PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

CALORIMETRY

Numerical Example

1. Mass of object is 200g and its specific heat is $0.09\ \text{cal. g}^{-1}.^{\circ}\ C^{-1}$. How much that heat is required to increase its temperature from $20^{\circ}C$ to $90^{\circ}C$?

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2. In which case more heat is required ? (i) Temperature of 1 kg of water is raised from $30^{\circ}C$ to $100^{\circ}C$. (ii) Temperature of 3 kg of iorn, is raised from $30^{\circ}C$ to $230^{\circ}C$. (specific heat of iron $= 0.12\,\text{cal.g}^{-1}.^{\circ}C^{-1}$.)

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3. It is given that the specific heat of water in $cal.\,g^{-1}$ unit is $s = 0.6t^2$, where t is the temperature in Celsius scale. what amount of heat is required to raise the temperature of 10g water from $0^{\circ}C$ to $10^{\circ}C$?

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4. Specific heat capacity of aluminium is $0.21\ \text{cal.g}^{-1}.^{\circ}C^{-1}$. What will be the thermal capacity and water equivalent of an aluminium strip of mass 200 g?

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5. The ratio of the densities of the materials of two bodies is $2:3$ and that of their specific heat capacities is $0.12:0.09$. Find the ratio of their thermal capacities per unit volume.

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6. Thermal capacities of mercury and glass of the same volume are equal. Densities of mercury and glass are $13.6\ \mathrm{g.cm^{-3}}$ and $2.5\ \mathrm{g.cm^{-3}}$ respectively. If the specific heat capacity of mercury is $0.03\ \mathrm{cal.g^{-1}.^{\circ}C^{-1}}$. Find that of glass.

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7. 600 g of water at $30^{\circ}C$ is kept in a vessel of water equivalent 60 g. If the vessel is supplied heat at the rate of $100\ \mathrm{cal.s^{-1}}$, how much time will the water take to reach its boiling point?

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8. Specific gravities of two liquids are 0.8 and 0.5. The thermal capacity of 3 L of the first one is equal to that of 2 L of the second one. Compare their specific heats.

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9. 50 g of an alloy containing $80\,\%$ copper and $20\,\%$ silver is heated up to $t_1 = 80^\circ C$ and then dropped in a calorimeter of water equivalent W = 10 g containing m = 90 g of water at $t_2 = 20^\circ C$. What will be the final temerature of the mixture ? Specific heat capacity of

copper and silver are $s_c = 0.09 \ \text{cal.g}^{-1}.^\circ C^{-1}$ and $s_s = 0.15\,\text{cal.g}^{-1}.^\circ C^{-1}$ respectively.

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10. A piece of platinum of mass 200 g, is heated for a sufficiently long time in a furnace and dropped quickly in 650 g of water at $10^\circ C$, kept in a container of water equivalent 50g. Final temperature of the mixture becomes $25^\circ C$. If the specific heat capacity of platinum is $0.03\,\text{cal.g}^{-1}.^\circ C^{-1}$, find the temperature of the furnace.

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11. A solid of mass 70 g is heated and dropped in a calorimeter of water equivalent 10 g conaining 116 g of water. If the fall in temperature of the solid is 15 times the rise in temperature of water, find the specific heat capacity of the solid .

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12. Ratio between the densities and specific heats of the materials of two bodies are $2:3$ and $0.12:0.09$ respectively . If their volumes are in the ratio $7:8$, what is the ratio of thermal capacities?

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13. A body of mass 100 g is heated up to $122^{\circ}C$ and dropped quickly in water of mass 300 g kept at $28^{\circ}C$ in a copper calorimeter of mass 50 g. The final temperature of the mixture becomes $30^{\circ}C$. If the specific heat of copper is $0.09\ \mathrm{cal.g}^{-1}.^{\circ}\ C^{-1}$, find the specific heat of the material of the body.

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14. Calculate the increase in energy (in joule) per atom of a piece of aluminium when its temperature is raised by $1^{\circ}C$. Given 27 g of aluminium contains 6×10^{23}

atoms, and specific heat capacity of aluminium $= 0.2\ \text{cal}\ .\text{g}^{-1}.^{\circ}\ C^{-1}$.

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15. When 210 g of water at $80^{\circ}C$ is kept in a calorimeter of water equivalent 90 g, its temperatue decreases to $60^{\circ}C$ in 10 min. If the water is replaced by a liquid of mass 100 g, the same fall in temperature takes place in 5 min. If the rate of cooling is the same in both cases, what is the specific heat capacity of the liquid ?

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16. Liquid A, B and C are at temperature $15^{\circ}C, 25^{\circ}C$ and $35^{\circ}C$ respectively. When equal masses of A and B are mixed, the temperature becomes $21^{\circ}C$. Temperature of the mixture of equal masses of B and C becomes $32^{\circ}C$. (i) Show that the ratio of the specific heats of A and C is $2:7$. (ii) What will be the final temperature of the mixture of equal masses of A and C?

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17. An iron of mass 10 g and of specific heat $0.1\,\text{cal.g}^{-1}.^{\circ}\,C^{-1}$ is heated in a furnace and quickly transferred to a thick - walled copper vessel of mass

200 g and of specific that $0.09\ \text{cal.g}^{-1}.^{\circ}\ C^{-1}$, kept at $50^{\circ}C$. The vessel along with its contents, is placed in a calorimeter of water equivalent 20g, containing 180 g water at $20^{\circ}C$. A thermometer dipped in the water of the calorimeter shows the maximum temperature to be $26^{\circ}C$. Find the temperature of the furnace. Will there be any local boiling of water in the calorimeter?

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18. Three liquids of the same amount are mixed. The specific heats of these liquids are s_1, s_2 and s_3 and their initial temperature are θ_1, θ_2 and θ_3,

respectively. Find out the final temperature of the mixture.

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19. Water, flowing through a pipe at the rate of $0.15\,\mathrm{kg.min}^{-1}$, is heated by a 25.2 W heater. Temperature of the incoming and the outgoing water are $15.2^{\circ}C$ and $17.4^{\circ}C$ respectively. When the rate of flow of water is increased to $0.2318\,\mathrm{kg.min}^{-1}$ and rate of heating to 37.8W, temperature of incoming and outgoing water remain the same. Find the specific heat capacity of water and the rate of loss of heat through the pipe.

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20. A vacuum flask contain 0.3 kg of liquid paraffin whose temperature can be increased at the rate of $1^{\circ}C$ per minute using an immersion heater of power 12.3W. When a 19.2 W heater is used to heat 0.4 kg of liquid paraffin, in same flask, the rate of rise of temperature is $1.2^{\circ}C$ per minute. Find the specific heat of paraffin and the thermal capacity of the flask.

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21. Two calorimeters of water equivalent 25 g and 60 g are initially at $0^{\circ}C$. Some water at $50^{\circ}C$ is poured in

the first calorimeter and after thermal equilibrium is attained, the first calorimeter is emptied into the second one. If the final temperature of water and the second calorimeter becomes $25^{\circ}C$, find the mass of water.

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22. 1 kg of water in a kettle of water equivalent 200 g can be heated from $15^{\circ}C$ to $90^{\circ}C$ in 15 min by the heat supplied by a kerosene stove at the rate of $6 \times 10^{5} \mathrm{cal} \cdot \mathrm{H}^{-1}$. What percentage of the heat produced by the stove is absorbed by the kettle and water?

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23. A calorimeter holds 200 g of water at $10^{\circ}C$. When 50 g of water at $100^{\circ}C$ is added to it, the temperature of the mixture becomes $27^{\circ}C$. A metal ball of mass 100 g at $10^{\circ}C$ is now added to water, and the final temperature reaches $26^{\circ}C$. Find the specific heat of the metal.

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24. Specific gravitives of two liquids are 0.7 and 0.4 respectively. 4 L of the first liquid has the same

thermal capacity as 3 L of the second. Find the ratio of their specific heat capacities.

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25. 40 g of water at $12^{\circ}C$ is kept in a container. When 50 g of water at $80^{\circ}C$ is addd to it, the final temperature becomes $46^{\circ}C$. Find the thermal capacity of the container.

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26. 50 g of an alloy containing 60% copper and 40% nickel is dropped in 55 g of water at $10^{\circ}C$, kept in a

calorimeter of water equivalent 5 g. The final temperature becomes $20^{\circ}C$. What was the initial temperature of the alloy? Specific heats of copper and nickel are $0.095\ \text{cal.g}^{-1}.^{\circ}\ C^{-1}$ and $0.11\ \text{cal.g}^{-1}.^{\circ}\ C^{-1}$ respectively.

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27. Temperatures of three liquids A, B and C of equal mass are $12^{\circ}C$, $19^{\circ}C$ and $28^{\circ}C$ respectively. If A and B are mixed the temperature becomes $16^{\circ}C$ and if we mixed B and C the temperature becomes $23^{\circ}C$. What will be the temperature of the mixture of A and C?

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28. A 20 kg load is suspended from a copper wire of radius 1 min. If the wire suddenly snaps, does its temperature change? Calculate this change in temperature. For copper Young's modulus $= 12 \times 10^{10} \mathrm{N.m}^{-2}$, density $= 9000\ \mathrm{kg.m}^{-3}$, specific heat = $100\ \mathrm{cal.kg}^{-1}.\ K^{-1}$. Mechanical equivalent of heat = $4.2\ \mathrm{J.cal}^{-1}$, $g = 9.8m.\ s^{-2}$.

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Section Related Questions

1. 'Specific heat of iron is $0.106\,\mathrm{cal.g^{-1}.^{\circ}}\,C^{-1}$'- what do you mean by this statement?

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Higher Order Thinking Skill Hots Questions

1. Equal masses of milk and water are taken in two identical kettles and heated by the same source. The ratio of rise of temperature of milk is found to be higher than that of water. Explain.

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2. Milk and water of equal mass are taken in two similar vessels at room temperature. Both of them are to be heated from the room temperature to a certain higher temperature. Which will take less heat and why?

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3. 1 kg of iron at $100^{\circ}C$ melts more ice than 1 kg of lead at $100^{\circ}C$. Explain why.

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4. What is the advantage of taking water in hot water bottles?

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5. Two copper spheres of the same external radius, one solid but the other hollow, are heated up to a certain temperature and then are allowed to cool under similar condition. Which sphere will cool faster ?

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6. State whether the fundamental law of calorimetry is applicable in the following cases : (i) sugar is added to water taken in a calorimeter

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7. State whether the fundamental law of calorimetry is applicable in the following cases : (ii) a chemical reaction occurs between a solid and a liquid in a calorimeter

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8. State whether the fundamental law of calorimetry is applicable in the following cases : (iii) calorimeter is kept open in air.

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9. Two small spherical balls of the same mass, made of copper and of lead are heated up to the same temperature and are placed on a thick wax slab. What will happen and what can we conclude from it?

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10. If two bodies of equal mass but of different materials are supplied equal amounts of heat, which one will have higher irse in temperature?

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11. 100 g of water and 100 g of iron are heated up to the same temperature and are separately added to 50 g of water at a lower temperature, kept in two identical vessels. Compare the temperature changes in the two vessels.

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12. When a hot body heats up a cold body, is the temperature change of both the bodies the same? Explain the answer.

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13. Why calorimeters are made of metal (mostly copper) instead of glass?

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14. Temerpature of a furnace is more than $500^{\circ}C$. Discuss a method of measuring the temperature of

the furnace with the help of a thermometer graduated up to $100^{\circ} C$.

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15. The diameter of an iron sphere and the length of the side of an iron cube are equal. Initially they are at the same temperature. If they take the same amount of heat, whose final temperature will be higher?

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Exercise Multiple Choice Questions

1. The amount of heat required by 1 g of a substance for its $1^{\circ} C$ rise in temperature is called its

A. specific heat

B. thermal capacity

C. water equivalent

D. latent heat

Answer: A

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2. SI unit of heat is

A. cal

B. kcal

C. J

D. W

Answer: C

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3. Mean calorie means

A. the amount of heat requred to increase the temperature of 1 g water from $0^\circ C$ to $1^\circ C$

B. the amount of heat requred to increase the temperature of 1 g water from $50^\circ C$ to $51^\circ C$

C. the amount of heat requred to increase the temperature of 1 g water from $14.5^\circ C$ to $15.5^\circ C$

D. $\frac{1}{100}$ part of the amount of heat required to increase the temperature of 1 g water from $0^\circ C$ to $100^\circ C$

Answer: D

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4. If the amount of heat required by mass m of a substance for a substance for a rise t in temperature be H, then

A. $t \propto mH$

B. $t \propto \frac{H}{m}$

C. $t \propto \frac{m}{H}$

D. $t \propto \frac{1}{mH}$

Answer: B

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5. $\text{cal.g}^{-1}.^{\circ} C^{-1}$ is unit of

A. specific heat capacity

B. thermal capacity

C. water equivalent

D. latent heat

Answer: A

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6. Which of the following substances has highest specific heat?

A. mercury

B. water

C. iron

D. diamond

Answer: B

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7. Due to higher specific heat of water compared to other solids and liquids

A. water warms up quickly but cools down slowly

B. water cools down quickly but warms up slowly

C. water warms up or cools down slowly

D. water warms up or cools down quickly

Answer: C

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8. To cool down the engine of a car, water is used in the radiator because

A. water is easily available

B. water does not cause any harm to the radiator

C. viscosity of water is much less

D. specific heat of water is high

Answer: D

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9. During boiling of water at $100^{\circ}C$, what will be its specific heat?

A. zero

B. 0.5

C. 1

D. infinite

Answer: A

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10. If the temperature of 1 g of water is raised by $1^\circ C$ for what initial temperature the heat gained is equal it magnitude to the mean calorie?

A. $0^\circ C$

B. 14.5°

C. $15^\circ C$

D. 15.5°

Answer: B

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11. An alternative name of 'mean calorie' is

A. $0^\circ - 100^\circ \mathrm{C}$ cal

B. $4.5^\circ \mathrm{C}$ cal

C. $15^\circ \mathrm{C}$ cal

D. $15.5^\circ \mathrm{C}$ cal

Answer: C

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12. The temperature erange and pressure, at which the heat required by 1 g water for $1^\circ C$ rise in its

temperature is called 1 cal, is

A. $3.5^{\circ}C$ to $4.5^{\circ}C$, 76 mm of Hg

B. $13.5^{\circ}C$ to $14.5^{\circ}C$, 76 mm of Hg

C. $14.5^{\circ}C$ to $15.5^{\circ}C$, 760 mm of Hg

D. $98.5^{\circ}C$ to $99.5^{\circ}C$, 760 mm of Hg

Answer: C

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13. 10 g of water is supplied with 420 J of energy. The rise in temperature of water is

A. $1^\circ C$

B. $4.2^\circ C$

C. $10^\circ C$

D. $32^\circ C$

Answer: C

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

A. heat is given out

B. heat is taken in

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

D. all of the above

Answer: C

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15. Calorimeters are made of which of the followings?

A. glass

B. metal

C. wood

D. either A or C

Answer: B

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16. Mass m of a substance requires an amount H of heat for a rise t in temperature. If the specific heat of the substance be s, then its water equivalent is

A. Hms_w

B. ms_wt

C. $\frac{ms}{s_w}$

D. $\frac{st}{s_w}$

Answer: C

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17. Thermal capacity of a body of mass 10 g is $8\ \text{cal}\ .^{\circ} C^{-1}$. The specific heat of the material of the body is

A. 0.8

B. 1.25

C. 0.4

D. 0.1

Answer: A

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18. If the specific heat of copper is $0.1\ \text{cal. G}^{-1}.^{\circ} C^{-1}$, then water equivalent of a copper calorimeter of mass 0.4 kg is

A. 40 g

B. 4000 g

C. 20 g

D. 4 g

Answer: A

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19. The ratio of the radii of two spheres made of the same material 1:4. The ratio of their thermal capacities is

A. $\frac{1}{64}$

B. $\frac{1}{32}$

C. $\frac{1}{2}$

D. $\frac{1}{4}$

Answer: A

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20. The ratio of the densities of two materials is 5:6 and of their specific heats is 3:5. The ratio of their thermal capacities per unit volume will be

A. $1:2$

B. $2:1$

C. $3:2$

D. $2:3$

Answer: A

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21. When two bodies at different temperatures are brought in contct, the basic principle of calorimetry (heat lost = heat gained) can not be applied if

A. the two bodies do not mix well with each other

B. any of the bodies undergoes a change of state

C. specific heats of the two bodies are widely different

D. chemical reaction occurs between the bodies

Answer: D

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22. If no change of state occurs, which of the following quantities is not required for the calculation of heat lost or heat gained?

A. mass

B. density

C. specific heat

D. change in temperature

Answer: B

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23. The ratio of specific heats of two liquids is $1:2$. If the two liquids at different temperature are mixed in the ratio 2:3 of their masses, then what will be the ratio of changes in their temperatures?

A. $1:3$

B. $1:6$

C. $3:1$

D. $6:1$

Answer: C

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24. Specific heat of aluminium is more than that of copper. Two spheres of equal masses made of these two metals are immersed in a hot liquid. In equilibrium

A. the temperature of aluminium sphere will be greater

B. the temperature of both the spheres will be equal

C. the temperature of copper sphere will be greater

D. none of the above

Answer: B

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25. A liquid of mass M and specific heat S is at a temperature 2t. If another liquid of thermal capacity 1.5 times, at a tempera-ture of $\frac{t}{3}$ is added to it, the resultant temperature will be

A. $\frac{4}{3}t$

B. t

C. $\frac{t}{2}$

D. $\frac{2}{3}t$

Answer: B

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26. Which substance, used in our everday life, has the highest specific heat?

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27. For a body of mass m and specific heat capacity s, how much heat is required to increase its temperature by t?

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28. What is the CGS unit of thermal capacity?

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29. What is the CGS unit of water equivalent?

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Problem Set I

1. How much heat is required to increase the temperature of a piece of platinum of mass 100 g from

$20^\circ C$ to $70^\circ C$? Specific heat of platinium $= 0.03$ cal. $\mathrm{G}^{-1}.^\circ C^{-1}$.

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2. Mass of a piece of cppper is 20 g. Find the rise in temperature of the piece when 100 cal of heat is supplied to it? Specific heat of copper $= 0.09$ cal. $\mathrm{g}^{-1}.^\circ C^{-1}$.

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3. A room contains 50 L air at $30^\circ C$. Density of air is 1.5 g. L^{-1}. How much heat will be required to

increase the temperature of air to $60^{\circ} C$? Specific heat of air $= 0.2\,\text{cal. G}^{-1}.^{\circ} C^{-1}$.

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4. Mass of a calorimeter made of copper is 80 g. If the specific heat of copper is $0.09\,\text{cal. g}^{-1}.^{\circ} C^{-1}$, determine the thermal capacity and water equivalent of the calorimeter?

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5. When 30 g water at $50^{\circ} C$ is poured into a calorimeter at a temperature $15^{\circ} C$, the final

temperature attained is $20^{\circ}C$. What is the water equivalent of the calorimeter?

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6. A body of mass 20 g at $100^{\circ}C$ is dropped into 200 g of water at $30^{\circ}C$. What will be the final temperature of the mixture ? Specific heat of the material of the body $= 0.1\ \text{cal. G}^{-1}.^{\circ}C^{-1}$.

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7. The ratio of the masses of two liquids is 3:4 and of their specific heats is 2:3. They are at $60^{\circ}C$ and $30^{\circ}C$

respectively. What will be the final temperature if they are mixed?

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8. Temperature of two liquids are $80^{\circ}C$ and $20^{\circ}C$. When they are mixed in the mass ratio of $8:5$, the temperature of the mixture becomes $60^{\circ}C$. Find the ratio of their specific heats.

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9. A liquid at $25^{\circ}C$, of specific heat $0.48\,\text{cal. G}^{-1}.^{\circ}C^{-1}$, is mixed with another liquid at

$10^\circ C$ of specific heat $0.36\,\text{cal. g}^{-1}.^\circ C$. If the final temperature of the mixture is $20^\circ C$, find the mass ratio of the two liquid in the mixture.

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10. An iron saucepan contains 100 g of water at $25^\circ C$. When 50 g of water at $60^\circ C$ is mixed with it, the final temperature of the mixture becomes $35^\circ C$. If no heat is lost due to radiation or other means, then what is the water equivalent of the saucepan? If hte mass of this saucepan is 238 g, then what is the specific heat of iron?

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11. The ratio of the densities of two substances is $3:10$ and of their specific heats is $7:3$. What will be the ratio of their thermal capacities per unit volume? Again, if the ratio of their volumes is $1:2$, then what will be the ratio of their thermal capacities?

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12. To measure the temperature of a furnace, a platinum ball of mass 80 g is kept inside it. When the ball attains the temperature of the furnace, it is dropped into water at $15^{\circ}C$ in a container. The amount of water in it and its water equivalent

together is 400 g. Find the temperature of the furnace. Specific heat of platinum $= 0.0365 \text{ cal . g}^{-1}.^{\circ} C.$

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13. What equivalent of a copper vessel is 100 g. It contains 1 kg of watar at $30^{\circ} C$. The vessel is heated with a Bunsen burner. If the burner supplies 200 cal of heat per second, then find the time required for the water to start boiling?

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Problem Set Ii

1. The specific heat of many solids at low temperature vary with absolute temperature T according to the relation $s = aT^3$, where a is a constant. Find the heat energy required to raise the temperature of a mass m of such a solid from $T = 0K \text{ to } T = 20K$

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2. In a experiment on the specific heat of a metal, a 0.20 kg block of the metal at $150^\circ C$ is dropped in a copper calorimeter (of water equivalent 0.025 kg) containing $150cm^3$ of water at $27^\circ C$. The final

temperature is $40^{\circ}C$. Compute the specific heat of the metal. If heat losses to the surroundings are not negligible, is your answer greater or smaller than the actual value for specific heat for the metal.

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3. A metal sphere of radius r and specific heat s is rotated about an axis passing through its centre at a speed of n rotations per second. It is suddenly stopped and $50\,\%$ of its energy is used in increasing its temperature. Prove that the raise in temperature of the sphere is $\frac{2\pi^2 n^2 r^2}{5s}$.

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4. A 10 kW drilling machine is used to drill a bore in a small aluminium block of mass 8.0 kg. How much is the rise in temperature of the block in 2.5 minutes, assuming $50\,\%$ of power is used up in heating the machine itself or lost to the surroundings. Specific heat of aluminium $= : 0.91 J.\, g^{-1}.\, K^{-1}.$

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Hots Numerical Problems

1. An alloy contains $60\,\%$ copper and $40\,\%$ nickel. A piece of this alloy of mass 50 g is heated to $50^{\circ}C$ and than dropped into a calorimeter of water equivalent 10 g containing 40 g of water at $20^{\circ}C$. Calculate the final temperature of the mixture. Specific heat of copper $= 0.09\,\text{cal.g}^{-1}.^{\circ}\,C^{-1}$, and of nickel = $0.11\,\text{cal.g}^{-1}.^{\circ}\,C^{-1}$

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2. There are three liquids A, B and C having equal masses. Their temperature are respectively $14^{\circ}C, 24^{\circ}C$ and $40^{\circ}C$. When A and B are mixed, the

temperature of the mixture becomes $20^\circ C$, When B and C are mixed, the temperature of the mixture becomes $34^\circ C$. What would be the temperature of the mixture when all the three liquids are mixed?

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3. The temperature of three liquids A, B and C are $14^\circ C, 24^\circ C$ and $34^\circ C$ respectively. When A and B are mixed in equal masses, the temperature of the mixture becomes $20^\circ C$, when B and C are mixed in equal masses, the temperature of the mixture becomes $31^\circ C$. If A and C are mixed in equal masses, then what will be the temperature of the mixture?

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4. A liquid kept in a calorimeter cools down from $50^{\circ}C$ to $40^{\circ}C$ in 2 minutes, and an equal volume of water in that calorimeter takes 5 minutes to cool down through the same range of temperature. If the mass of the water is 100 g and that of the liquid is 85 g. then calculate the specific heat of the liquid. Water equivalent of the calorimeter = 10 g.

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5. A vessel initially contains 200 kg of water at $60^{\circ}C$. More water is supplied to the vessel from two taps.

Temperature of water from the first tap is $80^{\circ}C$ and that from the second tap is $20^{\circ}C$. Each tap supplies water at the rate of 5kg. min^{-1}. After what time, will the temperature of water in the vessel be $55^{\circ}C$?

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6. A vessel made of copper weighs 1 kg and it contains 1 kg of water at $10^{\circ}C$. How much coal will be required to raise the temperature of this water to $100^{\circ}C$? On burning 1 kg of coal, 10^4 cal of heat can be produced and $40\,\%$ of this heat is lost. Specific heat of copper $= 0.09\,\text{cal.g}^{-1}.^{\circ}C^{-1}$.

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7. A thermometer of mass 55 g and specific heat $0.2\,\text{cal.g}^{-1}.^{\circ}\,C^{-1}$ reads $15^{\circ}C$ at the room temperature. When the thermometer, it reads $44.4^{\circ}C$. If the water equivalent of the calorimeter is 50 g and the mass of water taken is 250 g, find the temperature of water before the immersion of the thermometer.

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8. The mass of a copper steam boiler is 200 kg. It contains 100 kg of water at $25^{\circ}C.7 \times 10^{6}$ cal of heat is produced by burning 1 kg of coal and only $3\,\%$ of it is absorbed by the boiler to heat water. How much

coal is to be burnt to raise the temperature of the water in the boiler to its boiling point? Specific heat of copper $= 0.09\ \text{cal.g}^{-1}.^{\circ}C^{-1}$.

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9. Three liquids of masses m_1, m_2 and m_3 are mixed together. Their specific heats are s_1, s_2 and s_3, and they were at temperature t_1, t_2 and t_3 respectively. Calculate the temperature of the mixture.

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10. Water equivalent of an electric kettle is 100 g. 890 g of water is taken in it, and it is then switched on. If water needs 3 min 45 s to reach its boiling point from and initial temperature of $20^{\circ}C$, find the rate of production of heat by the kettle? (Assume that $20\,\%$ of the energy produced is wasted.)

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11. A, B and C are three liquids. 4 g of liquids A at $60^{\circ}C$ is mixed with 1 g of liquid C at $50^{\circ}C$, the final temperature of the mixture is $55^{\circ}C$. Again, if 1 g of liquid A (at $60^{\circ}C$) is mixed with 1 g of liquid B at $50^{\circ}C$

, the final temperature of the mixture becomes $55^\circ C$. What will be the final temperature if 1 g of liquid B at $60^\circ C$ is mixed with 1 g of liquid C at $50^\circ C$?

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12. Mass of a body is M, its specific heat is S and temperature is T. The body is dropped in a liquid. If the mass of the liquid is m, specific heat is s and temperature is t,then prove that the final temperature of the mixture is $\theta = \frac{MST + mst}{MS + ms}$.

If the liquid is water then show that, $S = \frac{m(\theta - t)}{M(T - \theta)}$.

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13. A calorimeter of water equivalent 10 g contains 100 g of water at $90^{\circ}C$. On exposure to air, its temperature falls to $80^{\circ}C$ in 5 min. If the same calorimeter is filled with 50 g of an oil, the time for the same drop in temperature is 2 min. Calculate the specific heat of the oil if the rate of heat loss in both the cases is assumed to be the same.

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14. One tonne of water is heated from $10^{\circ}C$ to $70^{\circ}C$ using coal. The heat of combustion of coal is 1.5×10^{4} cal.g^{-1}. How many kilograms of

coal is required if 60% of the heat is utilised in heating water ?

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Entrance Corner Assertion Reason Type

1. Statement I : A gas have a unique value of specific heat.

Statement II : Specific heat is defined as the amount of heat required to raise the temperature of unit mass of the substance through unit degree.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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2. Statement I : When a body of mass M loses heat, the time rate of fall of temperature for given amount of loss of heat is inversely proportional to mass.

Statement II : $\Delta Q = Ms\Delta T$ where, $\Delta Q =$ amount of heat, s = specific heat and $\Delta T =$ decrease in temperature.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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3. Statement I : Specific heat capacity is the cause of formation of land and sea breeze.

Statement II : The specific heat of water is more than land.

A. Statement I is true, statement II is true , statement II is a correct explanation for

statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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4. Statement I : Specific heat of a body is always greater than its thermal capacity.

Statement II : Thermal capacity is the heat required for raising temperature of a body by unity.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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5. Statement I : Two bodies at different temperatures, if brought in thermal contact do not necessarily settle to the mean temperature.

Statement II : The two bodies may have different thermal capacities.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for

statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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Entrance Corner Multiple Correct Answers Type

1. Thermal capacity of a body depends on

A. the heat given

B. the temperature raised

C. the mass of the body

D. the material of the body

Answer: C::D

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2. Specific heat of a substance can be

A. finite

B. infinite

C. zero

D. negative

Answer: A::B::C::D

3. When two samples at different temperatures are mixed, the temperature of the mixture can be

A. lesser than lower or greater than higher temperature

B. equal to lower or higher temperature

C. greater than lower but lesser than higher temperature

D. average of lower and higher temperature.

Answer: B::C::D

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Entrance Corner Matrix Match Type

1. Three liquids A, B and C having same specific heat and masses $m, 2m$ and $3m$ have temperatures $20^\circ C, 40^\circ C$ and $60^\circ C$ respectively. Temperature of the mixture when

Column I	Column II
i. A and B are mixed at	(A) $35^\circ C$
ii. A and C are mixed at	(B) $52^\circ C$
iii. B and C are mixed at	(C) $50^\circ C$
iv. A, B and C all three are mixed at	(D) $45^\circ C$
	(E) none

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Entrance Corner Comprehension Type

1. A vacuum flask contains 0.4 kg liquid paraffin whose temperature can be increased at the rate of $1^{\circ}C$ per minute using an immersion heater of power 12.3 W. When a heater of 19.2 W is used to heat 0.5 kg of liquid paraffin, in the same flask, the rate of rise temperature is $1.2^{\circ}C$ per minute.

What is specific heat of the paraffin?

A. $0.529\ \text{cal.g}^{-1}.^{\circ}C^{-1}$

B. $0.429\ \text{cal.g}^{-1}.^{\circ}C^{-1}$

C. $0.472\ \text{cal.g}^{-1}.^{\circ}\ C^{-1}$

D. $0.623\ \text{cal.g}^{-1}.^{\circ}\ C^{-1}$

Answer: A

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2. A vacuum flask contains 0.4 kg liquid paraffin whose temperature can be increased at the rate of $1^{\circ}C$ per minute using an immersion heater of power 12.3 W. When a heater of 19.2 W is used to heat 0.5 kg of liquid paraffin, in the same flask, the rate of rise temperature is $1.2^{\circ}C$ per minute.

What is the thermal capacity of the material of the flask?

A. $17.67\ \text{cal.}^{\circ}\ C^{-1}$

B. $16.85\ \text{cal.}^{\circ}\ C^{-1}$

C. $17.01\ \text{cal.}^{\circ}\ C^{-1}$

D. $116.63\ \text{cal.}^{\circ}\ C^{-1}$

Answer: B

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3. When a block of metal of specific heat $0.1\ \text{cal.g}^{-1}.^{\circ}\ C^{-1}$ and weighing 110 g is heated to

$100^\circ C$ and then quickly transferred to a calorimeter containing 200 g of a liquid at $10^\circ C$, the resulting temperature is $18^\circ C$. On repeating the experiment with 400 g of same liquid in the same calorimeter at same initial temperature, the resulting temperature is $14.5^\circ C$.

Find the specific heat of the liquid .

A. $0.42\ \text{cal.g}^{-1}.^\circ C^{-1}$

B. $0.52\ \text{cal.g}^{-1}.^\circ C^{-1}$

C. $0.48\ \text{cal.g}^{-1}.^\circ C^{-1}$

D. $0.62\ \text{cal.g}^{-1}.^\circ C^{-1}$

Answer: C

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4. When a block of metal of specific heat $0.1\,\text{cal.g}^{-1}.^{\circ}\,C^{-1}$ and weighing 110 g is heated to $100^{\circ}C$ and then quickly transferred to a calorimeter containing 200 g of a liquid at $10^{\circ}C$, the resulting temperature is $18^{\circ}C$. On repeating the experiment with 400 g of same liquid in the same calorimeter at same initial temperature, the resulting temperature is $14.5^{\circ}C$.

Find the wa ter equivalent of calorimeter.

A. 15.5 g

B. 16.6 g

C. 17.3 g

D. 18.2 g

Answer: B

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Entrance Corner Intger Answer Type

1. 50 g of copper is heated to increase its temperature by $10^{\circ} C$. If the same quantity is given to 10 g of water, what will be the rise in its temperature (in $.^{\circ} C$)?

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2. Water of volume 2 L in a container is heated with a coil of 1 kW at $27^{\circ} C$. The lid of the container is open and energy dissipates at rate of $160 \mathrm{~J} . \mathrm{S}^{-1}$. In how much time (in minutes) temperature will rise from $27^{\circ} C$ to $75^{\circ} C$?

$\left[\text{Given specific heat of water is } 4.2 \mathrm{~kJ} . \mathrm{kg}^{-1}\right]$

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3. If 0.5 kg of coal on burning raises the temperature of 50 L of water from $20^{\circ} C$ to $90^{\circ} C$, then the heat of combustion of coal is $n \times 10^{6} \mathrm{~cal} . \mathrm{Kg}^{-1}$. Find the value of n.

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4. When x gram of steam is mixed with y grams of ice at $0^\circ C$, we obtain $(x+y)$ grams of water at $100^\circ C$. Find the value of $\frac{y}{x}$

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Examination Archive

1. A 10 Watt electric heater is used to heat a container filled with 0.5 kg of water. It is found that the temperature of water and the container rises by 3, K in 15 minutes. The container is then emptied, dried and

filled with 2 kg of oil. The same heater now raises the temperature of container-oil system by 2"K in 20 minutes. Assuming that there is no heat loss in the process and the specific heat of water as $4200\ \mathrm{J}\ .\ \mathrm{kg}^{-1}.\ K^{-1}$, the specific heat of oil in the same unit is equal to

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2. Three bodies of the same material and having masses m, m and 3m are at temperature $40^{\circ}C$, $50^{\circ}C$ and $60^{\circ}C$ respectively. If the bodies are brought in the thermal contact, the final temperature will be

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3. A copper ball of mass 100 g is at a temperature T. It is dropped in a copper calorimeter of mass 100 g, filled with 170 g of water at room temperature. Subsequently, the temperature of the system is found to be $75^{\circ}C$. T is given by : room temperature $= 30^{\circ}C$, specific heat of copper $= 0.1\ \mathrm{cal/g.^{\circ}}\ C$)

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4. Explain why the coolant in a chemical or a nuclear plant (i.e., the liquid used to prevent the different parts of a plant from getting too hot) should have high specific heat.

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5. Explain why two bodies at different temperature T_1 and T_2 if brought in thermal contact do not necessarily settle to the mean temperature $T_1 + T_2 / 2.$

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