WEEKLY TEST TYJ -1 TEST - 29 R

SOLUTION Date 01-12-2019

[PHYSICS]

1. $\dfrac{C_{H_2}}{C_{O_2}} = \sqrt{\dfrac{32}{2}} = 4$

or $C_{H_2} = 4 \times C_{O_2} = 4 \times 400\ \text{m s}^{-1} = 1600\ \text{m s}^{-1}$

2. The kinetic energy of gas w.r.t. centre of mass of the system $\text{K.E.} = \dfrac{5}{2}nRT$

Kinetic energy of gas w.r.t. ground = Kinetic energy of centre of mass w.r.t. ground + Kinetic energy of gas w.r.t. centre of mass.

$$\text{K.E.} = \frac{1}{2}MV^2 + \frac{5}{2}nRT$$

3. Ideal gas equation $PV = \mu RT = \left(\dfrac{N}{N_A}\right)RT$ where N = Number of molecule, N_A = Avogadro number

$$\therefore \frac{N_1}{N_2} = \left(\frac{P_1}{P_2}\right)\left(\frac{V_1}{V_2}\right)\left(\frac{T_2}{T_1}\right) = \left(\frac{P}{2P}\right)\left(\frac{V}{V/4}\right)\left(\frac{2T}{T}\right) = \frac{4}{1}.$$

4. $C = \sqrt{\dfrac{3RT}{M}}$ or $T \propto M$

$\therefore \dfrac{T'}{T} = \dfrac{4}{2} = 2$ or $T' = 2T$

or $T = 2 \times 273\ \text{K} = 546\ \text{K}$

5. or $m \propto (1/P)$ or, $m_2 > m_1 \therefore P_2 < P_1$

6. Since the graph is a straight line,

so, $V = mT$ where m is the slope.

$= (nRT)/P$ [From equation of state]

7. Given:

Initial volume $V_1 = 3V$

Initial pressure $P_1 = 2$ atmosphere.

Final pressure

$$P_2 = 2P_1 = 2 \times 2 = 4 \text{ atmosphere}$$

According to the Boyle's law we have

$P_1V_1 = P_2V_2$ (where V_2 is the final volume of gas)

or $2 \times 3V = 4 \times V_2$ or $V_2 = 1.5\ V$

8. For a given pressure, V is small for T_1. Since $V \propto T$, therefore, $T_1 < T_2$.

9. When, the container stops, its total kinetic energy is transferred to gas molecules in the form of translational kinetic energy, thereby increasing the absolute temperature.

Assuming n = number of moles.

Given, m = molar mass of the gas.

If ΔT = change in absolute temperature.

Then, kinetic energy of molecules due to velocity v_0,

$$\Delta K_{\text{motion}} = \frac{1}{2}(mn)v_0^2 \quad \text{(i)}$$

Increase in translational kinetic energy

$$\Delta K_{\text{translation}} = n\frac{3}{2}R(\Delta T) \quad \text{(ii)}$$

According to kinetic theory Eqs. (i) and (ii) are equal

$$\Rightarrow \quad \frac{1}{2}(mn)v_0^2 = n\frac{3}{2}R(\Delta T)$$

$$(mn)v_0^2 = n3R(\Delta T)$$

$$\Rightarrow \quad \Delta T = \frac{(mn)v_0^2}{3nR} = \frac{mv_0^2}{3R}$$

10. $\dfrac{C_t}{C_0} = \sqrt{\dfrac{273+t}{273}}$

or $4 \times 273 - 273 = t$

or $t = 3 \times 273 = 819°\text{C}$

11. 3 moles of H_2 are given.

12. $PV = \mu RT,\ PV = \dfrac{n}{N} \times hNT$ or $n = \dfrac{PV}{kT}$

13. For a constant value of density, pressure is more at T_1.

$\therefore \quad T_1 > T_2 \qquad [\because P \propto T]$

14.

15. Initial volume of gas = V_1

Final volume of gas = V_2

Initial temperature of gas $T_1 = 27°C = 300$ **K**

Final temperature of gas $T_2 = 54°C = 327$ **K**

Now from the Charles's law at constant pressure

$$\frac{V_1}{V_2} = \frac{T_1}{T_2} = \frac{300}{327} = \frac{100}{109}$$

16.

17. The given statement is zeroth law of thermodynamics. It was formulated by R. H. Fowler in 1931

18. The internal energy of ideal gas depends only upon temperature of gas not on other factors.

19. For monoatomic gas, $\frac{\Delta U}{Q} = \frac{1}{3}$ or, $\Delta U = \frac{Q}{3}$

From the first law of thermodynamics,

$$Q = \Delta U + W \quad \therefore \quad W = (2/3)Q$$

20. $\Delta U = nC_V\Delta T = n(5/2)R\Delta T$

$\Delta Q = nC_P\Delta T = n(7/2)R\Delta T$

$W = \Delta Q - \Delta U = \frac{n7}{2}R\Delta T - \frac{n5}{2}R\Delta T = nR\Delta T$

$\frac{W}{\Delta U} = \frac{2}{7}$

[CHEMISTRY]

21.

NH_3 donates pair of electrons while BF_3, Cu^{2+} and $AlCl_3$ accept lone pair of electrons.

22.

$\text{Acid} \xrightarrow{-H^+} \text{Conjugate base}, \quad \text{Base} \xrightarrow{+H^+} \text{Conjugate acid}$

23.

H_3O^+ (acid), H_2O (conjugate base) and not OH^-.

24.

pH [HCl] = 2.0

∴ $[H^+] = 10^{-2}$ M

$[HCl] = 10^{-2}$ M

Volume = 200 mL

pH [NaOH] = 12.0

pOH = 2.0

$[OH^-] = 10^{-2}$ M

$[NaOH] = 10^{-2}$ M

Volume = 300 mL

N_1V_1 (acid) $= 200 \times 10^{-2} = 2$

N_1V_2 (base) $= 300 \times 10^{-2} = 3$

$N_2V_2 > N_1V_1$

Thus, resultant mixture basic.

$$N(OH^-) = \frac{N_2V_2 - N_1V_1}{V_1 + V_2} = \frac{3-2}{500} = 2\times10^{-3}\text{ M}$$

pOH $= -\log(2 \times 10^{-3}) = 2.7$

∴ pH = 14 – pOH 14 – 2.7 = 11.3

25.

K_w changes with temperature. As temperature increases, $[OH^-]$ and $[H^+]$ decrease.

26.

Meq. of HCl $= 10 \times 10^{-1} = 1$

Meq. of NaOH $= 10 \times 10^{-1} = 1$

Thus both are neutralised and 1 Meq. of NaCl (a salt of strong acid and strong base) which does not hydrolyse and thus pH = 7.

27.

$pK_w = -\log K_w = -\log 1 \times 10^{-12} = 12.$

$K_w = [H^+][OH^-] = 10^{-12}$

$[H^+] = [OH^-]$

⇒ $[H^+]^2 = 10^{-12}$; $[H^+] = 10^{-6}$; pH $= -\log [H^+] = -\log 10^{-6} = 6.$

H_2O is neutral because $[H^+] = [OH^-]$ at 373 K even when pH = 6.

(d) is not correct at 373 K. Water cannot become acidic.

28.

$$\underset{}{AB_2(s)} \rightleftharpoons \underset{s}{A^{2+}(aq)} + \underset{2s}{2B^-(aq)}$$

$K_{sp} = [A^{2+}][B^-]^2 = (s)(2s)^2 = 4s^3$

$= 4(1.0 \times 10^{-5})^3 = 4 \times 10^{-15}$

In the presence of 0.1 M A^{2+}, solubility is decreased due to common ion effect.

Let, solubility be $= x$ mol L^{-1}

$AB_2(s) \rightleftharpoons A^{2+}(aq) + 2B^-(aq)$

A^{2+} (aq) added = 0.1 M

Total $[A^{2+}] = (x + 0.1\text{ M}) \approx 0.1$ M

∵ $x << 1.0 \times 10^{-5}$ M

$[B^-] = 2 \times$ M

∴ $[A^{2+}][B^-]^2 = 4 \times 10^{-15}$

$(0.1)(2x)^2 = 4 \times 10^{-15}$

$4x^2 = 4 \times 10^{-14}$

$x = 1 \times 10^{-7}$ M

29.

$pH = 4 \Rightarrow [H^+] = 10^{-4} M \Rightarrow [OH^-] = 10^{-10} M$

$$Al(OH)_3 \rightleftharpoons Al^{+3} + 3OH^-$$

$K_{sp}(Al(OH)_3) = [Al^{+3}][OH^-]^3$

$[Al^{3+}][OH^-]_3 = 1 \times 10^{-33}$

$[Al^{3+}](10^{-10})^3 = 1 \times 10^{-33} \Rightarrow [Al^{+3}] = 10^{-3} M$

30.

$$K = 2 = \sqrt{k_1}, K_2 = \frac{1}{K_4}, K_1 = \frac{1}{K_3}$$

$$\therefore \quad K_1K_3 = 1, \sqrt{K_1}\ K_4 = 1\ \sqrt{K_3} = 1$$

31.
32.
33.
34.

35. The equilibrium constant of second reaction is very large and hence the equilibrium concentrations may be determined by adding the reactions. On adding,

	A +	B $\rightleftharpoons$	D +	E	$K = K_1 \times K_2 = 1$
Initial moles	2	5	0	0	
Moles at equ.	$2-x$	$5-x$	x	x	
Equ. conc.	$\frac{2-x}{2}$M	$\frac{5-x}{2}$M	$\frac{x}{2}$M	$\frac{x}{2}$M	

Now, $$K = \frac{[D][E]}{[A][B]} = \frac{\left(\frac{x}{2}\right)\cdot\left(\frac{x}{3}\right)}{\left(\frac{2-x}{2}\right)\cdot\left(\frac{5-x}{2}\right)}$$

or, $$1 = \frac{x^2}{(2-x)(5-x)}$$

or $x = 1.428$

Now, for first reaction, $K_1 = \frac{[C][D]}{[A]}$

or, $$5 \times 10^{-6} = \frac{[C]\left(\frac{x}{2}\right)}{\left(\frac{2-x}{2}\right)}$$

$\therefore$ $[C] = \mathbf{2 \times 10^{-6}\ M}$

36. **Example 39** *Some solid* NH_4HS *is introduced in a vessel containing* NH_3 *gas at* 0.5 atm. *Calculate the equilibrium partial pressures of gases. For the reaction:*

$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g), K_p = 0.12\ atm^2.$

Solution

	$NH_4HS(g)$ $\rightleftharpoons$	$NH_3(g)$ +	$H_2S(g)$
Initial partial pressure		0.5 atm	0
Equ. par. pressure of gases		$(0.5 + x)$ atm	x atm

Now, $K_p = P_{NH_3} \cdot P_{H_2S}$

or, $0.12 = (0.5 + x) \times x$

or, $x = 0.177$

Hence, equilibrium pressure of $NH_3 = 0.5 + x = \mathbf{0.677\ atm}$

$H_2S = x = \mathbf{0.177\ atm}$

Now, $K = \frac{[D][E]}{[A][B]} = \frac{\left(\frac{x}{2}\right)\cdot\left(\frac{x}{3}\right)}{\left(\frac{2-x}{2}\right)\cdot\left(\frac{5-x}{2}\right)}$

or, $1 = \frac{x^2}{(2-x)(5-x)}$

or $x = 1.428$

Now, for first reaction, $K_1 = \frac{[C][D]}{[A]}$

or, $5 \times 10^{-6} = \frac{[C]\left(\frac{x}{2}\right)}{\left(\frac{2-x}{2}\right)}$

$\therefore$ $[C] = \mathbf{2 \times 10^{-6}\ M}$

37.

	$PCl_5(g)$ $\rightleftharpoons$	$PCl_3(g)$ +	$Cl_2(g)$
Initial moles	1 (say)	0	0
Moles at equ.	$1-\alpha$	α	α
Total moles at equ.	$= (1-\alpha) + \alpha + \alpha = 1 + \alpha$		
Equ. par pressure	$\frac{1-\alpha}{1+\alpha}\cdot P$	$\frac{\alpha}{1+\alpha}\cdot P$	$\frac{\alpha}{1+\alpha}\cdot P$

Now, $K_p = \frac{P_{PCl_3}\cdot P_{Cl_2}}{P_{PCl_5}} = \frac{\left(\frac{\alpha}{1+\alpha}\cdot P\right)\left(\frac{\alpha}{1+\alpha}\cdot P\right)}{\left(\frac{1-\alpha}{1+\alpha}\cdot P\right)} = \frac{\alpha^2 P}{1-\alpha^2}$

or, $0.2 = \frac{\alpha^2 \times 4}{1-\alpha^2}$

$\therefore$ $\alpha = \mathbf{0.218}$

[MATHEMATICS]

41. (c) **Trick :** $2a = 7$ or $a = \frac{7}{2}$

Also (5, –2) satisfies it, so $\frac{4}{49}(25) - \frac{51}{196}(4) = 1$

and $a^2 = \frac{49}{4} \Rightarrow a = \frac{7}{2}$.

42. (c) $(4x+8)^2 - (y-2)^2 = -44 + 64 - 4$

$\Rightarrow \frac{16(x+2)^2}{16} - \frac{(y-2)^2}{16} = 1$

Transverse and conjugate axes are $y = 2$, $x = -2$.

43. (c) Foci $(0, \pm 4) \equiv (0, \pm be) \Rightarrow be = 4$

Vertices $(0, \pm 2) \equiv (0, \pm b) \Rightarrow b = 2 \Rightarrow a = 2\sqrt{3}$

Hence equation is $\frac{-x^2}{(2\sqrt{3})^2} + \frac{y^2}{(2)^2} = 1$ or $\frac{y^2}{4} - \frac{x^2}{12} = 1$.

44. (b) Since $e > 1$ always for hyperbola and $\frac{2}{3} < 1$.

45. (a) The given equation is $2x^2 - 3y^2 = 5$

$\Rightarrow \frac{x^2}{5/2} - \frac{y^2}{5/3} = 1$

Now $b^2 = a^2(e^2 - 1) \Rightarrow \frac{5}{3} = \frac{5}{2}(e^2 - 1) \Rightarrow e = \sqrt{\frac{5}{3}}$.

The foci of hyperbola $(\pm ae, 0)$

$= \left(\pm\sqrt{\frac{5}{2}} . \sqrt{\frac{5}{3}}, 0\right) = \left(\pm\frac{5}{\sqrt{6}}, 0\right)$.

46. (d) $ae = 1$, $a = 2$, $e = \frac{1}{2} \Rightarrow b = \sqrt{4\left(1 - \frac{1}{4}\right)} = \sqrt{3}$

Hence minor axis $= 2\sqrt{3}$.

47. (b) $\frac{x^2}{(48/3)} + \frac{y^2}{(48/4)} = 1$

$a^2 = 16, b^2 = 12 \Rightarrow e = \sqrt{1 - \frac{b^2}{a^2}} = \frac{1}{2}$

Distance is $2ae = 2 \cdot 4 \cdot \frac{1}{2} = 4$.

48. (b) $\frac{x^2}{(30/2)} + \frac{y^2}{(30/3)} = 1 \Rightarrow \frac{x^2}{15} + \frac{y^2}{10} = 1$.

49. (c) $\frac{2b^2}{a} = 8,\ e = \frac{1}{\sqrt{2}} \Rightarrow a^2 = 64, b^2 = 32$

Hence required equation of ellipse is $\frac{x^2}{64} + \frac{y^2}{32} = 1$.

50. (d) Major axis = 3(Minor axis)

$\Rightarrow 2a = 3(2b) \Rightarrow a^2 = 9b^2 = 9a^2(1 - e^2) \Rightarrow e = \frac{2\sqrt{2}}{3}$

51. (b) $\frac{x^2}{2-r} + \frac{y^2}{r-5} + 1 = 0 \Rightarrow \frac{x^2}{r-2} + \frac{y^2}{5-r} = 1$
Hence $r > 2$ and $r < 5 \Rightarrow 2 < r < 5$.

52. (c) Given ellipse is $\frac{x^2}{\left(\frac{1}{3}\right)^2} + \frac{y^2}{\left(\frac{1}{2}\right)^2} = 1$

Here $b > a$; $\therefore$ Latus rectum $= \frac{2a^2}{b} = \frac{2 \times \frac{1}{9}}{\frac{1}{2}} = \frac{4}{9}$.

53. (c) Equation of the curve is $\frac{x^2}{5^2}+\frac{y^2}{4^2}=1$

$\Rightarrow -5 \le x \le 5,\ -4 \le y \le 4$

$PF_1 + PF_2 = \sqrt{[(x-3)^2+y^2]}+\sqrt{[(x+3)^2+y^2]}$

$=\sqrt{(x-3)^2+\frac{400-16x^2}{25}}+\sqrt{(x+3)^2+\frac{400-16x^2}{25}}$

$=\frac{1}{5}\left\{\sqrt{(9x^2+625-150x)}+\sqrt{(9x^2+625+150x)}\right\}$

$=\frac{1}{5}\left\{\sqrt{(3x-25)^2}+\sqrt{(3x+25)^2}\right\}=\frac{1}{5}\{25-3x+3x+25\}$

$=10$, $(\because 25-3x>0, 25+3x>0)$

54. (a) $\frac{x^2}{9}+\frac{y^2}{16}=(1+\sin 2t)+(1-\sin 2t)=2$.

55. (c) $E \equiv 4+9(3)^2-16(1)-54(3)+61<0$

Therefore, the point is inside the ellipse.

$\frac{4(x-2)^2}{36}+\frac{9(y-3)^2}{36}=1$

Equation of major axis is $y-3=0$ and point (1, 3) lies on it.

56. (c) Given equation of hyperbola, $\frac{x^2}{4}-\frac{y^2}{(16/9)}=1$,

$\therefore a=2,\ b=\frac{4}{3}$. As we know, $b^2=a^2(e^2-1)$

$\Rightarrow \frac{16}{9}=4(e^2-1)\Rightarrow e^2=\frac{13}{9}$, $\therefore e=\frac{\sqrt{13}}{3}$.

57. (c) The equation of hyperbola is $\frac{x^2}{16}-\frac{y^2}{9}=1$

Now $b^2=a^2(e^2-1)\Rightarrow e=\frac{5}{4}$

Hence foci are $(\pm ae, 0) \Rightarrow \left(\pm 4.\frac{5}{4}, 0\right)$ *i.e.*, $(\pm 5, 0)$.

58. (c) Using the condition the point (x_1, y_1) lies

(i) On the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}-1=0$ if

$$\frac{x_1^2}{a^2}+\frac{y_1^2}{b^2}-1=0$$

(ii) Outside the ellipse if $\frac{x_1^2}{a^2}+\frac{y_1^2}{b^2}-1>0$

(iii) Inside the ellipse if $\frac{x_1^2}{a^2}+\frac{y_1^2}{b^2}-1<0$

Given ellipse is $\frac{x^2}{1/4}+\frac{y^2}{1/5}=1$

$\therefore \frac{16}{1/4}+\frac{9}{1/5}-1=64+45-1>0$

Point (4, –3) lies outside the ellipse.

59. (a) $e=\sqrt{1+\frac{b^2}{a^2}} \Rightarrow e^2=\frac{a^2+b^2}{a^2}$

$e_1=\sqrt{1+\frac{a^2}{b^2}} \Rightarrow e_1^2=\frac{b^2+a^2}{b^2} \Rightarrow \frac{1}{e_1^2}+\frac{1}{e^2}=1$.

60. (d) For hyperbola $\Delta \neq 0$ and $h^2>ab$. Here $\Delta=0$.