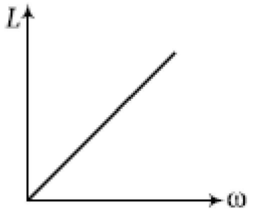
Medicine Paper 3 - Chapter 5 and 6

1. The graph between the angular momentum L and angular velocity ω will be

(a)



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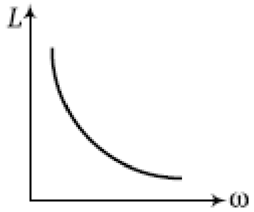

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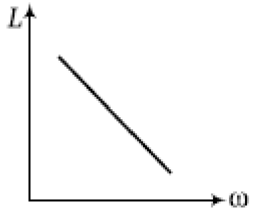

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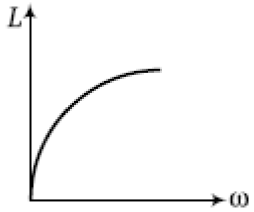


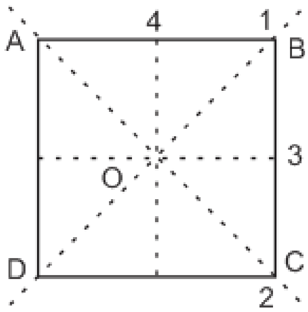
Answer: a

Solution

$L = I\omega \quad \therefore L \propto \omega$ (If I = constant)

So graph between L and ω will be straight line with constant slope.

2. The moment of inertia of a thin square plate ABCD of uniform thickness about as axis passing through the centre O and perpendicular to the plate is



(a) $I_1 + I_2$
(b) $I_3 + I_4$
(c) $I_1 + I_3$
(d) $I_1 + I_2 + I_3 + I_4$

Answer: c

Solution

According to theorem of perpendicular axes

$I = I_1 + I_2$ and $I = I_3 + I_4$

As $I_2 = I_3 \therefore I = I_1 + I_3$

3. The angular speed of cylinder is proportional to h^n , where h is the height through which mass falls, Then the value of n is___

(a) zero
(b) 1
(c) 2018/01/02
(d) 2

Answer: c

Solution

From conservation of energy we have

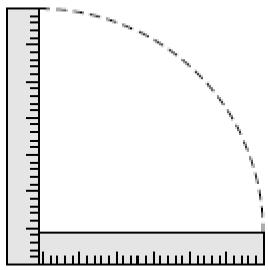
$$Mgh = \frac{1}{2}MV^2 + \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}MR^2\omega^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\omega^2 = \frac{1}{4}(2m + M)\omega^2R^2$$

$$\therefore \omega = \left[\frac{4mgh}{(M + 2m)R^2}\right]^{\frac{1}{2}}$$

$$As\ \omega \propto h^{\frac{1}{2}}$$

4. A metre stick is held vertically with one end of the floor and is then allowed to fall. If the end touching the floor is not allowed to slip, the other end will hit the ground with a velocity of ($g = 9.8\ m/s^2$)

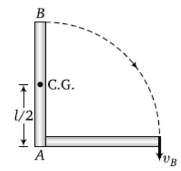


(a) 3.2 m/s
(b) 5.4 m/s
(c) 7.6 m/s
(d) 9.2 m/s

Answer: b

Solution

In this process potential energy of the metre stick will be converted into rotational kinetic energy.



P.E. of metre stick $= mg\left(\frac{l}{2}\right)$

Because its centre of gravity lies at the middle point of the rod.

Rotational kinetic energy $E = \frac{1}{2}I\omega^2$

I = M.I. of metre stick about point $A = \frac{ml^2}{3}$

ω = Angular speed of the rod while striking the ground
v_B = Velocity of end B of metre stick while striking the ground.

By the law of conservation of energy,

$$mg\left(\frac{l}{2}\right) = \frac{1}{2}I\omega^2 = \frac{1}{2}\frac{ml^2}{3}\left(\frac{v_B}{l}\right)^2$$

By solving we get, $v_B = \sqrt{3gl} = \sqrt{3 \times 10 \times 1} = 5.4$ m/s

5. The centre of mass of a system of three particles of masses 1g, 2g and 3g is taken as the origin of a coordinate system. The position vector of a fourth particle of mass 4g such that the centre of mass of the four particle system lies at the point (1, 2, 3) is $\alpha(\hat{i} + 2\hat{j} + 3\hat{k})$, where a is a constant. The value of α is

(a) 2018/10/03
(b) 2018/05/02
(c) 2018/01/02
(d) 2018/02/05

Answer: b

Solution

The (x, y, z) co-ordinates of masses 1g, 2g, 3g and 4g are $(x_1 = 0, y_1 = 0, z_1 = 0)$, $(x_2 = 0, y_2 = 0, z_2 = 0)$ $(x_3 = 0, y_3 = 0, z_3 = 0)$, $(x_4 = \alpha, y_4 = 2\alpha, z_4 = 3\alpha)$

$$\therefore \quad X_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3 + m_4x_4}{m_1 + m_2 + m_3 + m_4}$$

$$X_{CM} = \frac{1 \times 0 + 2 \times 0 + 3 \times 0 + 4 \times \alpha}{1 + 2 + 3 + 4}$$

$$1 = \frac{4\alpha}{10} \quad \text{or} \quad \alpha = \frac{5}{2}$$

The value of α can also be calculated by Y_{CM} and Z_{CM} as shown below

$$Y_{CM} = \frac{1 \times 0 + 2 \times 0 + 3 \times 0 + 4 \times 2\alpha}{1 + 2 + 3 + 4}$$

$$2 = \frac{8\alpha}{10} \text{ or } \alpha = \frac{20}{8} = \frac{5}{2}$$

$$Z_{CM} = \frac{1 \times 0 + 2 \times 0 + 3 \times 0 + 4 \times 3\alpha}{1 + 2 + 3 + 4}$$

$$3 = \frac{12\alpha}{10} \text{ or } \alpha = \frac{30}{12} = \frac{5}{2}$$

6. The angular velocity of a body changes from ω_1 to ω_2 without applying a torque but by changing the moment of inertia about its axis of rotation. The ratio of its corresponding radii of gyration is

(a) $\omega_1 : \omega_2$
(b) $\sqrt{\omega_1} : \sqrt{\omega_2}$
(c) $\omega_2 : \omega_1$
(d) $\sqrt{\omega_2} : \sqrt{\omega_1}$

Answer: d

Solution

Using angular momentum conservation

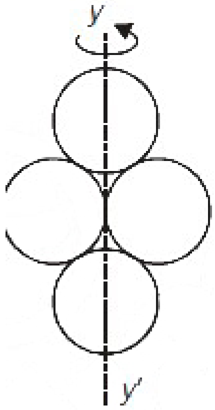
$$I_1\omega_1 = I_2\omega_2$$

$$\frac{I_1}{I_2} = \frac{\omega_2}{\omega_1}$$

$$\frac{mk_1^2}{mk_2^2} = \frac{\omega_2}{\omega_1}$$

$$\frac{k_1}{k_2} = \sqrt{\frac{\omega_2}{\omega_1}}$$

7. Four rings each of mass M and radius R are arranged as shown in the figure. The moment of inertia of the system about the axis yy' is



(a) $2MR^2$
(b) $3MR^2$
(c) $4MR^2$
(d) $5MR^2$

Answer: c

Solution

For upper and lower rings

$$I_1 = \frac{Mr^2}{2}$$

For middle rings, using parallel axis theorem

$$I_2 = \frac{Mr^2}{2} + Mr^2$$

$$= \frac{3}{2}Mr^2$$

$$I = 2I_1 + 2I_2$$

$$= Mr^2 + 3Mr^2$$

$$= 4Mr^2$$

8. A Pulley of radius 2 m is rotated about its axis by a force F = $(20t - 5t^2)$N where t is in sec applied tangentially. If the moment of inertia of the Pulley about its axis of rotation is $10KgM^2$ the number of rotations made by the pulley before its direction of motion is reversed is

(a) more than 3 but less then 6
(b) more than 6 but less then 9
(c) more than 9
(d) Less then 3

Answer: a

Solution

Here direction of Motion will be reversed when force

$F = 0$ or $20t - 5r^2 = 0$ or $t = 4s$.

If α is angular accellaration then forque

$\tau = I\alpha = F.r$ or $10 \times \alpha = (20 - 5t^2) \times 2$ or

$\alpha = 4t - t^2$ and $\omega = \frac{d\theta}{dt}$ also $\frac{d\theta}{dt} = \alpha t$

$\therefore d\theta = \alpha.tdt = (4t - t^2).tdt = (4t^2 - t^3)$ taking intigration

$\theta = \frac{4t^3}{3} - \frac{t^4}{4}$ If n rotations are completed in As then

Putting t = 4

$\theta = 2\pi n = \frac{4 \times 64}{3} - 64 = \frac{64}{3}$

$\therefore n = 3.4$ which is $3 < 3.4 < 6$

9. A bucket tied at the end of a 1.6 m long string is whirled in a vertical circle with a constant speed. The minimum speed at which water from the bucket does not spil when it is at the highest position is

(a) 4 m/s
(b) 6.25 m/s
(c) 2 m/s
(d) 16 m/s

Answer: a
Solution

$$For\ water\ not\ to\ spil, \frac{mv^2}{r} = mg$$

$$or\ v = \sqrt{rg} = \sqrt{1.6 \times 10} = 4\ ms^{-1}$$

10. Statement – 1 —Two cylinder one hollow and other solid (wood) with the same mass and identical dimensions are simultaneously allowed to roll without slipping down an inclined plane from the same height. The hollow will reach the bottom of inclined plane first.
Statement – 2 — By the principle of conservation of energy, the total kinetic energies of both the cylinders are identical when they reach the bottom of the incline.

(a) Statement – 1 is correct (true), Statement – 2 is true and Statement – 2 is correct explanation for Statement – 1
(b) Statement – 1 is true, statement – 2 is true but statement – 2 is not the correct explanation four statement – 1
(c) Statement – 1 is true, statement – 2 is false
(d) Statement – 2 is false, statement – 2 is true

Answer: c
Solution

$$Mg\frac{L}{2} = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{ML^2}{3}\right)\omega^2 \quad \therefore \omega = \sqrt{\frac{3g}{L}}$$

11. An earth satellite of mass m revolves in a circular orbit at a height h from the surface of the earth. R is the radius of the earth and g is acceleration due to gravity at the surface of the earth. The velocity of the satellite in the orbit is given by

(a) $\frac{gR^2}{R+h}$
(b) gR
(c) $\frac{gR}{R+h}$
(d) $\sqrt{\frac{gR^2}{R+h}}$

Answer: d
Solution

$$v_0 = \sqrt{\frac{Gm}{r}} = \sqrt{\frac{gR^2}{R+h}}$$

12. The radius of a planet is twice the radius of earth. Both have almost equal average mass-densities. If V_P and V_E are escape velocities of the planet and the earth, respectively, then

(a) $V_E = 1.5V_P$
(b) $V_P = 1.5V_E$
(c) $V_P = 2V_E$
(d) $V_E = 3V_P$

Answer: c
Solution

$$V_{escape} = R\left(\sqrt{\frac{8\pi GP}{3}}\right)$$

$$\Rightarrow \frac{V_P}{V_E} = 2$$

$$V_P = 2V_E$$

13. The escape velocity for a planet is v_e. A particle is projected from its surface with a speed v. For this particle to move as a satellite around the planet.

(a) $v_e < v < \sqrt{2}v_e$
(b) $\frac{v_e}{\sqrt{2}} < v < \frac{v_e}{2}$
(c) $\frac{v_e}{\sqrt{2}} < v < v_e$
(d) $\frac{v_e}{2} < v < v_e$

Answer: c
Solution

For a satellite orbiting close to earth, the orbital velocity, $v = \sqrt{gR}$. This is the minimum velocity required to put the satellite in orbit around the earth. The satellite would escape if

$v \geq v_e$, where $v_e = \sqrt{2gR} = \sqrt{2}v$ or $v = \frac{v_e}{\sqrt{2}}$

Therefore, $\frac{v_e}{\sqrt{2}} < v < v_e$

14. Weight of body of mass m decreases by 1% when it is raised to height h above the earth's surface. If the body is taken to a depth h in a mine. change in its weight is

(a) 2% decreases
(b) 0.5% decreases
(c) 1% increases
(d) 0.5% increases

Answer: b
Solution

For height $\frac{\Delta g}{g} \times 100\% = \frac{24}{4} \times 100\%$

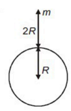
For depth $\frac{\Delta g}{g} \times 100\% = \frac{d}{R} = \frac{h}{R} = \frac{1}{2} = 0.5$

15. An object is taken to height 2R above the surface of earth, the increase in potential energy is [R is radius of earth]

(a) $\frac{mgR}{2}$
(b) $\frac{mgR}{3}$
(c) $\frac{2mgR}{3}$
(d) 2 mgR

Answer: c
Solution

I. Answer (3)



Potential energy at surface $= -\frac{GMm}{R}$

Potential energy at height, $2R = -\frac{GMm}{3R}$

Change in potential energy $= -\frac{GMm}{3R} + \frac{GMm}{R}$

$$= \frac{GMm}{R}\left(\frac{-1+3}{3}\right)$$

$$= \frac{2}{3}\frac{GMm}{R}$$

$$= \frac{2}{3}\left(\frac{GM}{R^2}\right)mR$$

$$= \frac{2}{3}mgR$$

16. An earth satellite X is revolving around earth in an orbit whose radius is one-fourth of the radius of orbit of a communication satellite. Time period of revolution of X is

(a) 3 hrs
(b) 6 hrs
(c) 4 days
(d) 72 days

Answer: a
Solution

Time period of a communication satellite = 24 hours.

Using kepler's third law,

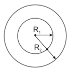
$T^2 \propto r^3$

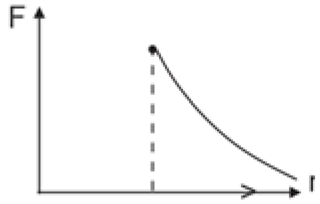
$\Rightarrow \frac{T_c}{T_x} = \left(\frac{r_c}{r_x}\right)^{3/2}$

$\Rightarrow \frac{24}{T_x} = (4)^{3/2}$

$\Rightarrow T_x = \frac{24}{8} = 3$ hrs

17. A sphere of mass M and Radius R_2 has a concentric cavity of Radius R_1 as shown in figure. The force F exerted by the shpere on a particle of mass m located at a distance r from the center of sphere varies as ($0 \le r \le \infty$)



(a)


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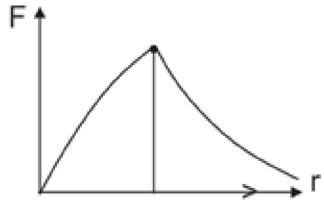

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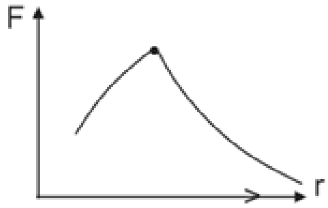

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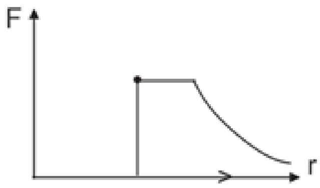


Answer: b
Solution

$F = 0$ When $0 \le r \le R_1$
Because intensity is zero inside
F increase When $R_1 \le r \le R_2$
$F \,\alpha \frac{1}{R}$ when $r > R_2$

18. A clock S is based on oscillation of a spring and a clock P is based on pendulum motion. Both clocks run at the same rate on earth. On a planet having the same density as earth but twice the radius

(a) S will run faster than P
(b) P will run faster than S
(c) They will both run at the same rate as on the earth
(d) None of the above

Answer: b
Solution

$g = \frac{4}{3}\pi\rho G R$. If density is same, then $g \propto R$

According to problem $R_p = 2R_e \therefore g_p = 2g_e$

For clock P (based on pendulum motion)

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Time period decreases on planet, so it will run faster because $g_p > g_e$.

For clock S (based on oscillation of spring)

$$T = 2\pi\sqrt{\frac{m}{k}}$$

So, it does not change.

19. The escape velocity of a sphere of mass m from the surface of earth is given by (G = Universal gravitational constant; M = Mass of the earth and Re = Radius of the earth)

(a) $\sqrt{\frac{2GMm}{R_e}}$

(b) $\sqrt{\frac{2GM}{R_e}}$

(c) $\sqrt{\frac{GM}{R_e}}$

(d) $\sqrt{\frac{2GM + R_e}{R_e}}$

Answer: b
Solution

$v_e = \sqrt{\frac{2GM}{R_e}}$

$\frac{-GMm}{R_e} + \frac{1}{2}mv_e^2 = 0$

$\Rightarrow v_e = \sqrt{\frac{2GM}{R_e}}$, independent of the mass of sphere.

20. The additional K.E. to be provided to a satellite of mass m revolving around a planet of mass M, to transfer it from a circular orbit of radius R_1 to another radius R_2 ($R_2 > R_1$) is

(a) $GMm\left(\frac{1}{R_1^2} - \frac{1}{R_2^2}\right)$

(b) $GMm\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

(c) $2GMm\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

(d) $\frac{1}{2}GMm\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Answer: d
Solution

$$-\frac{GMm}{2R_1} + K.E. = -\frac{GMm}{2R_2}$$

$$K.E = \frac{GMm}{2}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

21. Vander Waal's equation of state is obeyed by real gases. For n moles of a real gas, the expression will be

(a) $\left(\frac{P}{n}+\frac{na}{V^2}\right)\left(\frac{V}{n-b}\right)=RT$

(b) $\left(P+\frac{a}{V^2}\right)(V-b)=nRT$

(c) $\left(P+\frac{na}{V^2}\right)(nV-b)=nRT$

(d) $\left(P+\frac{n^2a}{V^2}\right)(V-nb)=nRT$

Answer: d

Solution

Van der Waal's equation is $\left(P+\frac{an^2}{V^2}\right)(V-nb)=$ nRT

22. For an ideal gas, number of moles per litre in terms of its pressure P, gas constant R and temperature T is

(a) PT/R
(b) PRT
(c) P/RT
(d) RT/P

Answer: c

Solution

$PV=nRT$ or $\frac{n}{V}=\frac{P}{RT}$ i.e. no of moles per litre = P/RT

23. Ratio of average to most probable velocity is

(a) 1.128
(b) 1.224
(c) 1
(d) 1.112

Answer: a

Solution

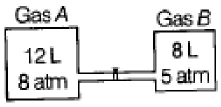
$$\frac{\text{Average velocity}}{\text{most probable velocity}}=\frac{\sqrt{\frac{8RT}{\pi M}}}{\sqrt{\frac{2RT}{M}}}$$

$$=\frac{\sqrt{8}}{\sqrt{\pi}\times\sqrt{2}}$$

$$=\frac{2}{\sqrt{\pi}}$$

$$\frac{\text{Average velocity}}{\text{most probable velocity}}=1.128$$

24. Two vessels containing gases A and B are interconnected as shown in the figure. The stopper is opened, the gases are allowed to mix homogeneously. The partial pressures of A and B in the mixture will be, respectively.



(a) 8 and 5 atm
(b) 9.6 and 4 atm
(c) 4.8 and 2 atm
(d) 6.4 and 4 atm

Answer: c

Solution

From an ideal gas equation, pV = nRT

$\Rightarrow n=\frac{pV}{RT}$

For moles of $A, n_A=\frac{p_AV_A}{RT}=\frac{8\times 12}{RT}=\frac{96}{RT}$

For moles of $B, n_B=\frac{p_BV_B}{RT}=\frac{8\times 5}{RT}=\frac{40}{RT}$

From equation pV = nRT

$p(V_A+V_B)=(n_A+n_B)RT$

$p(12+8)=\left(\frac{96}{RT}+\frac{40}{RT}\right)\times RT$

$p(20)=136$

$p=6.8$

∴ Partial pressure of A = p × mole fraction of A

$=6.8\times\left(\frac{\frac{96}{RT}}{\frac{96+40}{RT}}\right)$

$=4.8atm$

Partial pressure of $B=p\times$ mole fraction of B

$=6.8\left[\frac{\frac{40}{RT}}{\frac{96+40}{RT}}\right]=2atm$

∴The partial pressure of A and B in the mixture will be 4.8 and 2 atm respectively.

25. If 10^{-4} dm^3 of water is introduced into a $1dm^3$ flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established (given, vapour pressure of H_2O at 300 K is 3170 Pa, *R* = 8.314 JK^{-1} mol^{-1}).

(a) 5.56×10^{-6} mol
(b) 1.53×10^{-2} mol
(c) 4.46×10^{-2} mol
(d) 1.27×10^{-3} mol

Answer: d

Solution

From an ideal gas equation,

$pV=nRT$

$\Rightarrow n=\frac{pV}{RT}=\frac{3170\times 10^{-3}}{8.314\times 300}=1.27\times 10^{-3}mol$

26. If both oxygen and helium gases are at the same temperature, the rate of diffusion of O_2 is very close to

(a) 4 times that of He
(b) 2 times that of He
(c) 0.35 times that of He
(d) 8 times that of He

Answer: c

Solution

According to Graham's law of difffusion,

$\frac{r_{O_2}}{r_{He}}=\sqrt{\frac{M_{He}}{M_{O_2}}}=\sqrt{\frac{4}{32}}=\frac{2}{4\sqrt{2}}=\frac{1}{2\sqrt{2}}=0.35$

$\therefore\frac{r_{O_2}}{r_{He}}=0.35$

$\Rightarrow r_{O_2}=0.35r_{He}$

∴The rate of diffusion of O_2 is very close to 0.35 times that of Helium.

27. The volume of 1 g each of methane (CH_4), ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) was measured at 350 K and 1 atm. What is the volume of butane?

(a) 495 cm^3
(b) 600 cm^3
(c) 900 cm^3
(d) 1700 cm^3

Answer: a
Solution

$$PV = nRT = \frac{w}{M}RT, V = \frac{wRT}{PM}$$
$$= \frac{1 \times 0.0821 \times 350}{1 \times 58} = 0.495\ L = 495\ ml$$

28. For one mole of an ideal gas, the slope of V versus T curve at constant pressure of 2 atm is XL mol^{-1} K^{-1}. The value of the ideal universal gas constant R in terms of X is

(a) XL atm mol^{-1} K^{-1}
(b) $\frac{X}{2}$ L atm $mol^{-1}K^{-1}$
(c) $2X$ L atm mol^{-1} K^{-1}
(d) $2X$ atm L^{-1} mol^{-1} K^{-1}

Answer: c
Solution

Consider the ideal gas equation,

$pV = nRT$

$V = \frac{nRT}{p}$

for n = 1mole

$V = \frac{RT}{p}$

Graph of V verses T will give straight line and slope will be R/p

$\therefore$ Slope $= \frac{R}{p}$

$\Rightarrow x = \frac{R}{2}$

$\Rightarrow R = 2 \times L\, mol^{-1}K^{-1}$

29. Calculate the total pressure in a 10.0 L cylinder which contains 0.4 g helium, 1.6 g oxygen and 1.6 nitrogen at 27°C .

(a) 0.492 atm
(b) 49.2 atm
(c) 4.92 atm
(d) 0.0492 atm

Answer: a
Solution

We know that,

$$\text{Number of moles}(n) = \frac{\text{mass of substance}(m)}{\text{Molar mass of a substance}(M)}$$

$n_{He} = \frac{0.4}{4} = 0.1\ mole$

$n_{O_2} = \frac{1.6}{32} = 0.05\ mole$

$n_{N_2} = \frac{1.4}{28} = 0.05\ mole$

Total number of moles in a cylinder $= (0.1 + 0.05 + 0.05)$ mole
$= 0.2$ mole

From ideal gas equation,

$pV = nRT$

$\Rightarrow p = \frac{nRT}{V}$

$= \frac{0.2 \times 0.082 \times 300}{10}$

$p = 0.492\ atm$

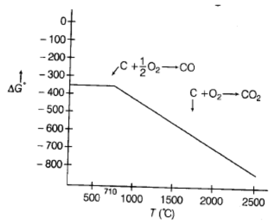
30. The density of helium is 0.1782 g per litre at N.T.P. Its density at 27°C and 740 mm Hg will be

(a) $\frac{0.1782 \times 300 \times 760}{273 \times 740}$ g per litre
(b) $\frac{0.1782 \times 300 \times 740}{273 \times 760}$ g per litre
(c) $\frac{0.1782 \times 273 \times 740}{300 \times 740}$ g per litre
(d) $\frac{0.1782 \times 273 \times 740}{300 \times 760}$ g per litre

Answer: d
Solution

$$d = \frac{PM}{RT}, \frac{d_2}{d_1} = \frac{P_2}{T_2} \times \frac{T_1}{P_1}, \frac{d_2}{0.1782} = \frac{740 \times 273}{300 \times 760}$$
$$d_2 = \frac{0.1782 \times 273 \times 740}{300 \times 760} gL^{-1}$$

31. Consider the following Ellingham's diagram for carbon.



Which of the statement is incorrect for the above Ellingham's diagram?

(a) Upto 710°C, the reaction of formation of CO_2 is energetically more favourable but above 710°C, the formation of CO is preferred
(b) Carbon can be used to reduce any metal oxide at a sufficiently high temperature
(c) Carbon reduces many oxides at elevated temperature because ΔG° vs temperature line has a negative slope
(d) $\Delta S^\circ\left[C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)\right] < \Delta S^\circ[C(s) + O_2(g) \rightarrow CO(g)]$

Answer: d
Solution

Standard Gibb's – Helmholtz equation is
$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$
In the Ellingham's diagram
ΔG° for $C + \frac{1}{2}O_2 \longrightarrow CO \longrightarrow (1)$ is less negative
Compare to $C + O_2 \longrightarrow CO_2 \longrightarrow (2)$ reaction
$\therefore$ ΔS° should be high for equation (1) compare to (2)
$\therefore$ $\Delta S^\circ(1) > \Delta S^\circ(2)$

32. The densities of graphite and diamond at 298 K are 2.25 and 3.31 g cm^{-3} respectively. If the standard free energy difference (ΔG^o) is equal to 1895 J mol^{-1}, the pressure at which graphite will be transformed into diamond at 298 K is

(a) 9.92×10^8 Pa
(b) 9.92×10^7 Pa
(c) 9.92×10^6 Pa
(d) 9.92×10^5 Pa
(e) None of these

Answer: e
Solution

$$-\Delta G = p\Delta V\ \ 1895 = P\left[\left(\frac{12}{2.25} - \frac{12}{3.31}\right) \times 10^{-6}\ m^3\right]$$

Calculate P.

From thermodynamics, $\left[\frac{\partial(\Delta G)}{\partial P}\right]_T = \Delta V$

or $\frac{\Delta G_2 - \Delta G_1}{P_2 - P_1} = \Delta V$

or $\Delta G_2 - \Delta G_1 = (P_2 - P_1)\Delta V$

Taking $P_1 = 1$ bar $= 10^5$ Pa calculate P_2

33. Ka for CH3COOH at 25ºC is 1.754×10^{-5} . At 50ºC, Ka is 1.633×10^{-5} What will be value of ΔSº for the ionisation of CH3COOH?

(a) –94.44 J/mole K
(b) –96.66 J/mole K
(c) –96.44 J/mole K
(d) –90.44 J/mole K

Answer: c

Solution

$(\Delta G^o)_{298} = -2.303 RT \log K$

$= -2.303 \times 8.314 \times \log(1.754 \times 10^{-5})$

$= 27194\, J$

$\Delta G^o = \Delta H^o - T\Delta S^o$

$29605 = \Delta H^o - 298\, \Delta S^o$

$\Delta S^o = -96.44 J/mol.K$

34. If the bond dissociation energies of XY, X_2 and Y_2 (all diatomic molecules) are in the ratio of 1 : 1 : 0.5 and DHf for the formation of XY is – 200 KJ mol^{-1}. The bond dissociation energy of X_2 will be

(a) 100 KJ mol^{-1}
(b) 200 KJ mol^{-1}
(c) 300 KJ mol^{-1}
(d) 800 KJ mol^{-1}

Answer: d

Solution

Let the bond dissociation energy of XY, X_2 and Y_2

be x, x and $x, KJ/mol$ respectively,

$\frac{1}{2}X_2 + \frac{1}{2}Y_2 \rightarrow XY;\ \Delta Hf = -200\, KJ\, mol^{-1}$

ΔH reaction

= [(sum of bond dissociation energy of all rectants)

−(sum of bond dissociation energy of product)]

Second method

$XY \rightarrow X_{(g)} + Y \Delta H_{(g)} a + KJ/mole; \rightarrow (1)$

$X_2 \rightarrow 2X \Delta H = a + KJ/mole; \rightarrow (2)$

$Y_2 \rightarrow 2Y \Delta H = 0.5\, a + KJ/mole; \rightarrow (3)$

$\frac{1}{2} \times (2) + \frac{1}{2} \times (3) - (1),$

gives $\frac{1}{2}X_2 + \frac{1}{2}Y_2 \rightarrow XY;$

$\Delta n = 2 - 4 = -2$

35. Given the following entropy values (in J K^{-1} mol^{-1})at 298 K and 1 atm: H_2(g) : 130.6, Cl_2(g) : 223.0 and HCl (g) : 186.7. The entropy change (in J K mol^{-1}) for the reaction $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ is

(a) 540.3
(b) 727
(c) -166.9
(d) 19.8

Answer: d

Solution

$\Delta S^o = 2S^o_{HCl} - (S^o_{H_2} + S^o_{Cl_2})$

$= 2 \times 186.7 - (130.6 + 223.0)$

$= 19.8\, JK^{-1} mol^{-1}$

36. Calculate the work performed when 2 moles of hydrogen expand isothermally and reversibly at 25ºC form 15 to 50 litres.

(a) –1438 Cal
(b) –1436 cal
(c) –1348 cal
(d) –1346 cal

Answer: b

Solution

$W - 2.303\, nRT \log \frac{V_2}{V_2} = -2.303 \times 2 \times 298 \times \log \frac{50}{15}$

$= -1436$ calories

37. For the given reaction $H_2(g) + Cl_2(g) \rightarrow 2H^+(aq) + 2Cl^-(aq), \Delta G^o = -262.4$ KJ. The value of free energy of formation (ΔG^o_f) for the ion $Cl^-(aq)$, therefore, will be

(a) – 131.2 kJ mol^{-1}
(b) 131.2 kJ mol^{-1}
(c) – 262.4 kJ mol^{-1}
(d) 262.4 kJ mol^{-1}

Answer: a

Solution

$\Delta G^o_{Reaction} = \Delta G^o_f(\text{Products}) - \Delta G^o_f(\text{Reactants})$

$= [2\Delta G^o_f(H^+) + 2\Delta G^o_f(Cl^-)] - [\Delta G^o_f(H_2) + \Delta G^o_f(Cl_2)]$

$= [0 + 2\Delta G^o_f(Cl^-)] - [0 + 0]$

or $-262.4 = 2\Delta G^o_f(Cl^-)$ or $\Delta G^o_f(Cl^-) = -131.2\, kJ\, mol^{-1}$

38. When two moles of water is boiled at 100^o C temperature which gets converted to vapour same temperature. Then what will be change in entropy of system ?

(a) 25.12
(b) 52.12
(c) 21.76
(d) 217.6

Answer: c

Solution

For 2 moles of water vapour, Absorbed energy by system is

$\Delta H_{vap} = 2 \times 9720 = 19440\, cal$

$\Delta S_{vap} = \frac{\Delta H_{vap}}{T_b}$

$= \frac{19440}{(100 + 273)}$

$= 52.12\, Cal\, K^{-1}\, mole^{-1}$

$= 52.12\ 4.184$

$= 217.6\, joulte\, k^{-1}.mole^{-1}$

39. A mixture of two moles of carbon monoxide and one mole of oxygen, in a closed vessel is ignited to convert the carbon monoxide to carbon dioxide. If ΔH is the enthalpy change and ΔE is the change in internal energy, then

(a) ΔH > ΔE
(b) ΔH < ΔE
(c) ΔH = ΔE
(d) the relationship depends on the capacity of the vessel

Answer: b

Solution

$2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$

enthalpy of a system is given as

$\Delta H = \Delta E + \Delta nRT$

$\Delta n = n(\text{products}) - n(\text{reactants})$

$\Delta n = 2 - 3 = -1$

Then , $\Delta H = \Delta E - RT$

$\Rightarrow \Delta H < \Delta E$

40. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is $CH_3OH(l) + 3/2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ At 298 K, standard Gibb's energies of formation for CH_3OH(l), H_2O(l) and CO_2 (g) are –166.2, –237.2 and –394.4 kJ mol^{-1} respectively. If standard enthalpy of combustion of methanol is –726kJ mol^{-1}, efficiency of the fuel cell will be :

(a) 0.87
(b) 0.9
(c) 0.97
(d) 0.8

Answer: c

Solution

$CH_3OH(l) + 3/2\, O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

$\Delta G_r = \Delta G_f(CO_2, g) + 2\Delta G_f(H_2), (l)) - \Delta G_f(CH_3OH(l))$

$- \Delta G_f(O_2, g)$

$= -394.4 + 2(-237.2) - 166.2 - 0$

$= -394.4 - 474.4 + 166.2 = -868.8 \times 166.2$

$\Delta G_r = -702.6\, KJ$

$\%\ \text{efficiency} = \frac{702.6}{726} \times 100 = 97\%$

41. Which of the following is not consumed in a biochemical process ?

(a) Hormone
(b) Enzyme
(c) vitamin
(d) Nucleotide

Answer: b

42. Which stain is commonly used in study of cell division :-

(a) Feulgen reaction
(b) Acetocarmine
(c) Eosine
(d) Saffranine

Answer: b

43. One gene-one enzyme hypothesis was postulated by -

(a) R.Franklin
(b) Hershay and Chase
(c) A.Garrod
(d) Beadle and Tatum

Answer: d

44. DNA is found in –

(a) ER & Ribosomes
(b) Mitochondria, Plastid & nucleolus
(c) Sphersome & Peroxysome
(d) Plasma membrane & lysosome

Answer: b

45. Which is very most structural part of the body -

(a) Protein
(b) Carbohydrates
(c) Lipid
(d) Nucleic acid

Answer: a

46. DNA duplication occurs at -

(a) Meiosis - II
(b) Mitotic interphase
(c) Mitosis only
(d) Meiosis and mitosis both

Answer: d

47. The non-protein part of an enzyme is -

(a) Prosthetic group
(b) Coenzyme
(c) Cofactor
(d) All the above

Answer: d

48. At boiling temperature an enzyme is -

(a) Denatured
(b) Unaffected
(c) Inactivated
(d) Killed

Answer: a

49. Carbohydrates are stored in mammals as-

(a) Glucose in liver
(b) Glycogen in muscles and spleen
(c) Lactic acid in muscles
(d) Glycogen in liver and muscles

Answer: d

50. Cholesterol is synthesized in –

(a) pancreas
(b) Burnners gland
(c) Spleen
(d) Liver

Answer: d

51. Genetic information is carried by the long chain molecules which are made up of–

(a) Amino acids
(b) Nucleotides
(c) Chromosomes
(d) Enzymes

Answer: b

52. Protein most abundant in human body is –

(a) Collagen
(b) Myosin
(c) Actin
(d) Albumin

Answer: a

53. Lipid derivatives which occurs in faecal material -

(a) Cholesterole
(b) Ergesterole
(c) Lanoline
(d) Coprosterole

Answer: d

54. Portion of gene which is transcribed but not translated is -

(a) exon
(b) intron
(c) cistron
(d) codon

Answer: b

55. Nucleus is the site for the synthesis of -

(a) DNA
(b) RNA
(c) t-RNA
(d) All

Answer: d

56. The catalytic efficiency of two different enzyme can be compared by the -

(a) The Km value
(b) The pH optimum value
(c) Formation of the product
(d) Molecular size of the enzyme

Answer: a

57. Gene composed of -

(a) Amino acids
(b) Polynucleotide
(c) Fatty acid
(d) Nitrogen bases

Answer: b

58. The most abundant RNA of cell is -

(a) r-RNA
(b) t-RNA
(c) m-RNA
(d) None of these

Answer: a

59. Part of active site of enzyme, where substrate is supported -

(a) Catalytic group
(b) Butteressing group
(c) Activation chamber
(d) Ki-constant

Answer: b

60. What is antisense technology ?

(a) When a piece of RNA that is complementry in sequence is used to stop expression of a specific gene
(b) RNA polymerase producing DNA
(c) A cell displaying a foreign antigen used for synthesis of antigens
(d) Production of somaclonal variants in tissue cultures

Answer: a