WEEKLY TEST RANKER'S BATCH TEST - 07 RAJPUR SOLUTION Date 10-11-2019

[PHYSICS]

1. **(a)** It is given that energy remains the same.

Hence, $E_A = E_B$

Energy $\propto a^2n^2 \Rightarrow \frac{a_B}{a_A} = \frac{n_A}{n_B}$ $\quad$ ($\because$ energy is same)

$\therefore \quad \left(\frac{a_A}{a_B}\right)^2 = \left(\frac{n_B}{n_A}\right)^2$

Given, $n_A = n,\ n_B = \frac{n}{8}$

$\therefore \quad \frac{a_A}{a_B} = \frac{n/8}{n} = \frac{1}{8} \quad \Rightarrow a_B = 8a_A = 8a$

2. **(d)** The frequency of note emitted by the wire,

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

m = mass m per unit length of wire and T = tension,
and l = length of wire.

$$\frac{n_1}{n_2} = \sqrt{\frac{T_1}{T_2}}$$

Given, $T_1 = 10$ N, $n_1 = n$, and $n_2 = 2n$

$\Rightarrow \quad \frac{n}{2n} = \sqrt{\frac{10}{T_2}} \quad \Rightarrow \quad T_2 = 10 \times 4 = 40$ N

3. **(a)** Time required for a point to move from maximum displacement to zero displacement is

$$t = \frac{T}{4} = \frac{1}{4n}$$

$\Rightarrow \quad n = \frac{1}{4t} = \frac{1}{4 \times 0.170} = 1.47$ Hz

4. **(c)** Phase difference $= \frac{2\pi}{\lambda} \times$ path difference

Path difference $\Delta = \frac{\lambda}{2\pi} \times \phi = \frac{\lambda}{2\pi} \times \frac{\pi}{3} = \frac{\lambda}{6}$

5. **(a)** The apparent change in the frequency of the source due to relative motion between source and observer is known as Doppler's effect. The perceived frequency (n') when listener is static and source is moving away is given by

$$n' = n\left(\frac{v}{v+v_s}\right)$$

where n is frequency of source, v is velocity of sound and v_s is velocity of source.

Putting $v = 330$ m/s, $v_s = 30$ m/s, $n = 800$ Hz.

$$n' = 800 \times \left(\frac{330}{330+30}\right)$$

$$n' = 733.3 \text{ Hz}$$

In the limit when speed of source and observer is much lesser than that of sound v_1, the change in frequency becomes independent of the fact whether the source is moved or the detector.

6. **(b)** The velocity of sound is given by $v = \sqrt{\frac{\gamma P}{\rho}}$

where P is pressure, ρ is density and γ is adiabatic constant.

$$\Rightarrow \quad \frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{4}{1}} = 2:1$$

7. **(b)** Compare with $y = a \sin(\omega t - kx)$

We have $k = \frac{2\pi}{\lambda} = 62.4 \quad \Rightarrow \quad \lambda = \frac{2\pi}{62.4} = 0.1$

8. **(b)** Since the point $x = 0$ is a node and reflection is taking place from point $x = 0$. This means that reflection must be taking place from the fixed end and hence the reflected ray must suffer an additional phase change of π or a path change of $\lambda/2$

So, if $y_{\text{incident}} = a\cos(kx - \omega t)$

$$\Rightarrow \quad y_{\text{reflected}} = a\cos(-kx - \omega t + \pi)$$

$$= -a\cos(\omega t + kx)$$

9. **(b)** The frequency produced in a string of length l, mass per unit length m, and tension T is

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Given $l_1 = 50$ cm, $n_1 = 800$ Hz

and $n_2 = 1000$ Hz

$n_1 l_1 = n_2 l_2$

$\Rightarrow$ $800 \times 50 = 1000 \times l_2$

$\Rightarrow$ $l_2 = 40$ cm

10. **(d)** Points B and F are in same phase as they are λ distance apart.

11. **(c)** Water waves are transverse as well as longitudinal in nature.

12. **(c)** Critical hearing frequency for a person is 20,000 Hz.

If a closed pipe vibration in N^{th} mode then frequency of vibration

$$n = \frac{(2N-1)v}{4l} = (2N-1)n_1$$

(where n_1 = fundamental frequency of vibration)

Hence $20{,}000 = (2N-1) \times 1500 \Rightarrow N = 7.1 \approx 7$

Maximum possible harmonics obtained are

1,3,5,7,9,11,13

Hence, man can hear up to 13^{th} harmonic

$= 7 - 1 = 6$

So, number of overtones heard = 6

13. **(d)** Path difference $(\Delta x) = 50 \text{ cm} = \frac{1}{2}\text{m}$

$\therefore$ Phase difference $\Delta\phi = \frac{2\pi}{\lambda}$

$$\Delta x \Rightarrow \phi = \frac{2\pi}{1} \times \frac{1}{2} = \pi$$

Total phase difference $= \pi - \frac{\pi}{3} = \frac{2\pi}{3}$

$$\Rightarrow \quad A = \sqrt{a^2 + a^2 + 2a^2 \cos\left(\frac{2\pi}{3}\right)} a$$

14. **(d)** Fundamental frequency of open organ pipe $= \frac{v}{2l}$

Frequency of third harmonic of closed pipe $= \frac{3v}{4l}$

$$\therefore \quad \frac{3v}{4l} = 100 + \frac{v}{2l}$$

$$\Rightarrow \quad \frac{3v}{4l} - \frac{2v}{4l} = \frac{v}{4l} = 100 \Rightarrow \frac{v}{2l} = 200 \text{ Hz}$$

15. **(a)** $dB = 10\log_{10}\left[\frac{I}{I_0}\right]$,

where $I_0 = 10^{-12}$ wm^{-2}

Since $40 = 10\log_{10}\left[\frac{I_1}{I_0}\right] \Rightarrow \frac{I_1}{I_0} = 10^4$

Also, $20 = 10\log_{10}\left[\frac{I_2}{I_0}\right] \Rightarrow \frac{I_2}{I_1} = 10^2$

$\Rightarrow \quad \frac{I_2}{I_1} = 10^{-2} = \frac{r_1^2}{r_2^2}$

$\Rightarrow \quad r_2^2 = 100 r_1^2 \quad \Rightarrow r_2 = 10$ m

16. **(a)** In first overtone mode, $l = \frac{3\lambda}{4}$

$\therefore \quad \frac{\lambda}{4} = \frac{l}{3} = \frac{1.2}{3} = 0.4$ m

Pressure variation will be maximum at displacement nodes, i.e., at 0.4 m from the open end.

17. **(b)** Given $\frac{I_1}{I_2} = \frac{4}{1}$

We know $I \propto a^2$

$\therefore \quad \frac{a_1^2}{a_2^2} = \frac{I_1}{I_2} = \frac{4}{1}$ or $\frac{a_1}{a_2} = \frac{2}{1}$

$\therefore \quad \frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \left(\frac{2+1}{2-1}\right)^2$

$= \left(\frac{3}{1}\right)^2 = \frac{9}{1}$

Therefore, difference of loudness is given by

$L_1 - L_2 = 10\log\frac{I_{max}}{I_{min}} = 10\log(9)$

$= 10\log 3^2 = 20\log 3.$

18. **(c)** The frequency of A, $n_A = n + \frac{2}{100}n$

and the frequency of B, $n_B = n - \frac{3}{100}n$

According to question, $n_A - n_B = 6$

$\therefore \quad \left(n + \frac{2}{100}n\right) - \left(n - \frac{3}{100}n\right) = 6$

or $\quad \frac{5}{100}n = 6 \quad \Rightarrow \quad n = \frac{600}{5} = 120$ Hz

The frequency of A

$$n_A = \left(n + \frac{2}{100}n\right) = 120 + \frac{2}{100} \times 120$$

$$= 122.4 \text{ Hz}$$

19. **(a)** When the source is coming to the stationary observer,

$$n' = \left(\frac{v}{v - v_s}\right)n \quad \text{or} \quad 1000 = \left(\frac{350}{350 - 50}\right)n$$

or $n = (1000 \times 300/350)$ Hz

When the source is moving away from the stationary observer.

$$n'' = \left(\frac{v}{v + v_s}\right)n$$

$$= \left(\frac{350}{350 + 50}\right)\left(\frac{1000 \times 300}{350}\right)$$

$$= 750 \text{ Hz}$$

20. **(c)** Fundamental frequency of closed pipe

$$n = \frac{v}{4l} = 220 \text{ Hz} \Rightarrow v = 220 \times 4l$$

If 1/4 of the pipe is filled with water then remaining length of air column is $\frac{3l}{4}$

Now fundamental frequency $= \dfrac{v}{4\left(\frac{3l}{4}\right)} = \dfrac{v}{3l}$ and

First overtone = 3 × fundamental frequency

$$= \frac{3v}{3l} = \frac{v}{l} = \frac{220 \times 4l}{l} = 880 \text{ Hz}$$

21. **(a, c)** $v_{max} = a\omega = \frac{v}{10} = \frac{10}{10} = 1$ m/s

$\Rightarrow \quad a\omega = a \times 2\pi n = 1$

$\Rightarrow \quad n = \dfrac{10^3}{2\pi} \qquad (\because a = 10^{-3} \text{ m})$

Since $v = n\lambda \Rightarrow \lambda = \dfrac{v}{n} = \dfrac{10}{10^3/2\pi} = 2\pi \times 10^{-2}$ m

22. **(b)** $n = \dfrac{1}{2l}\sqrt{\dfrac{T}{m}} \Rightarrow n_1 l_1 = n_2 l_2 = n_3 l_3 = k$

$$l_1 + l_2 + l_3 = l \Rightarrow \frac{k}{n_1} + \frac{k}{n_2} + \frac{k}{n_3} = \frac{k}{n}$$

$$\Rightarrow \quad \frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + \cdots$$

23. **(c)** $f \,\alpha\, \sqrt{T}$

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \Rightarrow \frac{\Delta f}{f} = \frac{1}{2}\frac{\Delta T}{T}$$

$$\Rightarrow \quad \Delta f = \frac{202}{2} \times \frac{1}{101} = 1$$

24. **(d)** $<v> = \frac{v_1 + v_2}{2} = \frac{\alpha\sqrt{T_1} + \alpha\sqrt{T_2}}{2}$

$$\Rightarrow \quad \text{Time taken } = \frac{2l}{\alpha(\sqrt{T_1} + \sqrt{T_2})}$$

Alternate Solution:

$$\frac{dx}{dt} = V = \alpha\sqrt{T_1 + \left(\frac{T_2 - T_1}{l}\right)x}$$

$$\int_{x=0}^{x=l} \frac{dx}{\sqrt{T_1 + \left(\frac{T_2 - T_1}{l}\right)x}} = \int_0^t \alpha dt$$

on solving we get $t = \frac{2l}{\alpha(\sqrt{T_1} + \sqrt{T_2})}$

25. **(d)** $\frac{v_1}{v_2} = \frac{28}{27}$

$$v_1 - v_2 = 3 \text{ or } \frac{28}{27}v_2 - v_2 = 3$$

$$v_2 = 27 \times 3 \text{ Hz} = 81 \text{ Hz}$$

or $\quad v_1 = v_2 + 3 = (81 + 3)\text{Hz}$

or $\quad v_1 = 84$ Hz

26. **(c)** At $t = 0$, $y = 10 \sin 2\pi\left(\frac{50x}{22}\right)$

Change in pressure will be maximum at $y = 0$

$$y = 0 \text{ at } \frac{(2\pi)(50x)}{22} = 0, \pi, 2\pi, 3\pi, \ldots\ 100x\pi$$

$$= (3\pi)(22)$$

or $\quad x = 0.66$ m

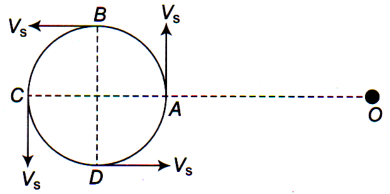
27. **(c)** Force closed pipe, $f = \frac{nV}{4\ell}$, $n = 1, 3, 5...$

$$f_1 = \frac{V}{4\ell} = \frac{330}{(4)(93.75/100)} = 88 \text{ Hz}$$

$$f_2 = \frac{3V}{4\ell} = \frac{(3)(330)}{(4)(93.75/100)} = 264 \text{ Hz}$$

Required $f = 264$ Hz

28. **(d)** Frequency heard by the observed will be maximum when the source is in the position *D*. In this case, source will be approaching towards the stationary observer, almost along the line of sight (as observer is stationed at a larger distance).

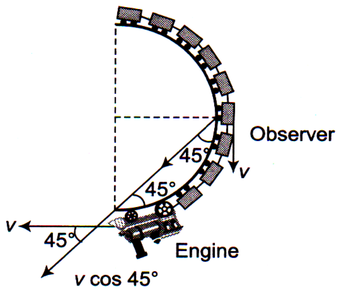


Similarly, frequency heard by the observer will be minimum when the source reaches at the position *B*. Now, the source will be moving away from the observer.

$$n_{min.} = \frac{v}{v+v_s} \times n = \frac{330}{330+1.5\times 20} \times 440$$

$$= \frac{330\times 440}{360} = 403.3 \text{ Hz}$$

29. **(c)** The situation is shown in the fig. Both the source (engine) and the observer (Person in the middle of the train) have the same speed, but their direction of motion is right angles to each other. The component of velocity of observer towards source is v cos 45° and that of source along the time joining the observer and source is also v cos 45°. There is number relative motion between them, so there is no change in frequency heard. So frequency heard is 200 Hz.



30. (a) When the train is approaching the stationary observer frequency heard by the observer $n' = \frac{v+v_0}{v} n$

when the train is moving away from the observer then frequency heard by the observer $n'' = \frac{v-v_0}{v} n$

it is clear that n' and n'' are constant and independent of time. Also and $n' > n''$.

31. (b) Equation of *A, B, C* and *D* are

$y_A = A\sin\omega t$, $y_B = A\sin(\omega t + \pi/2)$

$y_C = A\sin(\omega t - \pi/2)$, $y_D = A\sin(\omega t - \pi)$

It is clear that wave *C* lags behind by a phase angle of $\pi/2$ and the wave *B* is ahead by a phase angle at $\pi/2$.

32. (c) The particle velocity is maximum at *B* and is given by $\frac{dy}{dt} = (v_p)_{\max} = \omega A$

Also wave velocity is $\frac{dx}{dt} = v = \frac{\omega}{k}$

So slope $\frac{dy}{dx} = \frac{(v_p)_{\max}}{v} = kA$

33. (d) When pulse is reflected from a rigid support, the pulse is inverted both lengthwise and sidewise

34. (d) Given equation $y = y_0 \sin(\omega t - \phi)$

at $t = 0$, $y = -y_0 \sin\phi$

this is the case with curve marked *D*.

35. (c) We know frequency $n = \frac{p}{2l}\sqrt{\frac{T}{\pi r^2 \rho}} \Rightarrow n \propto \frac{1}{\sqrt{\rho}}$

i.e., graph between *n* and $\sqrt{\rho}$ will be hyperbola.

36. (c) Energy density (*E*) $= \frac{I}{v} = 2\pi^2 \rho n^2 A^2$

$v_{\max} = \omega A = 2\pi n A \Rightarrow E \propto (v_{\max})^2$

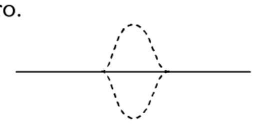
i.e., graph between *E* and $v_{\max}$ will be a parabola symmetrical about *E* axis.

37. (c) Here $A = 0.05m$, $\frac{5\lambda}{2} = 0.025 \Rightarrow \lambda = 0.1m$

Now standard equation of wave

$y = A\sin\frac{2\pi}{\lambda}(vt - x) \Rightarrow y = 0.05\sin 2\pi(33t - 10x)$

38. (c) After two seconds each wave travel a distance of 2.5 × 2 = 5 *cm i.e.* the two pulses will meet in mutually opposite phase and hence the amplitude of resultant will be zero.



39. (c) $n_Q = 341 \pm 3 = 344Hz$ or $338Hz$

on waxing *Q*, the number of beats decreases hence $n_Q = 344Hz$

40. (b) For observer approaching a stationary source

$n' = \frac{v+v_0}{v}.n$ and given $v_0 = at \Rightarrow n' = \left(\frac{an}{v}\right)t + n$

this is the equation of straight line with positive intercept n and positive slope $\left(\frac{n}{v}\right)$.

41.

42. (d) Intensity $\propto a^2\omega^2$

here $\frac{a_A}{a_B} = \frac{2}{1}$ and $\frac{\omega_A}{\omega_B} = \frac{1}{2} \Rightarrow \frac{I_A}{I_B} = \left(\frac{2}{1}\right)^2 \times \left(\frac{1}{2}\right)^2 = \frac{1}{1}$

43. (b) At $t = 0$ and $x = \frac{\pi}{2k}$. The displacement

$y = a_0 \sin\left(\omega x_0 - k \times \frac{\pi}{2x}\right) = -a_0 \sin\frac{\pi}{2} = -a_0$

from graph. Point of maximum displacement (a_0) in negative direction is Q.

44. (d) Particle velocity $(v_p) = -v \times$ Slope of the graph at that point

At point 1 : Slope of the curve is positive, hence particle velocity is negative or downward (↓)

At point 2 : Slope negative, hence particle velocity is positive or upwards (↑)

At point 3 : Again slope of the curve is positive, hence particle velocity is negative or downward (↓)

45. (c) Speed = $n\lambda = n(4ab) = 4n \times ab$ $\left(\text{As } ab = \frac{\lambda}{4}\right)$

Path difference between b and e is $\frac{3\lambda}{4}$

So the phase difference $= \frac{2\pi}{\lambda}$. Path difference

$$= \frac{2\pi}{\lambda}.\frac{3\lambda}{4} = \frac{3\pi}{2}$$

[CHEMISTRY]

46.

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

$$= \frac{6{\cdot}02 \times 10^{20}}{6{\cdot}02 \times 10^{23}} = 10^{-3} \text{ mol}$$

∴ Molar concentration of urea in the solution

$$= \frac{10^{-3}}{100} \times 1000 = 10^{-2} \text{ M} = 0{\cdot}01 \text{M}$$

47.

$x_X = \frac{1}{4} = 0{\cdot}25,\ x_Y = 0{\cdot}75$

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

i.e., $550 = 0{\cdot}25\, p_X^\circ + 0{\cdot}75\, p_Y^\circ$

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

After adding 1 mol of Y,

$x_X = \frac{1}{5} = 0{\cdot}20,\ x_Y = 0{\cdot}80$

$\therefore\ 560 = 0{\cdot}20\, p_X^\circ + 0{\cdot}80\, p_Y^\circ$

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

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

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

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

$\therefore\ 1000 + x_A\,(520 - 1000) = 760$

or $480\, x_A = 240$

or $x_A = 0{\cdot}50$, *i.e.*, 50 mol percent.

49.

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

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

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

$\therefore\ P_{total} = 5\, x\, p.$

Mole fraction in vapour phase

$$(y_A) = \frac{p_A}{P_{Total}} = \frac{x\,p}{5\,x\,p} = \frac{1}{5} = 0{\cdot}2$$

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,

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

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

$$\frac{3}{M} = 0.05 \quad \text{or} \quad M = 60$$

Empirical formula mass of CH_2O = 30

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

Hence, molecular formula = $2 \times CH_2O = C_2H_4O_2$

53.

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

$$C = \frac{\pi}{iRT} = \frac{7.8\ \text{bar}}{2 \times 0.083\ \text{bar L K}^{-1}\ \text{mol}^{-1} \times 310\ \text{K}}$$

$= 0.15$ mol L^{-1}.

54.

$$7\ g\ L^{-1}\ MgCl_2 = \frac{7}{24+71}\ \text{mol L}^{-1}$$

$$= \frac{7}{95}\ \text{mol L}^{-1} = \frac{7 \times 3}{95}\ \text{mol L}^{-1}\ \text{of ions} = 0.22\ M$$

$$7\ g\ L^{-1}\ NaCl = \frac{7}{23+35.5}\ M$$

$$= \frac{7}{58.5}\ M = \frac{7 \times 2}{58.5}\ \text{mol L}^{-1}\ \text{of ions} = 0.24\ M$$

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

55.

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

$$\text{or} \quad M_2' = \frac{w_2'}{w_1'} \times \frac{w_1}{w_2} \times M_2 = \frac{0.50}{100} \times \frac{200}{0.10} \times 100$$

$= 1000.$

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)

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

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

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.

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

$\therefore \quad i = 4$

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

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

$= 0.023 = 2.3 \times 10^{-2}$ °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	⇌	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	⇌	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 $w_2 = 225\text{ g}$ $(1\text{ L } H_2O = 1000\text{ g})$

66.

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

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

$$\begin{array}{cccc} NaCl & \longrightarrow & Na^+ & + \quad Cl \\ 1-\alpha & & \alpha & \quad \alpha \end{array}$$

$i = 1 + \alpha$ 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 $= 0{\cdot}2/x_2'$ or $x_2' = 0{\cdot}4$. Hence, $x_1' = 1 - 0{\cdot}4 = 0{\cdot}6$.

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, $h = 0{\cdot}0072 \times 76$ cm of Hg column, d = density of Hg = 13·6 g cm^{-3}, $g = 981$ cm s^{-2}

Hence, $P = 0{\cdot}0072 \times 76 \times 13{\cdot}6 \times 981$ (for Hg column)

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

$$P = h \times 1 \times 981$$

Thus, $h \times 981 = 0{\cdot}0072 \times 75 \times 13{\cdot}6 \times 981$

or $h = 7{\cdot}4$ cm

73.

$\Delta T_b = K_b \times m \therefore 0{\cdot}18 = 0{\cdot}512 \times m$

or $m = 0{\cdot}18/0{\cdot}512$

$$\Delta T_f = K_f \times m = 1{\cdot}86 \times \frac{0{\cdot}18}{0{\cdot}512} = 0{\cdot}654$$

$\therefore \quad T_f = -0{\cdot}654°C$

74.

$\pi(Na_2SO_4) = i\,CRT = i\,(0{\cdot}004)\,RT$

π (Glucose) = CRT = 0·010 RT

As solutions are isotonic, $i\,(0{\cdot}004)\,RT = 0{\cdot}01\,RT$.

This gives $i = 2{\cdot}5$

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

	Na_2SO_4	$2Na^+$	SO_4^{2-}
	1 mole	0	0
	$1 - \alpha$	2α	α,
		Total = $1 + 2\alpha$	

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

or $\quad \alpha = \frac{i-1}{2} = \frac{2{\cdot}5 - 1}{2} = 0{\cdot}75 = \mathbf{75\%}$.

75.

$$2\,C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_2$$

Before asso. 1 mol

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

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

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

76.

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

1–α	α	α
1–0·3	0·3	0·3

$\therefore \quad i = (1 - 0{\cdot}3) + 0{\cdot}3 + 0{\cdot}3 = 1{\cdot}3$

$\Delta T_f = i\,K_f\,m = 1{\cdot}3 \times 1{\cdot}86 \times 0{\cdot}1 = 0{\cdot}2418$

$T_f = 0 - 0{\cdot}2418°C = -0{\cdot}2418°C \simeq -0{\cdot}24°C.$

77.

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

	$BaCl_2$	Ba^{2+}	$2\,Cl^-$
Initial	1 mole	0	0
After disso.	$1 - \alpha$	α	$2\,\alpha$,

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

$i = 1 + 2\,\alpha$

or $\alpha = \frac{i-1}{2} = \frac{1{\cdot}98 - 1}{2} = \frac{0{\cdot}98}{2} = 0{\cdot}49 = 49\%$.