Calorimetry and Joule's Law

1. **H_2O is at its triple point. Keeping the pressure constant if its temperature is increased then it becomes**

   1) Steam 2) Ice 3) Water 4) Water + Ice

2. **Arrange the specific heats of the given substance in the increasing order**

   a) Copper b) Ice c) Water d) Lead

   1) a, d, b, c 2) d, a, b, c 3) a, d, c, b 4) d, a, c, b

3. **Arrange the latent heats of fusion of the given substances in the decreasing order**

   a) Oxygen b) Tungsten c) Water d) Lead

   1) a, b, d, c 2) b, a, d, c 3) d, a, b, c 4) c, b, d, a

4. **Substance which sublimate are**

   a) Camphor b) Dry ice c) Tungsten d) Iodine

   1) a, b, d 2) a, b, c 3) a, c, d 4) b, c, d

5. **Arrange the melting points of the following substances in the decreasing order**

   a) Water b) Nitrogen c) Tungsten d) Copper

   1) d, c, a, b 2) c, d, a, b 3) d, c, b, a 4) c, d, b, a

6. **The melting point of the following substances decreases with increasing pressure**

   A) Ice B) Wax C) Gallium D) Bismuth

   1) a, b, c 2) a, b, d 3) b, c, d 4) a, c, d

7. **Difference in temperature between the top and the bottom of a water fall is**

   a) Independent of the specific heat of water.

   b) Directly proportional to the height.

   c) Inversely proportional to the specific heat of water.

   d) Directly proportional to the mechanical equivalent of heat.

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1) b, c 2) a, b 3) a, d 4) b, d

8. **Assertion (A): The apparent weight of a metal ball in a liquid decreases with the decrease of temperature of the liquid.**

Reason (R): The density of the liquid decreases with the fall in temperature.

1) Both A and R are true and R is the correct explanation of A.

2) Both A and R are true but R is not the correct explanation of A.

3) A is true but R is false.

4) A is false but R is true.

9. **Assertion (A): The heat of vaporization of a substance is much greater than its heat of fusion.**

Reason (R): This follows from the structures of the various states of matter.

1) Both A and R are true and R is the correct explanation of A.

2) Both A and R are true but R is not the correct explanation of A.

3) A is true but R is false.

4) A is false but R is true.

10. **The heat capacity of a body depends on**

a) The range of temperature b) The material of the body

c) The heat intake d) The mass of the body

1) a, b 2) a, c 3) c, d 4) b, d

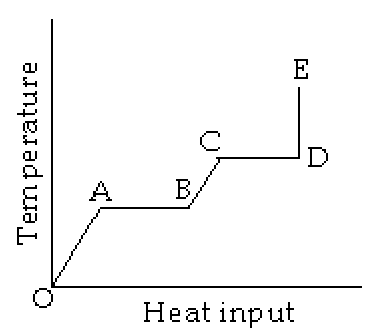
11. **When heat is supplied to a solid body temperature**

a) May increase b) May decrease c) May remain constant

d) Must increase

1) a, c 2) a, d 3) a, b 4) c, d

12. **A solid body is supplied heat at a constant rate. The temperature of the body is changing with the heat input as shown in the diagram.**



a) The horizontal region CD shows the change of state, solid to liquid.

b) The slope DE gives the inverse of water equivalent of the substance in the gaseous state.

c) If CD = 2.AB then the heat of fusion of the substance is twice the latent heat of condensation.

d) The fact that the slope of OA is greater than the slope of BC shows that the specific heat of the substance in the solid phase is smaller than that in the liquid phase.

1) a, c 2) a, d 3) b, c 4) b, d

13. Identify the correct statement.

a) At a temperature below that of its triple point, no substance can exist as a liquid.

b) The slope of the Hoarfrost line is negative.

c) The slope of the ice line is negative.

d) The slope of the steam line is negative.

14. Identify the correct statements.

A: The negative slope of ice line for water shows that melting point of ice decreases with the increase of pressure.

B: Liquids with low latent heat of vaporization are called volatile liquids.

C: Ether and petrol are examples of volatile liquids.

1) All are true. 2) All are false.

3) A & B are true. 4) A & B are wrong.

15. A: One cannot change water into steam by sending steam at 100^0C.

R: At thermal equilibrium heat exchange cannot take place between two systems.

1) Both (A) and (R) are true and (R) is the correct explanation of (A).

2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

3) (A) is true but (R) is false.

4) (A) is false but (R) is true.

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16. The quantity of heat which can raise the temperature of x gm of a substance through t_1°C can raise the temperature of y gm of water through t_2°C is same. The ratio of specific heats of the substances is

1) yt_1/xt_2 2) xt_2/yt_1 3) yt_2/xt_1 4) xt_1/yt_2

17. Two liquids at temperatures 60^oC and 20^oC respectively have masses in the ratio 3: 4 and their specific heats in the ratio 4: 5. If the two liquids are mixed, the resultant temperature is

1) 70^oC 2) 50^oC 3) 40^oC 4) 35^oC

18. 10 grams of steam at 100°C is mixed with 50 gm of ice at 0°C then final temperature is

1) 20°C 2) 50°C 3) 40°C 4) 100°C

19. A steel ball of mass 0.1 kg falls freely from a height of 10m an bounces to a height of 5.4m from the ground. If the dissipated energy in this process is absorbed by the ball, the rise in its temperature is (specific heat of steel =460 $JKg^{-1}K^{-1}$) ($g=10ms^{-2}$).

1) 0.01^0C 2) 0.1^0C 3) 1^0C 4) 1.1^0C

20. Two spheres A and B with masses in the ratio 2: 3 and specific heat 2: 3 fall freely from rest. If the rise in their temperatures on reaching the ground is in the ratio 1: 2 the ratio of their heights of fall is

1) 3: 1 2) 1: 3 3) 4: 3 4) 3: 4

21. 50 g of copper is heated to increase its temperature by 10^oC. If the same quantity of heat is given to 10 gm of water, the rise in temperature is (specific heat of copper = 420 $JKg^{-1}K^{-1}$, specific heat of water = 4200 $Jkg^{-1}K^{-1}$)

1) 5^oC 2) 6^oC 3) $7\ ^oC$ 4) 8^oC

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22. A lead bullet of 10g travelling at 300m/s strikes against a block of wood and comes to rest. Assuming 50% of heat is absorbed by the bullet, the increase in its temperature is (sp-heat of lead is 150J/Kg-K)

1) 25 ºC   2) 125^0 3) $150C^0$ 4) $200C^0$

23. The temperature of equal masses of three different liquids A,B and C are 12º C, 19ºc and 28ºC respectively. The temperature when A and B are mixed is 16ºC and when B and C are mixed it is 23ºC. What should be the temperature when A and C are mixed?

1) 20.26 ºC   2) 15.87 ºC   3) 25 ºC   4) 30 ºC

24. The fraction of ice that melts by mixing equal masses of ice at -10°C and water at 60°C is

1) $\frac{6}{11}$ 2) $\frac{11}{16}$ 3) $\frac{5}{16}$ 4) $\frac{11}{15}$

25. 'n' number of liquids of masses m,2m,3m, 4m, ... having specific heats s, 2s,3s,4s, ... are at temperatures t, 2t, 3t, 4t . . . . are mixed. The resultant temperature of mixture is

1. $\frac{3n}{(2n+1)}t$ 2. $\frac{2n(n+1)}{3(2n+1)}t$ 3. $\frac{3n(n+1)}{2(2n+1)}t$ 4. $\frac{3n(n+1)}{(2n+1)}t$

26. A tap supplies water at 10ºc and another tap at 100ºc. How much hot water must be taken so that we get 20kg of water at 35ºc?

1) 40/9 kg   2) 50/9 kg   3) 20/9 kg   4) 130/9 kg

27. A steel drill is making 180 revolutions per minute, under a constant torque of 5 N-m. If it drills a hole in 7 s. in a steel block of mass 600 gm, rise in temperature of the block is

(s = 0.1 cal/gm/ºC)

1) 2.6ºC   2) 1.3ºC   3) 5.2ºC   4) 3ºC

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28. 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 stopped and 50% of its energy is used in increasing its temperature, then the raise in temperature of the sphere is

1) $\frac{\pi^2 n^2 r^2}{S}$ 2) $\frac{1}{10}\frac{\pi^2 n^2}{r^2 S}$ 3) $\frac{7}{8}\pi r^2 n^2 S$ 4) $\frac{5(\pi rn)}{14S}$

29. A stationary object at 4°*C* and weighing 3.5 *kg* falls from a height of 2000 *m* on a snow mountain at 0°*C*. If the temperature of the object just before hitting the snow is 0°*C* and the object comes to rest immediately $(g = 10\ m/s^2)$ **and (latent heat of ice** $= 3.5\times10^5\ joule/\sec$ **), then the object will melt**

1) 2 *kg* of ice 2) 200 *gm* of ice

3) 20 *gm* ice 4) 2 *gm* of ice

30. Water of volume 2 *liters* in a container is heated with a coil of $1\,kW$ **at** $27\,°C$**. The lid of the container is open and energy dissipates at rate of** $160\ J/s.$ **. In how much time temperature will rise from** $27\,°C$ **to** $77\,°C$ **[Given specific heat of water is** $4.2\,kJ/kg$ **]**

(a) 8 *min* 20 *s* (b) 6 *min* 2 *s*

(c) 7 *min* (d) 14 *min*

Key

1) 1	**2) 2**	**3) 4**	**4) 1**	**5) 2**	**6) 4**	**7) 1**	**8) 3**	**9) 1**	**10)4**
11) 1	**12) 4**	**13) 1**	**14) 1**	**15) 1**	**16) 3**	**17) 4**	**18)3**	**19) 2**	**20) 3**
21) 1	**22) 3**	**23) 1**	**24) 2**	**25) 3**	**26) 2**	**27) 1**	**28) 1**	**29) 2**	**30) 1**

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Hints

16. $x\,S_1 t_1 = y s_2 t_2 \Rightarrow \frac{S_1}{S_2} = \frac{y t_2}{x t_1}$

17. $m_1 s_1 (60 - t) = m_2 s_2 (t - 20)$

$\frac{3}{4}.\frac{4}{5}(60-t)=(t-20)$

$t = 35^0C$

18. 10 x 540 + 10 x 1 (100 - t) = 50 x 80 + 50 x 1(t - 0)

5400 + 1000 - 10t = 4000 + 50 t

$t = 40^0C$

19. $mg (h_1 - h_2) = J.\ m.\ s\ (\Delta t)$

10 (10 - 5.4) = 1.460 x (Δt)

$\Delta t = \frac{10\times 4.6}{460} = 0.1^0 c$

20. $\frac{m_1}{m_2} = \frac{2}{3} \quad \frac{S_1}{S_2} = \frac{2}{3}$

$\frac{\Delta t_1}{\Delta t_2} = \frac{1}{2}$

$mgh = J.m.s\,(\Delta t)$

$\frac{\Delta t_1}{\Delta t_2} = \frac{h_1}{h_2}\frac{s_2}{s_1}$

$\therefore \frac{h_1}{h_2} = \frac{1}{3}$

21. 50 x 420 x 10 = 10 x 4200 x Δt

$\Delta t = \frac{50\times 420\times 10}{10\times 4200} = 5^0 c$

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22. $\frac{1}{2}\left(\frac{1}{2}m\upsilon^2\right) = J.m.S(\Delta t)$

$\frac{1}{2}\left(\frac{1}{2}\times 300\times 300\right) = 1\times 150\times \Delta t$

$\Delta t = 150^0 c$

23. $m.S_A.4 = m.S_B.3$

$\frac{S_A}{S_B} = \frac{3}{4} \Rightarrow S_A = \frac{3.S_B}{4}$

$m.S_B.4 = m.S_C.5$

$S_c = \frac{4}{5}.C_B$

$m.S_A(t-12) = m.S_c(28-t)$

$\frac{3.S_B}{4}(t-12) = \frac{4.S_B}{5}(28-t)$

$t = 20.26^0C$

24. $x\times\frac{1}{2}\times 10 + y\times 80 = x\times 1\times 60$

5x + 80y = 60x

80y = 55x

$\frac{y}{x} = \frac{55}{80} = \frac{11}{16}$

25. (m.s + (2m) (2s) + (3m) 3S....) t^1

= m.s.t + 2m (2s.2t).....

$(1^2 + 2^2 + 3^2 \ldots\ldots m^2).\ t^1 = (1^3 + 2^3 + 3^3 \ldots.)$

$$t^1 = \frac{\frac{n^2(n+1)^2}{4}}{\frac{n(n+1)(2n+1)}{6}}$$

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$t^1 = \frac{3n(n+1)}{2(2n+1)}$

26. $m_c + m_H = 20kg$

$m_H(1)\times(100-35)=(20-m_H)\times1\times25$

$m_H \times 65=(20-m_H)\times25$

$m_H = \frac{50}{9}kg$

27. P = $\tau\ \omega$

$\frac{W}{t} = \tau\ \omega$

mS $\Delta t = \tau\ .\omega.t$

1 x 600 x 0.1 x 4.2 x Δt = 5 x 180 x $\frac{2\pi}{60}\times7$

$\Delta t = \frac{15\times44}{6\times4.2}\times2.6^0C$

28. $\frac{1}{2}.\left(\frac{1}{2}IW^2\right)=(1)\ m.s(\Delta t)$

$\frac{1}{2}\ \frac{1}{2}\frac{2}{5}mr^2.4\pi^2n^2 = n.s.\Delta t$

$\Delta t = \frac{2}{5}\frac{\pi^2.n^2r^2}{s}$

29. Suppose *m kg* of ice melts then by using $\underset{\text{(Joules)}}{W} = \underset{\text{(Joules)}}{H}$

$\Rightarrow Mgh = mL \Rightarrow 3.5\times10\times2000 = m\times3.5\times10^5$

$\Rightarrow m = 0.2\,kg = 200\ gm$

30. Heat gained by the water = (Heat supplied by the coil) – (Heat dissipated to environment)

$\Rightarrow mc\ \Delta\theta = P_{Coil}\ t - P_{Loss}\ t$

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$\Rightarrow\ 2\times 4.2\times 10^{3}\times(77-27)=1000\ t-160\ t$

$\Rightarrow\ t=\dfrac{4.2\times 10^{5}}{840}=500\ sec=8\ min\ 20\ sec$

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