WEEKLY TEST MEDICAL PLUS -01 TEST - 17 BALLIWALA SOLUTION Date 08-09-2019

[PHYSICS]

1. Kepler's second law is a consequence of conservation of angular momentum

2. According to Kepler's first law, every planet moves in an elliptical orbit with the sun situated at one of the foci of the ellipse.

   In options (a) and (b) sun is not at a focus while in (c) the planet is not in orbit around the sun. Only (d) represents the possible orbit for a planet.

3. Kepler's law $T^2 \propto R^3$

4. During path DAB planet is nearer to sun as comparison with path BCD. So time taken in travelling DAB is less than that for BCD because velocity of planet will be more in region DAB.

5. Time period of a revolution of a planet,

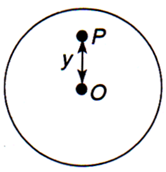
$$T = \frac{2\pi r}{v} = \frac{2\pi r}{\sqrt{\frac{GM_S}{r}}} = \frac{2\pi r^{3/2}}{\sqrt{GM_S}}$$

6. Gravitational force is independent of the medium. Thus, gravitational force will be same i.e., F.

7. In arrangement 1, both forces act in the same direction. In arrangement 3, both the forces act in opposite direction. This alone decides in favour of option (a),

8. If a point mass is placed inside a uniform spherical shell, the gravitational force on the point mass is zero. Hence, the gravitational force exerted by the shell on the point mass is zero.

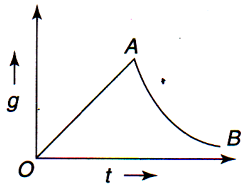
9. $g_d = g\left(1 - \frac{d}{g}\right)$



or $g_d = g\frac{R-d}{R}$

or $g_d = \frac{gy}{R}$ or $g_d \propto y$

So, within the Earth, the acceleration due to gravity varies linearly, with the distance from the centre of the Earth. This explains the linear portion *OA* of the graphs.



10. The value of g at the height h from the surface of earth

$$g' = g\left(1 - \frac{2h}{R}\right)$$

The value of g at depth x below the surface of earth

$$g' = g\left(1 - \frac{x}{R}\right)$$

These two are given equal, hence $\left(1 - \frac{2h}{R}\right) = \left(1 - \frac{x}{R}\right)$

On solving, we get $x = 2h$

11. Acceleration due to gravity $g = \frac{4}{3}\pi\rho GR \;\therefore\; g \propto \rho R$

or $\frac{g_m}{g_e} = \frac{\rho_m}{\rho_e} \cdot \frac{R_m}{R_e}$

$$\left[\text{As } \frac{g_m}{g_e} = \frac{1}{6} \text{ and } \frac{\rho_e}{\rho_m} = \frac{5}{3}(\text{given})\right]$$

$$\therefore \quad \frac{R_m}{R_e} = \left(\frac{g_m}{g_e}\right)\left(\frac{\rho_e}{\rho_m}\right) = \frac{1}{6} \times \frac{5}{3} \therefore R_m = \frac{5}{18} R_e$$

12. Acceleration due to gravity $g = \frac{GM}{R^2}$

$$\therefore \quad \frac{g_{\text{moon}}}{g_{\text{earth}}} = \frac{M_{\text{moon}}}{M_{\text{earth}}} \cdot \frac{R_{\text{earth}}^2}{R_{\text{moon}}^2} = \left(\frac{1}{80}\right)\left(\frac{4}{1}\right)^2$$

$$g_{\text{moon}} = g_{\text{earth}} \times \frac{16}{80} = \frac{g}{5}$$

13. Acceleration due to gravity $g = \frac{4}{3}\pi\rho GR$

$$\therefore \quad g_1 : g_2 = R_1\rho_1 : R_2\rho_2$$

14. $g' = g\left(1 - \frac{d}{R}\right) \Rightarrow \frac{g}{4} = g\left(1 - \frac{d}{R}\right) \Rightarrow d = \frac{3R}{4}$

15. We know $g = \frac{GM}{R^2} = \frac{GM}{(D/2)^2} = \frac{4GM}{D^2}$

If mass of the planet $= M_0$ and diameter of the planet $= D_0$. Then $g = \frac{4GM_0}{D_0^2}$.

16. $\frac{g'}{g} = \left(\frac{R}{R+h}\right)^2 = \left(\frac{R}{R+2R}\right)^2 = \frac{1}{9} \quad \therefore g' = \frac{g}{9}$.

17. Acceleration due to gravity on earth is

$$g = \frac{GM_E}{R_E^2} \qquad \text{(i)}$$

As $\rho = \frac{M_E}{\frac{4}{3}\pi R_E^3} \Rightarrow M_E = \rho \frac{4}{3}\pi R_E^3$

Substituting this value in Eq. (i), we get

$$g = \frac{G\left(\rho \frac{4}{3}\pi R_E^3\right)}{R_E^2} = \frac{4}{3}\pi \rho G R_E \text{ or } \rho = \frac{3g}{4\pi G R_E}$$

18. $g = \frac{GM}{R^2}$

$$\frac{\Delta g}{g} \times 100 = 2\frac{\Delta R}{R} \times 100 = 2 \times 1\% = 2\%$$

19. Gravitational P.E. = $m \times$ gravitational potential

$U = mV$

So the graph of U will be same as that of V for a spherical shell.

20. $\Delta U = U_2 - U_1 = \frac{mgh}{1 + \frac{h}{R_e}} = \frac{mgR_e}{1 + \frac{R_e}{R_e}} = \frac{mgR_e}{2}$

$$\Rightarrow \quad U_2 - (-mgR_e) = \frac{mgR_e}{2} \Rightarrow U_2 = -\frac{1}{2}mgR_e$$

21. $\Delta K.E. = \Delta U$

$$\frac{1}{2}MV^2 = GM_eM\left(\frac{1}{R} - \frac{1}{R+h}\right) \qquad \text{(i)}$$

Also $g = \frac{GM_e}{R^2}$ (ii)

On solving (i) and (ii) $h = \frac{R}{\left(\frac{2gR}{V^2} - 1\right)}$

22. Potential energy $U = \frac{-GMm}{r} = -\frac{GMm}{R+h}$

$$U_{\text{initial}} = -\frac{GMm}{3R} \text{ and } U_{\text{final}} = -\frac{-GMm}{2R}$$

Loss in PE = gain in $KE = \frac{GMm}{2R} - \frac{GMm}{3R} = \frac{GMm}{6R}$

23. $v = -\frac{GMM}{R} = -\frac{GM^2}{R}$

24. Before collision, $PE = mV = -\frac{GMm}{r}$

After collision, velocity will be zero. The wreckage will come to rest. The energy will be only potential energy.

$$PE = -\frac{GMm}{r} = -\frac{2GMm}{r} \text{ Ratio} = 1/2$$

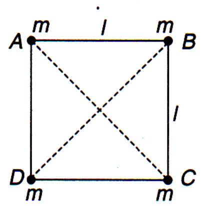
25. $\Delta u = -\left(\frac{GMm}{R+h}\right) - \left(-\frac{GMm}{R}\right)$

$H = 3R$

$\Delta u = -\frac{GMm}{4R} + \frac{GMm}{R} = \frac{3GMm}{4R^2} \times R$

$\Delta u = \frac{3}{4}mgR$

26.



From figure

$AB = BC = CD = AD = l$

27. $U = \frac{-GMm}{r}, K = \frac{GMm}{2r}$ and $E = \frac{-GMm}{2r}$

For a satellite U, K and E vary with r and also U and E remain negative whereas K remains always positive.

28. $v = \sqrt{\frac{GM}{r}}$ if $r_1 > r_2$ then $v_1 < v_2$

Orbital speed of satellite does not depend upon the mass of the satellite.

29. $v = \sqrt{\frac{GM}{R+h}}$

For first satellite $h = 0$, $v_1 = \sqrt{\frac{GM}{R}}$

For second satellite $h = \frac{R}{2}$, $v_2 = \sqrt{\frac{2GM}{3R}}$

$$v_2 = \sqrt{\frac{2}{3}}v_1 = \sqrt{\frac{2}{3}}v$$

30. Since the planet is at the centre, the focus and centre of the elliptical path coincide and the elliptical path becomes circular and the major axis is nothing but the diameter. For a circular path:

$$\frac{mv^2}{r} = \sqrt{\frac{GM}{r^2}}m$$

Also $T = \frac{2\pi r}{v} = \frac{2\pi r^{3/2}}{\sqrt{GM}} \Rightarrow T^2 = \frac{4\pi^2 r^3}{GM}$

$\Rightarrow \quad r = \left(\frac{GMT^2}{4\pi^2}\right)^{1/3} = \text{Radius}$

$\Rightarrow \quad \text{Diameter (major axis)} = 2\left(\frac{GMT^2}{4\pi^2}\right)^{1/3}$

31. Orbital velocity of the satellite is

$v = \sqrt{\frac{GM_E}{r}}$ where M_E is the mass of the earth

Kinetic energy, $K = \frac{1}{2}mv^2 = \frac{GM_E m}{2r}$

where m is the mass of the satellite.

$$K \propto \frac{1}{r}$$

Hence, option (b) in incorrect.

Linear momentum, $p = mv = m\sqrt{\frac{GM_E}{r}}$

$$p \propto \frac{1}{\sqrt{r}}$$

Hence, option (c) is incorrect.

Frequency of revolution, $v = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{GM_E}{r^3}}$

$$v \propto \frac{1}{r^{3/2}}$$

Hence, option (d) is correct.

32. Time period, $T = \frac{2\pi R}{\sqrt{\frac{GM_m}{R}}} = \frac{2\pi R^{3/2}}{\sqrt{GMm}}$

where the symbols have their meanings as given. Squaring both sides, we get

$$T^2 = \frac{4\pi^2 R^3}{GMm}$$

33. Total energy of the orbiting satellite of mass m having orbital radius r is

$$E = -\frac{GMm}{2r}$$ where M is the mass of the planet.

Additional kinetic energy required to transfer the satellite from a circular orbit of radius R_1 to another radius R_2 is

$$= E_2 - E_1$$

$$= -\frac{GMm}{2R_E} - \left(-\frac{GMm}{2R_1}\right) = -\frac{GMm}{2R_2} + \frac{GMm}{2R_1}$$

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

34. Total energy of orbiting satellite at a height h is

$$E = -\frac{GM_E m}{2(R_E + h)}$$

The total energy of the satellite at infinity is zero.

$\therefore$ Energy expended to rocket the satellite out of the earth's gravitational field is

$$\Delta E = E_\infty - E$$

$$= 0 - \left(-\frac{GM_E m}{2(R_E + h)}\right) = \frac{GM_E m}{2(R_E + h)}$$

35. Let m_1 is mass of core and m_2 is of outer portion

$$m_1 = \frac{4}{3}\pi R^3 \rho_1, \quad m_2 = \frac{4}{3}\pi[(2R)^3 - R^3]\rho_2$$

Given that: $\frac{Gm_1}{R^2} = \frac{G(m_1 + m_2)}{(2R)^2} \Rightarrow \frac{\rho_1}{\rho_2} = \frac{7}{3}$

36. $v_1 r_1 = v_2 r_2$

$$\frac{KE_1}{KE_2} = \frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2} = \left(\frac{v_1}{v_2}\right)^2 = \left(\frac{r_2}{r_1}\right)^2$$

37 For two points on same orbit $L = mv_A r_A = mvr_B$

$$v_A = \frac{vr_B}{r_A} \qquad \text{(i)}$$

For two points on different orbits.

$$v = \sqrt{\frac{GM}{r}} \quad \frac{v_0}{v_A} = \left(\frac{r_A}{1.2r_A}\right)^{1/2}$$

$$v_0 = v_A\left(\frac{r_A}{1.2r_A}\right)^{1/2} = \frac{vr_B}{r_A}\left(\frac{r_A}{1.2r_A}\right)^{1/2} = \frac{vr_B}{r_A\sqrt{1.2}}$$

38. $\frac{1}{2}mv_{min}^2 = \left[-\frac{GMm}{r} - \frac{GMm}{r}\right]$

$$-\left[-\frac{GMm}{(2r-a)} - \frac{GMm}{a}\right]$$

$$= \frac{2GMm(a^2 - 2ar + r^2)}{ar(2r-a)}$$

or $\quad v_{min} = \sqrt{\frac{GM}{a}} \times \frac{2(r-a)}{[r(2r-a)]^{1/2}}$

So, $\quad K = \frac{2(r-a)}{[r(2r-a)]^{1/2}}$

39. $m_1r_1 = m_2r_2\, r_1 = \frac{m_2 r}{m_1 + m_2}$ (i)

$$m_1r_1\omega^2 = \frac{Gm_1m_2}{r^2}\,\omega^2 = \frac{G(m_1+m_2)}{r^3}$$

[From (i)] or $r = \left[\frac{G(m_1+m_2)}{\omega^2}\right]^{1/3}$

$$(m_1 + m_2)^{1/3} = 2m_1 + m_2 = 8$$

and $\quad m_2 - m_1 = 6 \qquad$ (given)

which gives $m_1 = 1$ and $m_2 = 7$ units

$$\frac{m_1}{m_2} = \frac{1}{7}$$

40. Interstellar velocity $v' = \sqrt{\frac{GM}{r}} = R\sqrt{\frac{g}{(R+h)}}$

$$= \sqrt{v^2 - v_e^2}$$

where v = projection velocity

$$\frac{R^2 g}{(r+h)} = v^2 - 2gR \text{ Solving } v^2 = \frac{23gR}{11}$$

41. For observer, $T' = \frac{2\pi}{\omega_S - \omega_E} = \frac{T_S T_E}{T_E - T_S}$

$= T_E$ (given) or, $T_E^2 = 2T_S T_E \quad T_S = T_E/2$

42. Time period is minimum for the satellites with minimum radius of the orbit i.e. equal to the radius of the planet. Therefore.

$$\frac{GMm}{R^2} = \frac{mv^2}{R} \Rightarrow V = \sqrt{\frac{GM}{R}}$$

$$T_{\min} = \frac{2\pi R}{\sqrt{\frac{GM}{R}}} = \frac{2\pi R\sqrt{R}}{\sqrt{GM}}$$

using $M = \frac{4}{3}pR^3 \cdot \rho$ $T_{\min} = \sqrt{\frac{3\pi}{G\rho}}$

Using values $T_{\min} = 3000$ s

43. Conserving angular momentum

$m \cdot (V_1 \cos 60°) \cdot 4R = m \cdot V_2 \cdot R;$ $\frac{V_2}{V_1} = 2$ Conserving energy of the system

$$-\frac{GMm}{4R} + \frac{1}{2}mV_1^2 = -\frac{GMm}{R} + \frac{1}{2}mV_2^2$$

$$\frac{1}{2}V_2^2 - \frac{1}{2}V_1^2 = \frac{3}{4}\frac{GM}{R}$$

or $$V_1^2 = \frac{1}{2}\frac{GM}{R}$$

$$V_1 = \frac{1}{\sqrt{2}}\sqrt{64 \times 10^6} = \frac{8000}{\sqrt{2}} \text{ m/s}$$

44. The time period of satellite, $T \propto r^{3/2}$

or $T \propto (R_e + h)^{3/2}$

For a satellite revolving close to surface of earth's $h = 0$

$\therefore$ $T \propto R_e^{3/2}$. It is evident that the period of revolution of a satellite depends upon its height above the earth's surface. Greater is the height of a satellite above the earth's surface greater is its period of revolution.

45. Geostationary satellites orbit around the earth in the equatorial plane with time period of 24 hours. Since the earth rotates with the same period, the satellite would appear fixed from any point on earth.

[CHEMISTRY]

46.

$$N_2O_4 \rightleftharpoons 2NO_2$$

At Eqm. 4.8×10^{-2} mol L^{-1} $\quad$ 1.2×10^{-2} mol L^{-1}

$$K_c=\frac{[NO_2]^2}{[N_2O_4]}=\frac{[1.2\times10^{-2}]^2}{[4.8\times10^{-2}]}=\frac{1.2\times1.2\times10^{-4}}{4.8\times10^{-2}}=\mathbf{3\times10^{-3}\ mol\ L^{-1}}$$

47.

$$COCl_2(g)\rightleftharpoons CO(g)+Cl_2(g)$$

At $t=0$ $\quad$ 450 mm Hg $\quad$ – $\quad$ –

At Eqm. $\quad$ $450-P$ $\quad$ P $\quad$ P

$\Rightarrow \quad 450+P=600$

$\Rightarrow \quad P=150$

$$K_p=\frac{150\times150}{300}=\mathbf{75}$$

48.

$N_2(g)+O_2(g)\rightleftharpoons 2NO(g)$; $\quad K_1=4\times10^{-4}$

$2NO(g)\rightleftharpoons N_2(g)+O_2(g)$; $\quad K_2=\frac{1}{K_1}=\frac{1}{4\times10^{-4}}$

$NO(g)\rightleftharpoons \frac{1}{2}N_2(g)+\frac{1}{2}O_2(g)$; $\quad K_c=(K_2)^{\frac{1}{2}}=\frac{1}{2\times10^{-2}}=\mathbf{50}$

49.

$$NH_4HS(s)\rightleftharpoons NH_3(g)+H_2S(g)$$

At $t=0$ $\quad$ a moles $\quad$ 0.5 atm $\quad$ —

At Eqm. $\quad$ $(a-x)$ mole $\quad$ $(0.5+P)$ atm $\quad$ P atm

When x moles of solid NH_4HS decompose, total pressure $=0.5+P+P$

$=(0.5+2P)$ atm

$\Rightarrow \quad 0.5+2P=0.84$ (given value)

$\Rightarrow \quad P=0.17$ atm

$\Rightarrow \quad P_{NH_3}=0.5+0.17=0.67$ atm

Eqm. constt. $K_p=P_{NH_3}\times P_{H_2S}$

$=0.67\times0.17$

$=\mathbf{0.1139\ atm}$

50.

$SO_3(g)\rightleftharpoons SO_2(g)+\frac{1}{2}O_2(g)$; $\quad K_c=4.9\times10^{-2}$

$2SO_3(g)\rightleftharpoons 2SO_2(g)+O_2(g)$; $\quad K=K_c^2=(4.9\times10^{-2})^2$

$2SO_2(g)+O_2(g)\rightleftharpoons 2SO_3(g)$; $\quad K'=\frac{1}{K}=\frac{1}{(4.9\times10^{-2})^2}=\frac{10000}{(4.9)^2}=\mathbf{416.5}$

The closest choice is **(d).**

51.

$$H_2(g)+I_2(g)\rightleftharpoons 2HI(g)$$

At $t=0$ $\quad$ 40 mL $\quad$ 50 mL $\quad$ —

At Eqm. $\quad$ 30 mL $\quad$ 30 mL $\quad$ 60 mL

	consumed			produced
Ratio of volumes	(40 – 30)	:	(50 – 30) :	60
Ratio of moles	1	:	2 :	6

(Avogadro's law)

$$K_c = \frac{C_{HI}^2}{C_{H_2} \times C_{I_2}} = \frac{6\times 6}{1\times 2} = \mathbf{18}$$

52.

$$H_2 + I_2 \rightleftharpoons 2HI,\ K = 49$$

$$2HI \rightleftharpoons H_2 + I_2,\ K' = \frac{1}{K} = \frac{1}{49}$$

$$HI \rightleftharpoons \frac{1}{2} H_2 + \frac{1}{2} I_2,$$

$$K'' = (K')^{1/2} = \frac{1}{\sqrt{49}} = \frac{1}{7} = \mathbf{0.143}$$

53.

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

$$K_p = K_c (RT)^{\Delta n} = K_c (RT)^{1-(1+1)} = \frac{K_c}{RT}$$

$$\frac{K_p}{K_c} = \frac{\mathbf{1}}{\boldsymbol{RT}}$$

54.

$$K_p = K_c (RT)^{\Delta n}$$

Since, Δn is $[2 + 1 - 2] = 1$, $\boldsymbol{K_p > K_c}$

55.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

At $t = 0$	1 mole	—	—
At Eqm.	$(1 - x)$ moles	x moles	x moles

(x is degree of dissociation of PCl_5)

$$P_{PCl_3} = \frac{n_{PCl_3}}{n_{total}} \times P_{total} = \left(\frac{\boldsymbol{x}}{\mathbf{1}+\boldsymbol{x}}\right)\boldsymbol{P}$$

56.

Δn (gaseous substances) for this equation is zero.

Hence, $K_p = K_c (RT)^{\Delta n} = \boldsymbol{K_c}$.

57.

$$\Delta n = (c+d) - (a+b)$$

$$K_p = K_c (RT)^{\Delta n} = \boldsymbol{K_c (RT)^{(c+d)-(a+b)}}$$

58.

$$SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$$

$$K_p = K_c (RT)^{\Delta n_g}$$

Here, $\Delta n_g = x = 1 - \left(1 + \frac{1}{2}\right) = -\frac{\mathbf{1}}{\mathbf{2}}$

59.

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{0.41}{(0.082\times 300)^{-1}} = 0.41\times 0.082\times 300 = \mathbf{10.08\ L\ mol^{-1}}$$

60.

$$\begin{array}{llll} & X & \rightleftharpoons & 2Y \\ \text{At } t=0 & 1 \text{ mole} & & - \\ \text{At Eqm.} & 1-\alpha & & 2\alpha \end{array}$$

Total moles $= 1-\alpha+2\alpha = 1+\alpha$

Total pressure $= P_1$

$$K_{p_1} = \frac{P_Y^2}{P_X} = \frac{\left(\frac{2\alpha}{1+\alpha} P_1\right)^2}{\left(\frac{1-\alpha}{1+\alpha}\cdot P_1\right)} = \frac{4\alpha^2 P_1^2 (1+\alpha)}{P_1 (1+\alpha)(1+\alpha)(1-\alpha)} = \frac{4\alpha^2 P_1}{1-\alpha^2} \quad ...(i)$$

$$\begin{array}{llllll} & Z & \rightleftharpoons & P & + & Q \\ \text{At } t=0 & 1 \text{ mole} & & - & & - \\ \text{At Eqm.} & 1-\alpha & & \alpha & & \alpha \end{array}$$

Total moles $= 1-\alpha+\alpha+\alpha = 1+\alpha$

Total pressure $= P_2$

$$K_{p_2} = \frac{P_P P_Q}{P_Z} = \frac{\left(\frac{\alpha}{1+\alpha} P_2\right)\cdot\left(\frac{\alpha}{1+\alpha} P_2\right)}{\left(\frac{1-\alpha}{1+\alpha}\right) P_2} = \frac{\frac{\alpha^2}{(1+\alpha)^2}\cdot P_2^2}{\left(\frac{1-\alpha}{1+\alpha}\right) P_2} = \frac{\alpha^2 P_2}{1-\alpha^2} \quad ...(ii)$$

From eqns. (i) and (ii)

$$\frac{K_{p_1}}{K_{p_2}} = \frac{4\alpha^2 P_1}{1-\alpha^2} \times \frac{1-\alpha^2}{\alpha^2 P_2} = \frac{4P_1}{P_2} \quad ...(iii)$$

Given, $\frac{K_{p_1}}{K_{p_2}} = \frac{1}{9}$ ...(iv)

From eqns. (iii) and (iv)

So, $\frac{4P_1}{P_2} = \frac{1}{9} \Rightarrow \frac{P_1}{P_2} = \mathbf{\frac{1}{36}}$

61.

$$\begin{array}{lllllll} & RCOOH & + & R'OH & \rightleftharpoons & RCOOR' & + & H_2O \\ \text{At } t=0 & 100 \text{ moles} & & 100 \text{ moles} & & \text{Nil} & & \text{Nil} \\ \text{At Eqm.} & 100-67 & & 100-67 & & 67 & & 67 \end{array}$$

$$K = \frac{67\times 67}{33\times 33} = \mathbf{4.12}$$

62.

$$\begin{array}{llll} & 2AB_2(g) \rightleftharpoons & 2AB(g) + & B_2(g) \\ \text{At } t=0 & 2 \text{ moles (let)} & — & — \\ \text{At Eqm.} & (2-2x) \text{ moles} & 2x \text{ moles} & x \text{ mole} \end{array}$$

(x is degree of dissociation)

Total $= 2-2x+2x+x = (2+x)$ moles;

Total pressure $= P$

$$K_p = \frac{P_{AB}^2 \cdot P_{B_2}}{P_{AB_2}^2} = \frac{\left(\frac{2x}{2+x}\cdot P\right)^2 \left(\frac{x}{2+x}\cdot P\right)}{\left(\frac{2-2x}{2+x}\cdot P\right)^2} = \frac{x^3}{2}\cdot P$$

$$\Rightarrow \quad x = \left[\frac{\mathbf{2K_p}}{\mathbf{P}}\right]^{1/3} \quad (\text{given is } x \ll 1)$$

63.

On adding the first two equations,

$$K = K_1 \cdot K_2 = \mathbf{5 \times 10^{-23}}$$

64.

The value of equilibrium constant will not change by addition of reactant 'A', since the value of equilibrium constant changes with temperature only.

65.

3rd equation is the sum of first and second equation. Hence, its Eqm. Constt. $= \boldsymbol{K_1 \times K_2}$.

66.

67.

$$N_2 + 3H_2 \underset{}{\overset{K_1}{\rightleftharpoons}} 2NH_3$$

$$\Rightarrow \quad 2NH_3 \overset{K'}{\rightleftharpoons} N_2 + 3H_2;\ K' = \frac{1}{K_1}$$

$$N_2 + O_2 \overset{K_2}{\rightleftharpoons} 2NO;\ K_2$$

$$H_2 + \frac{1}{2}O_2 \overset{K_3}{\rightleftharpoons} H_2O$$

$$\Rightarrow \quad 3H_2 + \frac{3}{2}O_2 \overset{K''}{\rightleftharpoons} 3H_2O;\ K'' = K_3^3$$

Adding of eqns. (i), (ii) and (iii)

$$2NH_3 + \frac{5}{2}O_2 \longrightarrow 2NO + 3H_2O;\ K = ?$$

$$K = K' \times K_2 \times K'' = \frac{\boldsymbol{K_2 \cdot K_3^3}}{\boldsymbol{K_1}}$$

* For $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O;\quad K = \dfrac{K_2^2 \cdot K_3^6}{K_1^2}$

68.

$$k_f = 3k_b \quad \Rightarrow \quad K = \frac{k_f}{k_b} = \mathbf{3}$$

69.

	$NH_2COONH_4(s)$	$\rightleftharpoons$	$2NH_3(g)$	+	$CO_2(g)$	
At $t=0$	solid		–		–	
At Eqm.	–		2 moles		1 mole	; $n_{total} = 3$

$$K_p = (P_{NH_3})^2 (P_{CO_2})$$

For $\quad P = 3\,atm$

$$K_p = \left(\frac{2}{3} \times 3\right)^2 \times \left(\frac{1}{3} \times 3\right) = \mathbf{4}$$

70.

The third equation is obtained by adding the first and second. So, $\boldsymbol{K_3 = K_1 \cdot K_2}$

71.

	A	+	$2B$	$\rightleftharpoons$	$2C$	+	D
At $t=0$	1.1 moles		2.2 moles		Nil		Nil
At Eqm.	$(1.1-0.1) = 1.0$ mole		$(2.2-0.2) = 2.0$ moles		0.2 mole		0.1 mole (given)
	left		left		produced		produced

$$K = \frac{(0.2)^2 \times (0.1)}{(1) \times (2)^2} = 1 \times 10^{-3} = \mathbf{0.001}$$

72.

$$H_2A \rightleftharpoons H^+ + HA^-, \qquad K_a = 1\times 10^{-5}$$
$$HA \rightleftharpoons H^+ + A^{2-}, \qquad K'_a = 5.0\times 10^{-10}$$

Overall, $H_2A \rightleftharpoons 2H^+ + A^{2-}$,

$K = K_a \cdot K'_a = 1\times 10^{-5} \times 5\times 10^{-10} = \mathbf{5\times 10^{-15}}$

73.

	N_2	+	$3H_2$	$\rightleftharpoons$	$2NH_3$
At $t = 0$	10 moles		10 moles		Nil
At Eqm.	$1\times\frac{6}{3}$ mol consumed *i.e.*, 8 moles left		4 mol left 6 moles consumed		$2\times\frac{6}{3}$ moles *i.e.*, 4 moles produced

40% of 10 moles of H_2 = 4 moles left

Moles of H_2 consumed = 10 – 4 = 6

Total moles in the chamber at equilibrium = 8 + 4 + 4 = **16 mol**

74.

	$CO_2(g) + C(s) \rightleftharpoons 2CO$		
At $t = 0$	0.5 atm	—	—
At Eqm.	$0.5 - P$	—	$2P$

Total pressure $0.8 = 0.5 - P + 2P \quad \Rightarrow \quad P = 0.3$

$$K_p = \frac{P^2_{CO}}{P_{CO_2}} = \frac{(0.6)^2}{0.2} = \mathbf{1.8\ atm}$$

75.

$$K = \frac{k_f}{k_b} = \frac{3.25\times 10^{-3}}{1.62\times 10^{-4}} = \mathbf{20}$$

76.

The reaction is endothermic. It will be favoured by **increase in temperature.**

77.

First eqn. is obtained by adding the 2nd and 3rd equations. So,

$K_1 = K_2 \cdot K$

$\boldsymbol{K = K_1 \div K_2}$

78.

Add the two equations

$$Ag^+ + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+$$

$$K = K_1 \cdot K_2 = 6.8\times 10^{-3} \times 1.6\times 10^{-3} \doteq \mathbf{1.088\times 10^{-5}}$$

79.

1000 mL water at 4°C = 1000 g

$$= \frac{1000}{18}\ \text{mol} = 55.55\ \text{mol}$$

So, one litre water has 55.55 mol of water. Active mass of water

$= \mathbf{55.55\ mol\ L^{-1}}$.

80.

$$\%\ \text{dissociation} = \frac{D-d}{(n-1)\,d}\times 100 = \frac{(30-15)}{(3-1)\times 15}\times 100 = \mathbf{50\%}$$

81.

$\Delta G = \Delta G^0 + RT \ln Q$

At equilibrium, $Q = K$ and $\Delta G = 0$

$$0 = \Delta G^0 + RT \log_e K$$

$$RT \log_e K = -\Delta G^0$$

$$\log_e K = -\frac{\Delta G^0}{RT}$$

$$K = e^{-\frac{\Delta G^0}{RT}}$$

82.

$$\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightleftharpoons XY_3;\ \Delta H = -30 \times 1000\,\text{J}$$

$$\Delta S = 50 - \frac{3}{2} \times 40 - \frac{1}{2} \times 60 = -40\,\text{J K}^{-1}\,\text{mol}^{-1}$$

$$T = \frac{\Delta H}{\Delta S} = \frac{-30 \times 1000}{-40}\,\text{K} = \mathbf{750\ K}$$

83.

$$K_c = \frac{[AB]^2}{[A_2][B_2]} = \frac{(2.8 \times 10^{-3})^2}{(3.0 \times 10^{-3})(4.2 \times 10^{-3})}$$

$$= \frac{2.8 \times 2.8}{3.0 \times 4.2} = \mathbf{0.62}$$

84.C

85.

86.

B

88. (c) Assertion is true but reason is false. This is based on common ion effect.

$NaCl \rightleftharpoons Na^+ + Cl^-$; $HCl \rightleftharpoons H^+ + Cl^-$

Concentration of Cl^- ions increases due to ionisation of HCl which increases the ionic product $[Na^+][Cl^-]$. This result in the precipitation of pure $NaCl$.

89. (b) Both assertion and reason are true and reason is not the correct explanation of assertion, solid+heat $\rightleftharpoons$ liquid,

so on heating forward reactions is favoured and amount of solid will decrease.

90. (a) $aA + bB \rightleftharpoons cC + dD$

$$K_C = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

For $2aA + 2bB \rightleftharpoons 2cC + 2dD$

$$K_C = \frac{[C]^{2c}[D]^{2d}}{[A]^{2a}[B]^{2b}}.$$