WEEKLY TEST MEDICAL PLUS - 03 TEST - 15 RAJPUR SOLUTION Date 17-11-2019

[PHYSICS]

1. As long as $\rho \le \rho_w$, pressure at the bottom of the pan would be same everywhere, according to the Pascal's law.

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

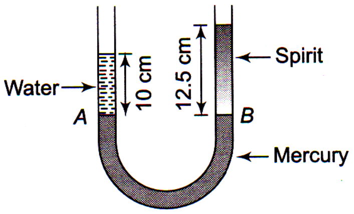
$\therefore$ Pressure exerted by the heel on the horizontal floor is

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

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

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

3. 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

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

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

4. Weight of water displaced by steel block

= Loss of weight of block in water

= (234 – 197)gf = 37 gf

Volume of water displaced = 37 cm^3

This is the volume of the block with cavity.

Volume of block without cavity = $\frac{234}{7.8} cm^3 = 30 \ cm^3$

Volume of cavity = (37 – 30) cm^3 = 7 cm^3

5. Specific gravity of body = $\frac{150}{30} = 5$

Volume of body = $\frac{150}{5} = 30 \ cm^3$.

Now, $(150 - 130)g = 30 \times \rho_1 \times g$

$\Rightarrow \quad \rho_l = \frac{20}{30} = \frac{2}{3}$

6. 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.

7. A stream lined body has less resistance due to air.

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

9. Pressure energy per unit mass is $\frac{P}{\rho}$.

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

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

The iceberg is floating in sea water then

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

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

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

$0.2 \ V = 1.1x$

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

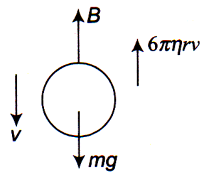
Percentage of fraction of the volume of iceberg above the level of sea water

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

$v_0 \propto r^2$

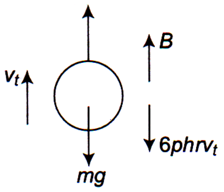
12. since r becomes one-half therefore v_0 becomes one-fourth.

13. First case:



$$B + 6\pi\eta rv = mg \qquad \text{(i)}$$

For second case:



$$F + B = mg + 6\pi\eta rv_i$$

$$\Rightarrow \quad 2mg - 2B + B = mg + 6\pi\eta rv_i$$

$$mg - B = 6\pi\eta rv_i \qquad \text{(ii)}$$

From (i) and (ii), $v_t = v = 10$ cm/s

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

Now, $6\pi\eta rv_0 = mg$ or $v_0 \propto \frac{mg}{\eta r}$

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

16. $t = \frac{A}{a}\sqrt{\frac{2}{g}}[\sqrt{H_1} - \sqrt{H_2}]$

Now, $T_1 = \frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{H} - \sqrt{\frac{H}{\eta}}\right]$

and $T_2 = \frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{\frac{H}{\eta}} - \sqrt{0}\right]$

According to problem $T_1 = T_2$

$$\therefore \quad \sqrt{H} - \sqrt{\frac{H}{\eta}} = \sqrt{\frac{H}{\eta}} - 0 \Rightarrow \sqrt{H} = 2\sqrt{\frac{H}{\eta}} \Rightarrow \eta = 4$$

17. 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 $v = \sqrt{2gh}$

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

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

19. $x = \sqrt{2gh_1} \times \sqrt{\frac{2h_2}{g}}$ or $x = 2\sqrt{h_1 h_2}$

Now, imagine a hole at a depth h_2 below the free surface of the liquid. The height of this hole will be h_1. Clearly, x remains the same.

20. $v = \sqrt{2gh}$

But $p = h\rho g$ or $\frac{p}{\rho} = gh$

$$\therefore \quad v\sqrt{\frac{2p}{\rho}} = \sqrt{\frac{2 \times 2 \times 10^5}{10^3}} \text{ ms}^{-1} = 20 \text{ ms}^{-1}$$

$R^2 v = \text{constant}$

21. From Torricelli's theorem

$$v = \sqrt{2gd} \qquad \text{(i)}$$

where v is horizontal velocity and d is the depth of water in barrel.

Time t to hit the ground is given by

$$h = \frac{1}{2}gt^2 \quad \text{or} \quad t = \sqrt{\frac{2h}{g}}$$

$$\therefore \quad R = vt = \sqrt{(2gd)}\sqrt{\frac{2h}{g}} = 2\sqrt{dh} \quad \text{(Using (i))}$$

$$\therefore \quad R^2 = 4dh \text{ or } d = \frac{R^2}{4h}$$

22. $4(H - 4) = 6(H - 6)$

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

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

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

24. 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

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

25. Let A and a be the cross-sectional areas of the vessel and hole respectively. Let h be the height of water in the vessel at time. Let $\left(-\frac{dh}{dt}\right)$ represent the rate of fall of level.

Then, $A\left(-\frac{dh}{dt}\right) = \alpha v = a\sqrt{2gh}$

or $\quad -\frac{dh}{\sqrt{h}} = \frac{\alpha\sqrt{2g}}{A}dt$

$$-\int_A^0 \frac{1}{\sqrt{h}}dh = \frac{a\sqrt{2g}}{A}\int_0^g dt$$

$$-(-2\sqrt{h}) = \frac{\alpha\sqrt{2g}}{A}t$$

or $\quad t = \frac{A}{\alpha}\frac{1}{\sqrt{2g}} \times 2\sqrt{h}$ or $t = \frac{A}{\alpha}\sqrt{\frac{2h}{g}}$

Now, $t \propto \sqrt{h}$

When h is quadrupled, t is doubled.

26. $7.5g = 1g + 1.5g +$ Downward reaction force of block

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

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

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

27. Let A = The area of cross section of the hole

v = Initial velocity of efflux

d = Density of water,

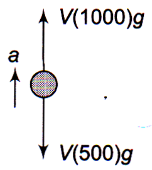
Initial volume of water flowing out per second = Av
Initial mass of water flowing out per second = Avd
Rate of change of momentum = Adv^2
Initial downward force on the flowing out water = Adv^2
So equal amount of reaction acts upwards on the cylinder.

$\therefore$ Initial upward reaction = Adv^2 [As $v = \sqrt{2gh}$]

$\therefore$ Initial decrease in weight = $Ad(2gh)$

$= 2Adgh = 2 \times \left(\frac{1}{4}\right) \times 1 \times 980 \times 25 = 12.5$ gm-wt.

28. Velocity of ball when it reaches to surface of liquid



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

$a = 10$ m/sec^2

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

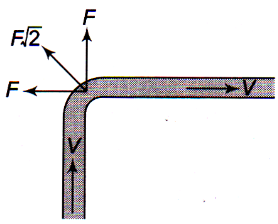
$\Rightarrow \quad \sqrt{2gh} = 10 \times (2)$

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

29. Force exerted in vertical direction and horizontal direction are

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

$\Rightarrow \quad F_{\text{net}} = \rho VL\sqrt{2}$



30. The velocity of system will not change in horizontal direction as water is leaking out vertically down. Because leaking water does not exchange any momentum with trolley in horizontal direction.

31. **(c)** $V = V_0(1 + \gamma\Delta\theta)$

$$L^3 = L_0(1+\alpha_1\Delta\theta)L_0^2(1+\alpha_2\Delta\theta)^2$$
$$= L_0^3(1+\alpha_1\Delta\theta)(1+\alpha_2\Delta\theta)^2$$

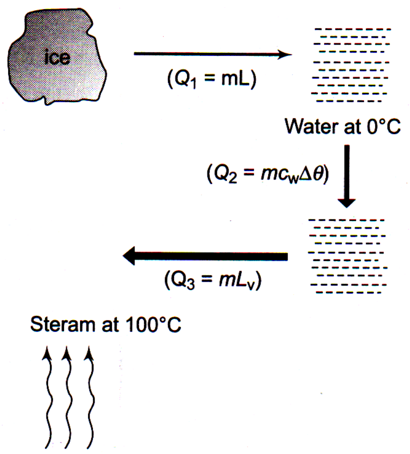
Since $L_0^3 = V_0$ and $L^3 = V$

Hence $1+\gamma\Delta\theta = (1+\alpha_1\Delta\theta)(1+\alpha_2\Delta\theta)^2$
$$\cong (1+\alpha_1\Delta\theta)(1+2\alpha_2\Delta\theta)$$
$$\cong (1+\alpha_1\Delta\theta+2\alpha_2\Delta\theta)$$

$\Rightarrow \quad \gamma = \alpha_1 + 2\alpha_2$

32. **(a)** As the coefficient of thermal expansion of the brass is greater than steel. Hence, the length of brass strip will be more than steel strip. Therefore, brass strip will be on convex side.

33. **(c)** Ice (0°C) converts into steam (100°C) in following three steps.



Total heat required $Q = Q_1 + Q_2 + Q_3$

$= 5\times 80 + 5\times 1\times(100-0) + 5\times 540 = 3600$ cal

34. **(c)** $Q_1 = 10\times 1\times 10 = 100$ cal

$Q_2 = 10\times 0.5(0-(-20)) + 10\times 80$

$= (100 + 800)$ cal $= 900$ cal.

As $Q_1 < Q_2$, so ice will not completely melt and final temperature = 0°C.

As heat given by water in cooling up to 0°C is only just sufficient to increase the temperature of ice from

35. **(a)** $W = JQ \Rightarrow \frac{1}{2}\left(\frac{1}{2}Mv^2\right) = J(m.c.\Delta\theta)$

$\Rightarrow \quad \frac{1}{4}\times 1\times(50)^2 = 4.2[200\times 0.105\times\Delta\theta]$

$\Rightarrow \quad \Delta\theta = 7.1°C$

36. **(b)** $\frac{m_A c_A}{m_B c_B} = \frac{(4/3)\pi r_A^3 \rho_A c_A}{(4/3)\pi r_B^3 \rho_B c_B} = \left(\frac{r_A}{r_B}\right)^3 \frac{\rho_A c_A}{\rho_B c_B}$ –

$$\frac{m_A c_A}{m_B c_B} = \left(\frac{1}{2}\right)^3 \times \frac{2}{1} \times \left(\frac{1}{3}\right) = \frac{1}{12}$$

37. **(a)** If heat is supplied at constant rate P, then $Q = P\Delta\tau$ and as during change of state $Q = mL$, so, $mL = P\Delta t$

i.e., $L = \left[\frac{P}{m}\right]\Delta t = \frac{P}{m}$ (length of line AB)

Hence $L_1 > L_2$

i.e., the ratio of latent heat of fusion of the two substances are in the ratio 3 : 4.

In the portion OA the substance is in solid state and its temperature is changing.

$$\Delta Q = mC\Delta T \text{ and } \Delta Q = P\Delta t$$

So, $\frac{\Delta T}{\Delta t} = \frac{P}{mC}$ or slope $= \frac{P}{mS} = \left[\text{as } \frac{\Delta T}{\Delta t} = \text{slope}\right]$

Hence $C_1 < C_2$

38. **(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.

39. **(d)** Absolute temperatures of the black body corresponding to curve P and Q are in the inverse ratio of λ_m (Wein's displacement law).

i.e., $\frac{T_P}{T_Q} = \frac{1987}{2980}$

Area under curves represent the total power radiated by a body and is proportional to the fourth power of absolute temperature (Stefan's law)

$$\therefore \quad \frac{A_P}{A_Q} = \left(\frac{T_P}{T_Q}\right)^4 = \frac{16}{81}$$

40. **(c)** According to Stefan-Boltzmann law, the energy radiated per second through the surface of area A is given by

$$E = \sigma A T^4$$

$$\therefore \quad \frac{E_1}{E_2} = \frac{A_1}{A_2}\left(\frac{T_1}{T_2}\right)^4$$

or $\quad 10000 = \frac{r_1^2}{r_2^2}\left(\frac{2000}{6000}\right)^4$

or $\quad \frac{r_1^2}{r_2^2} = (30)^4,$

or $\quad r_1 : r_2 = 900 : 1$

41. **(a)** By Stefan's law, Rate of cooling, $H \propto (T^4 - T_0^4))$

$$\therefore \quad \frac{H'}{H} = \frac{(900)^4 - (300)^4}{(600)^4 - (300)^4} = \frac{9^4 - 3^4}{6^4 - 3^4} = \frac{3^4(3^4 - 1)}{3^4(2^4 - 1)}$$

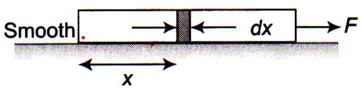
$$\therefore \quad H' = \frac{16}{3} H$$

42. **(b)** According to Wien's law, $\lambda_m \propto \frac{1}{T}$

When temperature becomes $\frac{3}{2}$ times λ_m becomes $\frac{2}{3}$ times

43. Breaking stress does not depend upon the length of the cable.

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



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

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

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

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

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

45. 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]

46.

No. of moles of urea present in 100 mL of solution

$$= \frac{6.02 \times 10^{20}}{6.02 \times 10^{23}} = 10^{-3} \text{ mol}$$

∴ Molar concentration of urea in the solution

$$= \frac{10^{-3}}{100} \times 1000 = 10^{-2} \text{ M} = 0.01 \text{M}$$

47.

$x_X = \frac{1}{4} = 0.25, \; x_Y = 0.75$

$P_{total} = x_X \times p_X{}^{\circ} + x_Y \times p_Y{}^{\circ}$,

i.e., $550 = 0.25\, p_X{}^{\circ} + 0.75\, p_Y{}^{\circ}$

or $2200 = p_X{}^{\circ} + 3\, p_Y{}^{\circ}$ ...(*i*)

After adding 1 mol of Y,

$x_X = \frac{1}{5} = 0.20, \; x_Y = 0.80$

∴ $560 = 0.20\, p_X{}^{\circ} + 0.80\, p_Y{}^{\circ}$

or $2800 = p_X{}^{\circ} + 4\, p_Y{}^{\circ}$ ...(*ii*)

Solving the two equations, we get

$p_Y{}^{\circ} = 600$ mm, $p_X{}^{\circ} = 400$ mm.

48.

P_{total} (at 80°C) = 760 mm

$P_{total} = x_A\, p_A{}^{\circ} + x_B\, p_B{}^{\circ}$

$= x_A\, p_A{}^{\circ} + (1 - x_A)\, p_B{}^{\circ}$

$= p_B{}^{\circ} + x_A\, (p_A{}^{\circ} - p_B{}^{\circ})$

∴ $1000 + x_A\, (520 - 1000) = 760$

or $480\, x_A = 240$

or $x_A = 0.50$, *i.e.*, 50 mol percent.

49.

In solution, if $x_A = x, \quad x_B = 2x$

and if $p_A{}^{\circ} = p, \quad p_B{}^{\circ} = 2p$

∴ $p_A = x \times p, \quad p_B = 2x \times 2p = 4x \times p$

∴ $P_{total} = 5xp$.

Mole fraction in vapour phase

$$(y_A) = \frac{p_A}{P_{Total}} = \frac{xp}{5xp} = \frac{1}{5} = 0.2$$

50.

Mole fraction in the vapour phase $(x_1) = \frac{p_A}{P_{total}}$

But $p_A = x_A \times p_A{}^{\circ} = x_2 \times p_A{}^{\circ}$

Hence, $x_1 = \frac{x_2\, p_A{}^{\circ}}{P_{total}}$ or $P_{total} = \frac{p_A{}^{\circ}\, x_2}{x_1}$

51.

According to Raoult's law,

$$p_A = x_A \times p_A^\circ = \frac{1}{3} \times 45 \text{ torr} = 15 \text{ torr}$$

$$p_B = x_B \times p_B^\circ = \frac{2}{3} \times 36 \text{ torr} = 24 \text{ torr}$$

$\therefore$ Pressure expected by Raoult's law = 15 + 24 = 39 torr

Thus, observed pressure (38 torr) is less than expected value.

Hence, the solution shows negative deviation.

52.

Conc. of compound in solution = 3 gL^{-1}

$= \frac{3}{M}$ mol L^{-1}

As it is isotonic with 0·05 M glucose solution,

$$\frac{3}{M} = 0{\cdot}05 \text{ or } M = 60$$

Empirical formula mass of CH_2O = 30

$$\therefore \ n = \frac{\text{Mol. mass}}{\text{E.F. mass}} = \frac{60}{70} = 2$$

Hence, molecular formula = 2 × CH_2O = $C_2H_4O_2$

53.

NaCl sol. used should be isotonic with blood stream. For NaCl, i = 2. $\pi = i$ CRT

$$C = \frac{\pi}{i\text{RT}} = \frac{7{\cdot}8 \text{ bar}}{2 \times 0{\cdot}083 \text{ bar L K}^{-1} \text{mol}^{-1} \times 310 \text{ K}}$$

$= 0{\cdot}15$ mol L^{-1}.

54.

$$7 \text{ g L}^{-1} \text{ MgCl}_2 = \frac{7}{24+71} \text{ mol L}^{-1}$$

$$= \frac{7}{95} \text{ mol L}^{-1} = \frac{7 \times 3}{95} \text{ mol L}^{-1} \text{ of ions} = 0{\cdot}22 \text{ M}$$

$$7 \text{ g L}^{-1} \text{ NaCl} = \frac{7}{23+35{\cdot}5} \text{ M}$$

$$= \frac{7}{58{\cdot}5} \text{ M} = \frac{7 \times 2}{58{\cdot}5} \text{ mol L}^{-1} \text{ of ions} = 0{\cdot}24 \text{ M}$$

As concentration of ions in NaCl solution is greater, NaCl solution (solution B) will have greater osmotic pressure.

55.

$$\Delta T_f = \frac{1000 K_f \, w_2}{w_1 \times M_2} = \frac{1000 K_f \, w_2'}{w_1' \times M_2'}$$

$$\text{or } M_2' = \frac{w_2'}{w_1'} \times \frac{w_1}{w_2} \times M_2 = \frac{0{\cdot}50}{100} \times \frac{200}{0{\cdot}10} \times 100$$

$= 1000.$

56.

$\Delta T_b = K_b \times m.$

Hence, molality, $m = \frac{\Delta T_b}{K_b} = \frac{0.52}{0.52} = 1$

Molality = 1 means 1 mole of solute in 1000 g of solvent.

But 1000 g of solvent (water)

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

$\therefore$ Mole fraction of urea $= \frac{1}{1+55.55} = 0.018$.

57. (c)

58.

$$\Delta T_f = i \times K_f \times m = i \times K_f \times \frac{w_2}{M_2} \times \frac{1}{w_1} \times 1000$$

$$3.82 = i \times 1.86 \times \frac{5}{142} \times \frac{1}{45} \times 1000$$

(Molar mass of Na_2SO_4 = 142)

or $i = 2.62$

59.

$K_3[Fe(CN)_6] \rightleftharpoons 3K^+ + [Fe(CN)_6]^{3-}$

$\therefore$ $i = 4$

$$\Delta T_f = i\, K_f m = i \times K_f \times \frac{w_2}{M} \times \frac{1}{w_1} \times 1000$$

$$= 4 \times 1.86 \times \frac{0.1}{329} \times \frac{1}{100} \times 1000$$

$= 0.023 = 2.3 \times 10^{-2}$ °C or K

60.

We have to calculate mass of liquid water that is present in the solution. The remaining will freeze as ice.

$$\Delta T_f = \frac{1000\, K_f\, w_2}{w_1 M_2}$$

$$9.3 = \frac{1000 \times 1.86 \times 50}{w_1 \times 62} \quad \left[M_2 \text{ for } \begin{array}{c} CH_2OH \\ | \\ CH_2OH \end{array} = 62 \right]$$

or $w_1 = 161.29$ g

$\therefore$ Ice separated out = 200 − 161.29 = 38.71 g

61.

Observed molecular mass of phenylacetic acid

$$= \frac{1000 \times 5.12 \times 0.223}{(5.3 - 4.47) \times 4.4} = 312.6$$

Calculated molecular mass of $C_6H_5CH_2COOH$

= 72 + 5 + 12 + 2 + 12 + 32 + 1 = 136

As observed molecular mass is nearly double of the theoretical value, it dimerizes in benzene.

62.

For association, $i < 1$, For dissociation, $i > 1$.
For no change, $i = 1$. Hence, order is $x < z < y$.

63.

$pK_a = 4$ means K_a for HA $= 10^{-4}$

For weak acid, $HA \rightleftharpoons H^+ + A^-$

$K_a = C\alpha^2$ (Ostwald's dilution law)

$\therefore \quad \alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{10^{-4}}{0.01}} = 10^{-1} = 0.10$

	HA	$\rightleftharpoons$	H^+	A^-
Initial	1 mole			
Moles after dissoc.	$1 - \alpha$		α	α, Total $= 1 + \alpha$

$i = 1 + \alpha = 1 + 0.10 = 1.10$

64.

pH = 2 means $[H^+] = 10^{-2}$ M

	HA	$\rightleftharpoons$	H^+	A^-
Initial	C mol L^{-1}		0	0
After disso.	$C - C\alpha$		$C\alpha$	$C\alpha$,

Total $= C(1 + \alpha)$

Thus, $[H^+] = C\alpha$, *i.e.*, $10^{-2} = 1 \times \alpha$ or $\alpha = 10^{-2}$

$i = 1 + \alpha = 1 + 0.01 = 1.01$

65.

Required $\Delta T_b = 100 - 96 = 4°$

$$\Delta T_b = i\,K_b\,m = i\,K_b \frac{w_2}{M_2} \times \frac{1}{w_1} \times 1000$$

i.e., $4 = 2 \times 0.52 \times \frac{w_2}{58.5} \times \frac{1}{1000} \times 1000$

or $w_2 = 225\,g$ (1 L H_2O = 1000 g)

66.

$\Delta T_f(\text{calculated}) = K_f \times m = 1.86 \times \frac{5.85}{58.5} = 0.186°$

$\Delta T_f(\text{observed}) = 0.344°C \quad \therefore\ i = \frac{0.344}{0.186} = 1.85$

NaCl	$\longrightarrow$	Na^+	+	Cl
$1 - \alpha$		α		α

$i = 1 + \alpha$ or $\alpha = i - 1 = 0.85 = 85\%$.

67.

$\Delta T_f = i\,K_f\,m \therefore 0.372 = 2 \times 1.86 \times m$ or $m = 0.1$.
Thus, 0.1 mole, *i.e.*, 5.85 g of NaCl should be dissolved in 1 kg of water.

68.

By Henry's law, $p_A = K_H \times x_A$

or $x_A = \frac{p_A}{K_H} = \frac{200\ \text{Torr}}{5.55 \times 10^7\ \text{Torr}} = 3.6 \times 10^{-6}$

But $x_A = \frac{n_A}{n_A + n_{H_2O}} \simeq \frac{n_A}{n_{H_2O}} = \frac{n_A}{1000/18}$

$\therefore\ n_A = x_A \times \frac{1000}{18} = 3.6 \times 10^{-6} \times \frac{1000}{18}$ mole

$= 2.0 \times 10^{-4}$ mole.

69.

$\Delta p/p^0 = x_2$. Hence, $\Delta p/\Delta p' = x_2/x_2'$, *i.e.*, 10/20 = $0.2/x_2'$ or $x_2' = 0.4$. Hence, $x_1' = 1 - 0.4 = 0.6$.

70.

$$\frac{p^\circ - p_s}{p^\circ} = \frac{n_2}{n_1} = \frac{w_2 M_1}{w_1 M_2}$$

As $(p^\circ - p_s)/p^\circ$ is same in the two cases

$$\left(\frac{w_2 M_1}{w_1 M_2}\right)_{glucose} = \left(\frac{w_2 M_1}{w_1 M_2}\right)_{urea}$$

$$\frac{w_2 \times 18}{50 \times 180} = \frac{1 \times 18}{50 \times 60} \quad \text{or} \quad w_2 = 3\ \text{g}.$$

71. (d)

72.

P = hdg

But P = 0·0072 atm. Hence, h = 0·0072 × 76 cm of Hg column, d = density of Hg = 13·6 g cm^{-3}, g = 981 cm s^{-2}

Hence, P = 0·0072 × 76 × 13·6 × 981 (for Hg column)

For water, d = 1 g cm^{-3}. Hence, for water column

P = h × 1 × 981

Thus, h × 981 = 0·0072 × 75 × 13·6 × 981

or h = 7·4 cm

73.

$\Delta T_b = K_b \times m\ \therefore\ 0.18 = 0.512 \times m$

or $m = 0.18/0.512$

$\Delta T_f = K_f \times m = 1.86 \times \frac{0.18}{0.512} = 0.654$

$\therefore\ T_f = -0.654$°C

74.

$\pi\ (Na_2SO_4) = i\ CRT = i\ (0.004)\ RT$

π (Glucose) = CRT = 0·010 RT

As solutions are isotonic, i (0·004) RT = 0·01 RT.

This gives i = 2·5

Now, $Na_2SO_4 \rightleftharpoons 2Na^+ + SO_4^{2-}$

1 mole 0 0

$1 - \alpha$ 2α α,

Total = $1 + 2\alpha$

$\therefore$ $i = 1 + 2\alpha$

or $\alpha = \frac{i-1}{2} = \frac{2.5-1}{2} = 0.75 = \mathbf{75\%}$.

75.

$2\ C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_2$

Before asso. 1 mol

After asso. $1 - x$ $\frac{x}{2}$

Total $= 1 - x + \frac{x}{2} = 1 - \frac{x}{2}$

$\therefore$ $i = \frac{1 - x/2}{1} = 1 - \frac{x}{2}$.

76.

$HA \longrightarrow H^+ + A^-$

$1-\alpha$ α α

$1-0.3$ 0.3 0.3

$\therefore$ $i = (1 - 0.3) + 0.3 + 0.3 = 1.3$

$\Delta T_f = i K_f m = 1.3 \times 1.86 \times 0.1 = 0.2418$

$T_f = 0 - 0.2418°C = -0.2418°C \simeq -0.24°C$.

77.

$BaCl_2 \rightleftharpoons Ba^{2+} + 2\ Cl^-$

Initial 1 mole 0 0

After disso. $1 - \alpha$ α 2α,

Total no. of particles = $1 + 2\alpha$

$i = 1 + 2\alpha$

or $\alpha = \frac{i-1}{2} = \frac{1.98-1}{2} = \frac{0.98}{2} = 0.49 = 49\%$.