WEEKLY TEST TYJ TEST - 27 B
SOLUTION Date 17-11-2019

[PHYSICS]

1. Here, $m = 50$ kg, $D = 1$ cm $= 10^{-2}$ m, $g = 10$ ms^{-1}

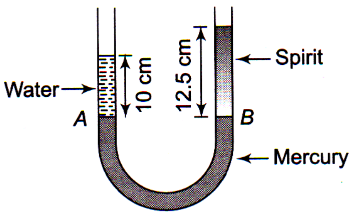
$\therefore$ Pressure exerted by the heel on the horizontal floor is

$$p = \frac{F}{A} = \frac{mg}{\pi(D/2)^2} = \frac{4mg}{\pi D^2}$$

$$= \frac{4 \times 50\text{ kg} \times 10\text{ ms}^{-2}}{3.14 \times (10^{-2}\text{ m})^2}$$

$$= 6.4 \times 10^6\text{ Pa}$$

2. As the mercury columns in the two arms of U tube are at the same level, therefore



Pressure due to water = Pressure due to spirit column

$$\rho w_h w_g = \rho_s h_s g$$

$$\rho_s = \frac{h_w}{h_s}\rho_w$$

3. In a streamline flow at any given point, the velocity of each passing fluid particles remains constant. If we consider a cross-sectional area, then a point on the area cannot have different velocities at the same time, hence two streamlines of flow cannot cross each other.

4. Pressure energy per unit volume of a liquid equals pressure.

5. At A, area is more, hence velocity is less, hence more pressure.

6. V be the volume of the iceberg, x be the volume out of sea water.

The iceberg is floating in sea water then

$V\rho_{\text{ice}}\, g = (V - x)\, \rho_{\text{sea water}}\, g$

or $\quad V \times 0.9 \times g = (V - x)1.1\ g$

or $\quad \eta = 2.0 \times 10^{-5}\ \text{kg m}^{-1}\ \text{s}^{-1}$

$0.2\ V = 1.1x$

$\therefore \quad \frac{x}{V} = \frac{0.2}{1.1}$

Percentage of fraction of the volume of iceberg above the level of sea water

$$\frac{x}{V} \times 100 = \frac{0.2}{1.1} \times 100 = 18\%$$

$v_0 \propto r^2$

7. since r becomes one-half therefore v_0 becomes one-fourth.

8. Since the steel ball is given to be small therefore up-thrust may be neglected.

Now, $6\pi\eta r v_0 = mg$ or $v_0 \propto \frac{mg}{\eta r}$

9. $F = 6\pi\eta r v$, $F' = 6\pi\eta(2r)(2v) = 4F$

10. Pressure at the bottom of tank $P = h\rho g = 3 \times 10^5\ \frac{N}{m^2}$.

Pressure due to liquid column $P_l = 3 \times 10^5 - 1 \times 10^5 = 2 \times 10^5$ and velocity of water $v = \sqrt{2gh}$

$$\therefore \quad v = \sqrt{\frac{2P_l}{\rho}} = \sqrt{\frac{2 \times 2 \times 10^5}{10^3}} = \sqrt{400}\ \text{m/s}$$

11. Effective value of acceleration due to gravity becomes $(g + a_0)$.

12. $4(H - 4) = 6(H - 6)$

or $\quad 2H = 36 - 16 - 20$ or $H = 10$ cm

13. **(a)** Area under given curve represents emissive power and emissive power $\propto T^4 \Rightarrow A \propto T^4$

$$\Rightarrow \quad \frac{A_2}{A_1} = \frac{T_2^4}{T_1^4} = \frac{(273 + 327)^4}{(273 + 27)4} = \left(\frac{600}{300}\right)^4 = \frac{16}{1}$$

14. Velocity of water coming out from hole A

$$= v_1 = \sqrt{2gh}$$

Velocity of water coming out from hole B

$$= v_2 = \sqrt{2g(H-h)}$$

Time taken by water to reach the ground from hole A

$$= t_1 = \sqrt{2(H-h)/g}$$

Time taken by water to reach the ground from hole B

$$= t_2 = \sqrt{2h/g}$$

Obviously, range on the ground for both is the same

$$\therefore \quad R = v_1 t_1 = v_2 t_2 = 2g\sqrt{h(H-h)}$$

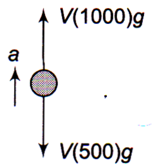
15. $7.5g = 1g + 1.5g +$ Downward reaction force of block

or $\quad 5g = |$ Downward reaction force$|$

$= |$Upthrust$| = 0.003\ \rho_1 g$

$$\therefore \quad \rho_1 = \frac{5}{0.003}\,\text{kg m}^{-3} = \frac{5000}{3}\,\text{kg m}^{-3}$$

16 Velocity of ball when it reaches to surface of liquid



$a = \dfrac{1000\text{ gV} - 500\text{ gV}}{500\text{ V}}$; where V is the volume of the ball.

$$a = 10\text{ m/sec}^2$$

Apply $v = u + at \Rightarrow 0 = \sqrt{2gh} - 10t$

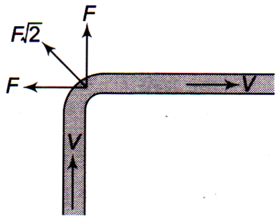
$\Rightarrow \quad \sqrt{2gh} = 10 \times (2)$

$\Rightarrow \quad 2 \times 10 \times h = 400 \Rightarrow = 20\text{ m}$

17. Force exerted in vertical direction and horizontal direction are

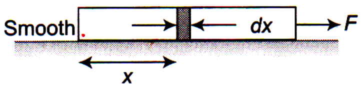
$$F_1 = F_2 = v_{rel} \times \frac{dm}{dt} = V\rho \cdot L$$

$\Rightarrow \quad F_{net} = \rho V L\sqrt{2}$



18. **(c)** Initially effective resistance = $2R$. In parallel effective resistance = $\frac{R}{2}$. It has reduced by a factor of 1/4 so rate of heat transfer would be increased by a factor of 4, keeping other parameters same.

19. Tension, $T = \frac{F}{L_0} \cdot x\,x$



Stress, $\sigma = \frac{T}{A} = \frac{F}{AL_0} x$

$$dU = \frac{1}{2} \cdot \frac{\sigma^2}{Y} A dx = \frac{1}{2} \frac{F^2}{A^2 L_0^2} \cdot x^2 \frac{A}{Y} dx$$

or $$dU = \frac{F^2}{2A^2 L_0^2 Y} \cdot x^2 dx$$

$\Rightarrow$ $$U = \frac{F^2}{2AY L_0^2} \int_0^{L_0} x^2 dx$$

$$U = \frac{F^2}{2AY L_0^2} \cdot \frac{L_0^3}{3} = \frac{F^2 L_0}{6AY}$$

20. Pressure = $h\rho g$
Pressure at the bottom is independent of the area of the base of the vessel. It depends on the height of water upto which the vessel is filled with water. As in all the three vessels, level of water are the same, therefore Pressure at the bottom in all the vessels is also same.
Hence, $P_A = P_B = P_C$

[CHEMISTRY]

21.

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

22.

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

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

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

23.

In $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, number of moles are increasing, it will be favoured by low pressure.

24.

$$K_1 = \frac{[NO]^2}{[N_2][O_2]}; \quad K_2 = \frac{[NO_2]^2}{[NO]^2[O_2]^2}$$

$$K = \frac{[N_2]^{1/2}[O_2]}{[NO_2]}$$

$$K_1K_2 = \frac{[NO_2]^2}{[N_2][O_2]^2} \quad \Rightarrow \quad \sqrt{K_1K_2} = \frac{[NO_2]}{[N_2]^{1/2}[O_2]} = \frac{1}{K}$$

$$K = \left[\frac{1}{\boldsymbol{K_1K_2}}\right]^{\mathbf{1/2}}$$

25.

$$K_c = \frac{[AB]^2}{[A_2][B_2]} = \frac{(2.8\times10^{-3})^2}{(3.0\times10^{-3})(4.2\times10^{-3})}$$

$$= \frac{2.8\times2.8}{3.0\times4.2} = \mathbf{0.62}$$

26.

The reaction is facing the decrease in number of moles and release of heat. According to Le-Chatelier's principle, forward reaction will be favoured by increase in pressure and decrease in temperature.

27.

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

28.

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

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

29.

Since, the number of moles of gaseous substances on product side is less, increase in pressure will increase the yield. Equilibrium constant will not change because it depends only on temperature (for a specific reaction).

30.

31.

	$COCl_2(g)$	$\rightleftharpoons$	$CO(g)$	+	$Cl_2(g)$
At $t=0$	450 mm Hg		–		–
At Eqm.	$450-P$		P		P

$$\Rightarrow \quad 450 + P = 600$$

$$\Rightarrow \quad P = 150$$

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

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

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

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

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

At $t = 0$	a moles	0.5 atm	—
At Eqm.	$(a - x)$ mole	$(0.5 + P)$ atm	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. $K_p = P_{NH_3} \times P_{H_2S}$

$= 0.67 \times 0.17$

$= \mathbf{0.1139\ atm}$

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

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

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

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

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

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

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

(x is degree of dissociation of PCl_5)

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

37. Δn (gaseous substances) for this equation is zero.

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

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

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

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

39.

	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

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

40. $$H_2A \rightleftharpoons H^+ + HA^-, \quad K_a = 1 \times 10^{-5}$$

$$HA \rightleftharpoons H^+ + A^{2-}, \quad K'_a = 5.0 \times 10^{-10}$$

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

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