \text{latent heat of vaporization of water} = 2.27 \times 10^6 \text{ J kg}^{-1}$

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6. A cube of iron (density $= 8000 \text{ kg m}^{-3}$ specific heat capacity $= 470 \text{ J kg}^{-1} \text{ K}^{-1}$) 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 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 $= 900 \text{kgm}^{-3}$ and the latent heat of fusion of ice $= 3.36 \times 10^5 \text{Jkg}^{-1}$

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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 $= 3.36 \times 10^5 \text{Jkg}^{-1}$ and latent heat of vaporization of water $= 2.26 \times 10^6 \text{Jkg}^{-1}$

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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 8% of the power input is used to heat the water specific heat capacity of water $= 4200 \text{Jkg}^{-1} \text{K}^{-1}$



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9. On a winter day temperature of the tap water is $20^{\circ}C$ where as the room temperature is $5^{\circ}C$ water is stored in a tank of capacity $0.5m^3$ for household use .If it were possible to use the heat liberated by the water to lift a $10kg$ mass vertically , how high can it be lifted as the water comes to the room temperature ? Take $g = 10ms^{-2}$



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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 be uses to increase the temperature of water from $30^{\circ}C$ 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 calories.



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13. A van of mass 1500kg travelling at a speed of 54kmh^{-1} is stopped in 10s . Assuming that all the mechanical energy lost appears as thermal energy in the brake mechanism, find the average rate 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. Two blocks of masses $10kg$ and $20kg$ moving at speeds of $10ms^{-1}$ and $20ms^{-1}$ respectively in opposite direction approach each other and collide .If the collision is completely inelastic , find the thermal energy developed in the process



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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 heat capacity of the ball is $800JK^{-1}$



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17. A copper cube of mass $200g$ slides down an a rough inclined plane of inclination 37° an 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 capper = $420Jkg^{-1}K^{-1}$



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



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