DAY FIFTEEN

Unit Test 2

(General Properties of Matter)

1 A thick rope of density 1.5×10^3 kgm^{-3} and Young's modulus 5×10^6 Nm^{-2}, 8 m in length when hung from the ceiling of room, the increase in its length due to its own weight is

(a) 9.6×10^{-5} m (b) 19.2×10^{-7} m
(c) 9.6×10^{-2} m (d) 9.6 m

2 A vessel contains oil (density = 0.8 g cm^{-3}) over mercury (density = 13.6 g cm^{-3}). A homogeneous sphere floats with half of its volume immersed in mercury and the other half in oil. The density of material of the sphere in (gcm^{-3}) is

(a) 3.3 (b) 6.4 (c) 7.2 (d) 2.8

3 Two wires A and B are of the same material. Their lengths are in the ratio 1 : 2 and the diameter are in the ratio 2 : 1. If they are pulled by the same force, their increase in length will be in the ratio

(a) 2 : 1 (b) 1 : 4 (c) 1 : 8 (d) 8 : 1

4 Two capillary tubes P and Q are dipped in water. The height of water level in capillary P is 2/3 to the height in Q capillary. The ratio of their diameters is

(a) 2 : 3 (b) 3 : 2 (c) 3 : 4 (d) 4 : 3

5 For a given material the Young's modulus is 2.4 times that of rigidity modulus. Its poission's ratio is

(a) 2.4 (b) 1.2
(c) 0.4 (d) 0.2

6 The work done when n smaller equal size spherical drops combine to form a bigger size single spherical drop of water is proportional to

(a) $(n^{-2/3} - 1)$ (b) $(n^{-1/3} - 1)$
(c) $(n^{1/3} - 1)$ (d) $(n^{4/3} - 1)$

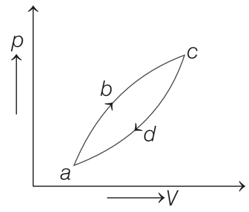
7 For adiabatic expansion of a monoatomic perfect gas, the volume increases by 2.4%. What is the percentage decrease in pressure?

(a) 2.4% (b) 4.0% (c) 4.8% (d) 7.1%

8 The work done in increasing the size of a soap film from 10 cm × 6 cm to 10 cm × 11 cm is 3×10^{-4} J. The surface tension of the film is

(a) 1.5×10^{-2} Nm^{-1} (b) 3.0×10^{-2} Nm^{-1}
(c) 6.0×10^{-2} Nm^{-1} (d) 11.0×10^{-2} Nm^{-1}

9 Figure below shows a cyclic process $abcda$. If ΔQ be the heat supplied to the system, ΔU be the change in internal energy and ΔW be the work done by the system, then which of the following relations is correct?



(a) $dQ - dU = 0$ (b) $dQ - dW = 0$
(c) $dU + dW = 0$ (d) None of these

10 How much force is required to produce an increase of 0.2% in the length of a brass wire of diameter 0.6 mm? [Young's modulus for brass = 0.9×10^{11} Nm^{-2}]

(a) Nearly 17 N (b) Nearly 51 N
(c) Nearly 34 N (d) Nearly 68 N

11 If two drops of same radius are falling through air with a velocity of 5 cm s^{-1}. If the two drops coalescence to form one drop, the terminal velocity of the drop is

(a) 2.5 cms^{-1} (b) 10 cms^{-1}
(c) $5\sqrt{2}$ cms^{-1} (d) $5 \times 4^{1/3}$ cms^{-1}

12 The pressure and density of a diatomic gas ($\gamma = 7/5$) changes adiabatically from (p, ρ) to (p', ρ'). If $\rho'/\rho = 32$, then (p'/p) should be

(a) 1/128 (b) 32 (c) 128 (d) None of these

13 One mole of monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with one mole of diatomic gas $\left(\gamma = \frac{7}{5}\right)$. What will be the value of γ for the mixture?

(a) 1.5 (b) 1.54 (c) 1.4 (d) 1.45

14 70 cal of heat is required to increase, the temperature of 2 moles of an ideal gas from 30°C to 35°C at constant pressure. The amount of heat required to increase the temperature of the same gas through the same temperature range (30°C to 35°C) at constant volume will be [(Gas constant $R = 2$ cal/(mol^{-1}K^{-1})].

(a) 30 cal (b) 50 cal (c) 70 cal (d) 90 cal

15 125 ml of gas A at 0.60 atm and 150 ml of gas B at 0.80 atm pressure at same temperature is filled in a vessel of 1 L volume. What will be total pressure of mixture at the same temperature?

(a) 0.195 atm (b) 0.212 atm
(c) 0.120 atm (d) 0.140 atm

16 At constant temperature, on increasing the pressure of a gas by 5%, its volume will decrease by

(a) 5% (b) 5.26%
(c) 4.26% (d) 4.76%

17 The density of hydrogen is 0.09 kgm^{-3}. What is its root mean temperature velocity at NTP ?

(a) 10/3 ms^{-1} (b) $\sqrt{10/3}$ kms^{-1}
(c) $\sqrt{10/3}$ ms^{-1} (d) (10/3) cm^{-1}

18 The gas having average speed four times as that of SO_2 (molecular mass = 64) is

(a) He (molecular mass 4) (b) O_2 (molecular mass 32)
(c) H_2 (molecular mass 2) (d) CH_4 (molecular mass 16)

19 Which of the graphs shown in the figure correctly represents the cooling of a body due to radiations?

(a) I (b) II (c) III (d) None of these

20 The temperature of a given mass is increased from 27°C to 327°C. The rms velocity of the molecules increases by

(a) $\sqrt{2}$ times (b) 2 times (c) $2\sqrt{2}$ times (d) 4 times

21 The quantity of heat required to heat 1 mole of a monoatomic gas through 1 K at constant pressure is

(a) 3.5 R (b) 2.5 R
(c) 1.5 R (d) None of these

22 The radiant energy from the sun, incident normally at the surface of the earth is 20 kcal m^{-2} min^{-1}. What would have been the radiant energy, incident normally on the earth, if the sun had a temperature, twice of the present one?

(a) 160 kcal m^{-2} min^{-1} (b) 40 kcal m^{-2} min^{-1}
(c) 320 kcal m^{-2} min^{-1} (d) 80 kcal m^{-2} min^{-1}

23 A solid ball of density half that of water falls freely under gravity from a height of 19.6 m and then enters water. Neglecting air resistance and viscosity effect in water, the depth upto which the ball will go is (take, $g = 9.8$ m/s^2)

(a) 19.6 m (b) 28.4 m (c) 9.8 m (d) 14.7 m

24 Newton's law of cooling is the special case of Stefan's law, when

(a) temperature of body is high
(b) temperature of surroundings is high
(c) temperature difference of body and surroundings is small
(d) temperature difference of body and surroundings is high

25 It takes 10 min to cool a liquid from 61°C to 59°C. If room temperature is 30°C, then time taken in cooling from 51°C to 49°C is

(a) 10 min (b) 11 min
(c) 13 min (d) 15 min

26 A planet of radius r radiates heat at a rate proportional to the fourth power of its surface temperature T. The temperature of the planet is such that, this loss is exactly compensated by the heat gained from the sun. If d is the mean distance of planet from the sun, then the temperature T of planet is directly proportional to

(a) $\sqrt{d}$ (b) $d^{2/3}$
(c) $\frac{1}{\sqrt{d}}$ (d) $\frac{1}{d^{2/3}}$

27 A body when fully immersed in a liquid of specific gravity 1.2 weight 44 gwt. The same body when fully immersed in water weight 50 gwt. The mass of the body is

(a) 36 g (b) 48 g
(c) 64 g (d) 80 g

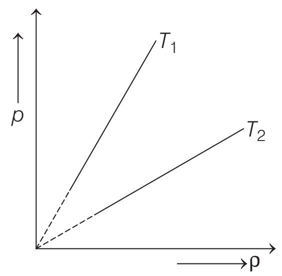
28 How much should the pressure of the gas be increased to decrease the volume by 10% at a constant temperature?

(a) 10% (b) 9.5%
(c) 11.11% (d) 5.11%

29 A black body at 227°C radiates heat at a rate of 7 cal/cm^{2}s. At a temperature of 727°C, the rate of heat radiated in the same units will be

(a) 112 (b) 105
(c) 101 (d) 89

30 The figure show the graph of pressure *versus* density for an ideal gas at two temperatures T_1 and T_2, then



(a) $T_1 > T_2$ (b) $T_1 = T_2$
(c) $T_1 < T_2$ (d) None of these

31 One end of a conducting rod is maintained at temperature 50°C and at the other end ice is melting at 0°C. The rate of melting of ice is doubled, if

(a) the temperature is made 200°C and the area of cross-section of the rod is doubled
(b) the temperature is made 100°C and length of the rod is made four times
(c) area of cross-section of rod is halved and length is doubled
(d) the temperature is made 100°C and area of cross-section of rod and length both are doubled

32 A small steel ball falls through a syrup at a constant speed of 1.0 m/s. If the steel ball is pulled upwards with a force equal to twice its effective weight, how fast will it move upward?

(a) 1.0 m/s (b) 2.0 m/s (c) 0.5 m/s (d) zero

33 A solid ball of density ρ_1 and radius r falls vertically through a liquid of density ρ_2. Assume that the viscous force acting on the ball is $F = krv$, where k is a constant and v its velocity. What is the terminal velocity of the ball?

(a) $\frac{4\pi gr^2(\rho_1 - \rho_2)}{3k}$ (b) $\frac{2\pi r\,(\rho_1 - \rho_2)}{3gk}$
(c) $\frac{2\pi g\,(\rho_1 + \rho_2)}{3gr^2k}$ (d) None of these

34 A block of mass M is suspended from a wire of length L, area of cross-section A and Young's modulus Y. The elastic potential energy stored in the wire is

(a) $\frac{1}{2}\frac{M^2g^2L}{AY}$ (b) $\frac{1}{2}\frac{Mg}{ALY}$ (c) $\frac{1}{2}\frac{M^2g^2A}{YL}$ (d) $\frac{1}{2}\frac{MgY}{AL}$

35 22320 cal of heat is supplied to 100g of ice at 0°C. If the latent heat of fusion of ice is 80 cal g^{-1} and latent heat of vaporisation of water is 540 cal g^{-1}, the final amount of water, thus obtained and its temperature respectively are

(a) 8g, 100°C (b) 100g, 100°C
(c) 92g, 100°C (d) 82g, 100°C

Direction (Q. Nos. 36-40) *In each of the following questions a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements mark the correct answer as*

(a) If both Assertion and Reason are true and the Reason is the correct explanation of the Assertion
(b) If both Assertion and Reason are true but the Reason is not the correct explanation of the Assertion
(c) If Assertion is true but Reason is false
(d) If both Assertion and Reason are false

36 **Assertion** (A) If length of a rod is doubled the breaking load remains unchanged.

Reason (R) Breaking load is equal to the elastic limit.

37 **Assertion** (A) The number of degrees of freedom of triatomic molecules is 6.

Reason (R) Triatomic molecules have three translational degrees of freedom and three rotational degrees of freedom.

38 **Assertion** (A) If the same load is attached to lead and rubber wires of the same cross-sectional area, the strain of lead is very much less than that of rubber.

Reason (R) Lead is more elastic than rubber.

39 **Assertion** (A) The coefficient of real expansion of liquid is independent of the nature of container.

Reason (R) $\gamma_a = \gamma_r + \gamma_v$

where, γ_a = coefficient of apparent expansion,
γ_r = coefficient of real expansion
and γ_v = coefficient of expansion of vessel.

40 **Assertion** (A) Thermodynamic processes in nature are irreversible.

Reason (R) Dissipative effects cannot be eliminated.

ANSWERS

1 (c)	**2** (c)	**3** (c)	**4** (b)	**5** (d)	**6** (c)	**7** (b)	**8** (b)	**9** (b)	**10** (b)
11 (d)	**12** (c)	**13** (a)	**14** (b)	**15** (a)	**16** (d)	**17** (b)	**18** (a)	**19** (c)	**20** (a)
21 (b)	**22** (c)	**23** (a)	**24** (c)	**25** (d)	**26** (c)	**27** (d)	**28** (c)	**29** (c)	**30** (a)
31 (d)	**32** (a)	**33** (a)	**34** (a)	**35** (a)	**36** (c)	**37** (a)	**38** (a)	**39** (d)	**40** (a)

Hints and Explanations

1 Weight of the rope

$$W = 8 \times A \times 1.5 \times 10^3 \times 10\,\text{N}$$

where, A is area of cross-section. The weight can be assumed to act at half the length of the rope. i.e. $L = 4$ m.

Hence, $\Delta L = \frac{W}{A} \times \frac{L}{Y}$

$= 8 \times 1.5 \times 10^3 \times 10 \times 4/5 \times 10^6$

$= 9.6 \times 10^{-2}$ m

2 Let the volume of the sphere be V. Then, weight of mercury displaced + weight of oil displaced = Weight of the sphere.

$$\frac{V}{2} \times 13.6 \times g + \frac{V}{2} \times 0.8 \times g = V \times \rho \times g$$

This gives $\rho = 7.2$ g cm^{-3}

3 $Y = \frac{F}{A} \times \frac{L}{\Delta L} = \frac{4F}{\pi d^2} \times \frac{L}{\Delta L}$

Hence, $\frac{\Delta L_1}{\Delta L_2} = \frac{F_1}{F_2} \times \frac{d_2^2}{d_1^2} \times \frac{L_1}{L_2} \times \frac{Y_2}{Y_1}$

$= \frac{F}{F} \times \left(\frac{1}{2}\right)^2 \times \left(\frac{1}{2}\right) \times \frac{Y}{Y} = \frac{1}{8}$

4 $h = 2T \cos\theta/\rho rg$,

$$r \propto \frac{1}{h} \Rightarrow \frac{r_P}{r_Q} = \frac{h_Q}{h_P} = \frac{h}{\frac{2}{3}h} = \frac{3}{2}$$

5 $Y = 2\eta\,(1 + \sigma)$ or $1 + \sigma = \frac{Y}{2\eta}$

$\Rightarrow \quad \sigma = \frac{Y}{2\eta} - 1 = \frac{2.4}{2} - 1 = 0.2$

6 Here, $R = n^{1/3} r \Rightarrow r = n^{-1/3} R$

and $W = (4\pi r^2 \times n - 4\pi R^2)T$

$= (4\pi R^2 n^{1/3} - 4\pi R^2)T$

$= 4\pi R^2\,(n^{1/3} - 1)T$

$W \propto (n^{1/3} - 1)$

7 $pV^{\gamma} = K$

Therefore, $\Delta\, pV^{\gamma} + p\gamma\, V^{\gamma-1}\,\Delta V = 0$

Hence, $\Delta p/p = -\,\gamma\,\Delta V/V$.

For monoatomic gas, $\gamma = 5/3$

Hence, $\frac{\Delta p}{p} = \frac{5}{3} \times 2.4\% = 4.0\%$

8 Change in area

$= 220 \times 10^{-4} - 120 \times 10^{-4} = 10^{-2}$ m^2

Surface tension, $T = \frac{W}{\text{Change in area}}$

$= \frac{3 \times 10^{-4}}{10^{-2}} = 3.0 \times 10^{-2}\,\text{Nm}^{-1}$

9 According to first law of thermodynamics, $dQ = dU + dW$

In cyclic process, $dU = 0$

$\Rightarrow \quad dQ - dW = 0$

10 $\therefore \quad Y = \frac{F}{A}\frac{l}{\Delta l}$

Here, $\frac{\Delta l}{l} = 0.2\% = \frac{2}{1000} \Rightarrow \frac{l}{\Delta l} = \frac{1000}{2}$

$A = \pi r^2 = \pi\left(\frac{d}{2}\right)^2 = 3.14 \times \left[\frac{0.6 \times 10^{-3}}{2}\right]^2$

$$\therefore F = \frac{0.9 \times 10^{11} \times 3.14 \times \left(\frac{0.6 \times 10^{-3}}{2}\right)^2 \times 2}{1000}$$

$= 50868 \times 10^{-3} = 50.868 \approx 51$ N

11 Let r = Radius of small drop

R = Radius of big drop

Then, volume of 2 small drops = Volume of one big drop, i.e.

$\frac{4}{3}\pi R^3 = 2 \times \frac{4}{3}\pi r^3$

$\Rightarrow \quad R = 2^{1/3} r$

Now, $\frac{v_1}{v_2} = \frac{r^2}{R^2} = \frac{r^2}{(2^{1/3} r)^2}$

Therefore, $v_2 = 5 \times 4^{1/3}$ cms^{-1}

12 For adiabatic process,

pV^{γ} = constant

$\Rightarrow \; p\rho^{-\gamma}$ = constant and $\gamma = \frac{7}{5}$

For diatomic gas,

$p\rho^{-\gamma} = p'\rho'^{-\gamma}$

$\Rightarrow \quad \frac{p}{p'} = \left(\frac{\rho'}{\rho}\right)^{-\gamma} = \left(\frac{1}{32}\right)^{7/5} = \frac{1}{128}$

$\Rightarrow \quad p' = 128\;p$

13 For monoatomic gas, $C_V = 3/2\;R$

For diatomic gas, $C_V = 5/2\;R$

Hence, for mixture,

$C_V = \frac{3/2\;R + 5/2\;R}{2} = 2\;R$

Therefore, C_p for mixture $= 3\;R$

$[\because C_p - C_V = R]$

$\Rightarrow \quad \gamma = \frac{C_p}{C_V} = \frac{3R}{2R} = 1.5$

14 $Q = nC_p\,\Delta T$

$70 = 2\,C_p\,(35 - 30) \Rightarrow C_p = 7$ cal

$C_V = C_p - R = 7 - 2 = 5$

$Q = n\,C_V \Delta T = 2 \times 5 \times (35 - 30)$

$= 50$ cal

15 Here, $p = p_A + p_B$ [Dalton's law]

and $p_A = \frac{125 \times 0.60}{1000} = 0.075$ atm

$\left[\because p_x = \frac{V_i}{V_f} \times p_i\right]$

$p_B = \frac{150 \times 0.80}{1000} = 0.120$ atm

So, $p = 0.075 + 0.120 = 0.195$ atm

16 According to Boyle's law,

$\Rightarrow \quad p_1V_1 = p_2V_2 \quad$ ...(i)

Here, $p_2 = p_1 + \frac{p_1}{20}$ or $p_2 = \frac{21}{20}\,p_1$

Substituting it in Eq. (i), we get

$V_2 = \frac{20}{21}\,V_1$ or $V_2 = 0.9524\,V_1$

Thus, V_2 is 95.24% of V_1.

In other words, volume decreases by 4.76%.

17 We know that, $c = \left(\frac{3p}{\rho}\right)^{1/2}$.

Here, $p = 1.0 \times 10^5$ Pa $\cong 10^5$ Pa

Therefore, $c = \left[\frac{3 \times 10^5}{0.09}\right]^{1/2} = \sqrt{\frac{10}{3}}$ kms^{-1}

18 $v_{\text{av}} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_{\text{Gas}}}{v_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_{\text{Gas}}}}$

$\Rightarrow \frac{4}{1} = \sqrt{\frac{64}{M_{\text{Gas}}}} \Rightarrow M_{\text{Gas}} = 4$ i.e. gas is He.

19 Temperature falls with time. As rate of loss of heat by radiation is directly proportional to T^4, so rate of loss of heat and time have inverse relation. So, the graph will be represented by hyperbolic curve III.

20 The rms speed of a gas molecule is given by

$c = \sqrt{\frac{3RT}{M}}$ or $c \propto \sqrt{T} \Rightarrow \frac{c_1}{c_2} = \sqrt{\frac{T_1}{T_2}}$

Substituting

$T_1 = 27°\text{C} = 27 + 273 = 300$ K

$T_2 = 327°\text{C} = 327 + 273 = 600$ K, we get

$\frac{c_1}{c_2} = \frac{1}{\sqrt{2}} \Rightarrow c_2 = \sqrt{2}\,c_1$

21 Molar specific heat at constant pressure is given by $Q = m\,C_p\Delta T$

where, m = mass of one mole gas,

C_p = specific heat of a one mole of gas at constant pressure,

ΔT = change in temperature.

On substituting $m = 1$ mol,

C_p (for monoatomic gas) $= \frac{5}{2}R$,

$\Delta T = 1$ K

we get, $Q = \frac{5}{2}R = 2.5R$

22 $E \propto T^4$ [Stefan's law]

$$\Rightarrow \frac{E_1}{E_2} = \left(\frac{T_1}{T_2}\right)^4 \Rightarrow \frac{20}{E_2} = \left[\frac{T_1}{2T_1}\right]^4$$

$$\Rightarrow E_2 = 320 \text{ kcal m}^{-2} \text{ min}^{-1}$$

23 Velocity of ball on reaching the water surface is $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6}$

$= 19.6$ m/s

If ρ be the density of ball, then density of water 2ρ.

If a is the retardation of the ball in water, then

$$a = \frac{\text{upward thrust} - \text{weight}}{\text{mass}}$$

$$= \frac{v(2\rho)g - v\rho g}{v\rho}$$

$$\Rightarrow a = g = 9.8 \text{ m/s}^2$$

So, the depth is

$$d = \frac{v^2}{2a} = \frac{19.6 \times 19.6}{2 \times 9.8} = 19.6 \text{ m}$$

24 Newton's law of cooling is valid when the temperature difference of body and surroundings is small. In such a case, Newton's law can be derived from Stefan's law.

25 $\because \frac{\theta_1 - \theta_2}{t} = K\left[\frac{\theta_1 + \theta_2}{2} - \theta_0\right]$

$$\frac{61° - 59°}{10} = K\left[\frac{61° + 59°}{2} - 30°\right]$$

$$K = \frac{1}{150}$$

Again

$$\frac{51° - 49°}{t} = \frac{1}{150}\left[\frac{51° + 49°}{2} - 30°\right]$$

$$t = 15 \text{ min}$$

26 Energy received per second

$$= \frac{Q}{4\pi d^2} \pi r^2 = \frac{Qr^2}{4d^2}$$

Energy emitted per second $= 4\pi r^2 (\sigma T^4)$

For equilibrium to exist,

$$\frac{Qr^2}{4d^2} = 4\pi r^2 (\sigma T^4)$$

$$\Rightarrow T^4 \propto \frac{1}{d^2} \text{ or } T \propto \frac{1}{\sqrt{d}}$$

27 Balancing equation,

$$w = mg - V\delta g$$

Hence, $44 = m - 1.2V$ ...(i)

$50 = m - V$ ...(ii)

On solving Eqs. (i) and (ii), $m = 80$ g

28 At constant temperature, pV = constant

As volume decreased by 10%, so pressure has to increase to keep the product of pV constant.

Therefore, volume becomes $= \frac{9}{10}V$

Pressure $= \frac{10}{9}p$

$$\% \text{ increase} = \left(\frac{\frac{10p}{9} - p}{p}\right) \times 100 = 11.11\%$$

29 According to Stefan's law $E = \sigma T^4$

$\therefore 7 = \sigma(227 + 273)^4 = \sigma \times (500)^4$

and $x = \sigma(727 + 273)^4 = \sigma \times (1000)^4$

Hence, $\frac{x}{7} = \frac{(1000)^4}{(500)^4} = 16$

$\Rightarrow x = 16 \times 7 = 112 \text{ cal/cm}^2\text{s}$

30 As, $pV = nRT = \frac{m}{M}RT$

where, M = molecular weight.

$$\Rightarrow \frac{p}{m/V} = \frac{RT}{M} \Rightarrow \frac{p}{\rho} = \frac{RT}{M} \Rightarrow \frac{p}{\rho} \propto T$$

($\because$ for a given gas, M is constant)

Temperature is directly proportional to the slope of p - ρ graph.

So, $T_1 > T_2$.

31 Rate of melting of ice $\propto$ rate of heat transfer $\left(\frac{dQ}{dt}\right)$

Further, $\frac{dQ}{dt} = \frac{\text{temperature difference}}{\left(\frac{l}{kA}\right)}$

or $\frac{dQ}{dt} \propto \frac{(\text{temperature difference})}{l} A$

If temperature difference, A and l are all doubled, then $\frac{dQ}{dt}$ and hence rate of melting of ice will be doubled.

32 w_e = effective weight

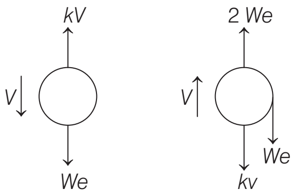
$kv = w_e$ ...(i)

In equilibrium

$2w_e - w_e = kv'$ ...(ii)

From Eqs. (i) and (ii), we get

$v' = v = 1.0$ m/s



33 Net force on the ball = 0

(when terminal velocity is attained)

Hence,

Weight = upthrust + viscous force

$$\therefore \frac{4}{3}\pi r^3 \rho_1 g = \frac{4}{3}\pi r^3 \rho_2 g + krv_T$$

$$\therefore v_T = \frac{4\pi g r^2}{3k}(\rho_1 - \rho_2)$$

34 $\Delta l = \frac{FL}{AY} = \frac{MgL}{AY}$; $U = \frac{1}{2}k(\Delta l)^2$

where, $k = \frac{YA}{L}$

$$\therefore U = \frac{1}{2}\left(\frac{YA}{L}\right)\left(\frac{MgL}{AY}\right)^2 = \frac{M^2 g^2 L}{2AY}$$

35 Heat required to convert ice to water at 100° C,

so initially water is at 0°C.

So, Q_1 = Heat required to convert 100 g ice to water

$= mL = 100 \times 80 = 8000$ Cal

Q_2 = Heat required to convert the temperature 0°C to 100°C for 100 g water

$= m\delta\Delta T = 100 \times 1 \times (100° - 0°)$

$= 100 \times 100 = 10{,}000$ Cal

So, $Q = Q_1 + Q_2 = 18000$ Cal

So remaining heat for vaporisation

$= 22320 - 18000 = 4320$ Cal

So amount of water vaporised by remaining heat,

$m \times L_{vapor} = 4320$

$m = \frac{4320}{540} = 8$ g(steam)

So the remaining water after vaporisation is,

$m = 100 - 8 = 92$ g at 100°C

So, option (c) is correct.

36 Breaking load depends on the area of cross-section and is independent of length of rod.

Hence, breaking load

= breaking stress × cross-sectional area.

37 A non-linear molecule can rotate about any of three coordinate axis. Hence, it has 6 degrees of freedom: 3 translational and 3 rotational.

38 On applying load on lead and rubber wires of same cross-sectional area, the strain produced in lead is much less than rubber wires. From the relation,

$$\text{Young's modulus } (Y) = \frac{\text{Stress}}{\text{Strain}}$$

The Young's modulus of elasticity is greater for lead wires.

39 Coefficient of real expansion,

$$\gamma_r = \gamma_a + \gamma_v$$

Here, γ_v is coefficient of cubical expansion of vessel (container).

Thus, real expansion coefficient depends on nature of vessel.

40 The thermodynamic process is irreversible, as there always occurs a loss of energy due to energy spent in working against the dissipative force which is not recovered back.