

WEEKLY TEST RANKER'S BATCH-02 TEST - 04 Balliwala
SOLUTION Date 06-10-2019

[PHYSICS]

- 1.
- 2.
- 3.

$$P = d(hg + la).$$

Now, h and l are maximum at point B . So, P_B is maximum. Further $h = 0$ and $l = 0$ at point D . So, P_D is minimum.

4. According to $\tan \theta = \frac{a}{g}$.

In the present problem, $\tan \theta = \frac{h}{l}$

So, $\frac{h}{l} = \frac{a}{g}$ or $h = \frac{al}{g}$

5. In a mercury barometer at equilibrium, the weight of mercury column with barometric height over a unit area inside the tube is equal to the weight of air column above unit area of the free surface of mercury outside the tube. Hence, mass of mercury column with barometric height is equal to mass of air column above unit area of free surface of mercury. Hence, change in g does not change the height of mercury column in the barometer.

6. Let P_1 and P_2 be the pressures at the bottom of the left end and right end of the tube respectively. Then,

$$F = (P_1 - P_2)A = \rho ghA$$

Where, A is the cross-section of the tube.

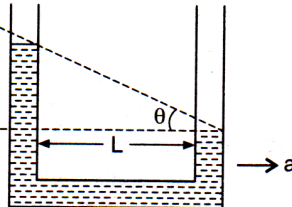
The mass of the liquid in the horizontal portion is,

$$m = \rho LA$$

Now, $F = ma$

So, $\rho ghA = \rho LAa$

$\therefore h = \frac{aL}{g}$



- 7.
- 8.
- 9.
- 10.

11. Pressure difference between lungs and atmosphere,
 $= 760 \text{ mm} - 750 \text{ mm} = 10 \text{ mm} = 1 \text{ cm of Hg} = 1 \times 13.6 \times g$
 $= l \times 1 \times g \text{ of water}$
i.e., one can draw from a depth of 13.6 cm of water.

- 12.

13.

14. In equilibrium, the pressure of liquid at the same level must be equal. Considering pressure at level D in both arms of U-tube. Pressure of h cm of oil + pressure of $(20 - h)$ cm of mercury = pressure of 20 cm of carbon tetrachloride,

$$h \times 0.9 \times g + (20 - h) \times 13.6 \times g = 20 \times 1.6 \times g$$

or $0.9h + 272 - 13.6h = 32$

or $12.7h = 240$

or $h = \frac{240}{12.7} = 18.9 \text{ cm.}$

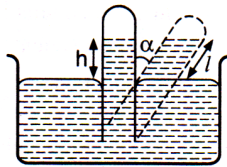
15.

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17. The vertical height of mercury level in a barometer does not change.

$$\frac{h}{l} = \cos \alpha$$

or $l = \frac{h}{\cos \alpha}.$



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21. (b) Let V be the total volume of the ball and v be the volume of the ball in the upper liquid. Then $V - v$ is the volume of the lower liquid displaced.

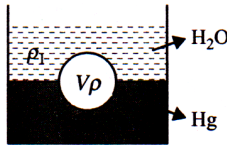
Using the law of floatation, we have

$$V\rho g = v\rho_1 g + (V - v)\rho_2 g$$

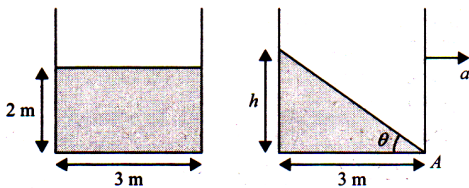
$$V\rho = v\rho_1 + V\rho_2 - v\rho_2$$

or $V(\rho - \rho_2) = v(\rho_1 - \rho_2)$

$$\frac{v}{V} = \frac{\rho - \rho_2}{\rho_1 - \rho_2} = \frac{\rho_2 - \rho}{\rho_2 - \rho_1}$$



22. (b)



Volume equality gives

$$2 \times 3 = \frac{1}{2} \times h \times 3 \Rightarrow h = 4 \text{ m}$$

$$\therefore \tan \theta = \frac{4}{3} = \frac{a}{g} \Rightarrow a = \frac{4}{3}g$$

23. (a) W = weight of liquid.
 f_B = buoyant force on the ball
 mg = weight of the ball
 N = normal reaction between the ball and the surface
 The free-body diagrams of the balls in each vessel are as follows.

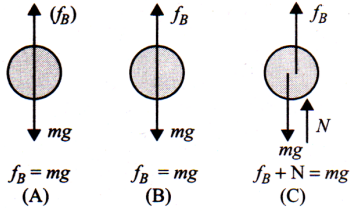


Fig. S11.13

At base, reaction force of buoyant force will act in downward direction.

The forces acting at the base of each tank are

$$F_A = W + f_B = W + mg$$

$$F_B = W + f_B = W + mg$$

$$F_C = W + f_B + N = W + mg$$

Thus, $F_A = F_B = F_C$

24. (c) Pressure at the bottom level of the block

$$P = \frac{mg}{a} + P_0$$

The pressure at the same level remains the same.

$$\text{Hence, } \frac{mg}{a} + P_0 = h\rho g + P_0 \Rightarrow h = \frac{m}{a\rho}$$

25. (d)

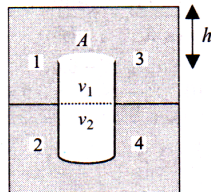


Fig. S11.25

$\rho_1 v_1 g$ is not the force applied by liquid 1 on body, it is $\rho_1 g h \times A$, although net force (buoyant) comes out to be $\rho_1 v_1 g + \rho_2 v_2 g$.

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28. (a) According to Pascal's law, the pressure at bottom of each vessels containing liquid in equilibrium of rest is the same.

$$P_1 = P_2 = P_3$$

$$\text{Hence } F_1 = F_2 = F_3$$

29. (a) Since the net buoyant force on the brick completely submerged in water is independent of its depth below the water surface, the man will have to exert the same force on both the bricks. Hence, Statement I is true, Statement II is true; Statement II is a correct explanation for Statement I.

30. (b) The density of concrete, of course, is more than that of water and block of concrete will sink like a stone if dropped into water. Concrete cargo were filled with air and as such, average density of cargo vessels is given by

$$\frac{\text{Mass of concrete} + \text{mass of air}}{\text{Volume of concrete} + \text{volume of air}}$$

31. For a hollow body, as $V_{\text{body}} > V_{\text{sub.}}$, hence density of body is less than that of substance.

32.
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34. We know that fluids move from higher pressure to lower pressure and in a fluid pressure increases with depth; so pressure at top ($= P_0$) is lesser than at the bottom ($P_0 + h\rho g$) and so the air bubble will move from bottom to top (it cannot move sideways as the pressure at same level in a fluid is same). Furthermore, in coming from bottom to top, pressure decreases; so in accordance with Boyle's law, *i.e.*, $PV = \text{constant}$, volume will increase, *i.e.*, bubble will grow in size.

35.

36. Specific gravity of alloy = $\frac{\text{mass of alloy}}{\text{volume of alloy}} \times \text{density of water}$

$$s_{\text{alloy}} = \frac{m_1 + m_2}{\left(\frac{m_1}{d_1} + \frac{m_2}{d_2}\right) \times d_w} = \frac{m_1 + m_2}{\left[\frac{m_1}{d_1/d_w} + \frac{m_2}{d_2/d_w}\right]} = \frac{m_1 + m_2}{\left(\frac{m_1}{s_1} + \frac{m_2}{s_2}\right)}$$

37. As the body floats completely immersed in water, hence

$$W_{\text{body}} = W_{\text{displaced water}} \\ = \text{weight of 100 cc of water}$$

or mass of body = mass of 100 cc of water = 100 g

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41. Applying Bernoulli's theorem, we have

$$\frac{P}{\rho} + \frac{1}{2}(v')^2 + gh = \frac{P}{\rho} + \frac{1}{2}v^2 + 0$$

where v' is the velocity of all surfaces of liquid and v the velocity of efflux.

Further, from continuity equation,

$$Av' = av \quad \text{or} \quad v' = \frac{av}{A}$$

$$\therefore \frac{1}{2} \left(\frac{av}{A}\right)^2 + gh = \frac{1}{2}v^2$$

$$\therefore v = \sqrt{2gh} \sqrt{\left(\frac{A^2 - a^2}{A^2}\right)}$$

42.
43.
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45.

CHEMISTRY

$$46. (c) : \text{Rate} = -\frac{d[\text{N}_2\text{O}_5]}{dt} = +\frac{1}{2} \frac{d[\text{NO}_2]}{dt}$$

$$= 2 \frac{d[\text{O}_2]}{dt}$$

$$\text{Given } -\frac{d[\text{N}_2\text{O}_5]}{dt} = 6.25 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

Rate of formation of NO_2

$$= \frac{[\text{NO}_2]}{dt} = -2 \frac{d[\text{N}_2\text{O}_5]}{dt}$$

$$= 2 \times 6.25 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

$$= 12.50 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

$$= 1.25 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$$

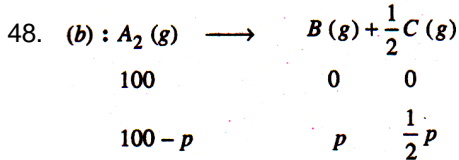
Rate of formation of O_2

$$= \frac{d[\text{O}_2]}{dt} = -\frac{1}{2} \frac{d[\text{N}_2\text{O}_5]}{dt}$$

$$= \frac{1}{2} \times 6.25 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

$$= 3.125 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$$

47. (b) : Minus signs are for reactants and positive signs for products. Dividing numbers are the coefficients.



$$100 - p + p + \frac{1}{2} p = 120 \text{ or } p = 40 \text{ mm}$$

$$\therefore -\frac{dp_{\text{A}_2}}{dt} = \frac{40}{5} = 8 \text{ mm min}^{-1}$$

49. (c) : Initially, Rate = $k [\text{Y}] [\text{Z}]^{1/2}$
 New rate = $k [\text{Y}] [2 \text{Z}]^{1/2}$
 $= \sqrt{2} k [\text{Y}] [\text{Z}]^{1/2} = 1.414 k [\text{Y}] [\text{Z}]^{1/2}$.
50. (d) : The rate of reaction is same as expressed in terms of any reactant or product.
51. (a) : Rate of reaction = $\frac{1}{4} \frac{\Delta[\text{NO}_2]}{\Delta t}$
 $= \frac{1}{4} \times \frac{[5.2 \times 10^{-3} \text{ M}]}{100 \text{ s}} = 1.3 \times 10^{-5} \text{ M s}^{-1}$.
52. (b) : Rate = $k [\text{NO}]^2 [\text{O}_2]$. Initially rate = $ka^2 b$. If volume is reduced to half, concentration are doubled so that new rate
 $= k (2a)^2 (2b) = 8ka^2 b$, i.e., 8 times.



53. (b) : For zero order reaction, $k = \frac{1}{t} \{ [A]_0 - [A] \}$
 or $[A] = -kt + [A]_0$. Thus, plot of $[A]$ vs t is linear with -ve slope ($= -k$).

54. (c) : From slow step, rate $= k [B_2] [A]$.

$$\text{From 1st eqn, } K_{eq} = \frac{[A]^2}{[A_2]}$$

$$\text{or } [A] = \sqrt{K_{eq} [A_2]} = K_{eq}^{1/2} [A_2]^{1/2}$$

$$\begin{aligned} \text{Hence, rate} &= k [B_2] K_{eq}^{1/2} [A_2]^{1/2} \\ &= k' [A_2]^{1/2} [B_2]. \end{aligned}$$

$$\text{Hence, order} = 1\frac{1}{2}.$$

55. (c) : On the basis of given units of k , the reaction is of 3rd order.

56. (d) : $r = k [A]^\alpha [B]^\beta = k a^\alpha b^\beta$. If concentration of B is doubled, $\frac{r}{4} = k a^\alpha (2b)^\beta$. Dividing 2nd eqn. by 1st eqn.,

$$\frac{1}{4} = 2^\beta \text{ or } 2\beta = 2^{-2}. \text{ Hence, } \beta = -2.$$

57. (a) : As step I is the slowest, hence it is the rate determining step.

58.

59. (d) : $k = \frac{2.303}{32} \log \frac{a}{a-0.99a}$
 $= \frac{2.303}{32} \log 10^2 = \frac{2.303}{16} \text{ min}^{-1}$
 $t_{99.9\%} = \frac{2.303}{k} \log \frac{a}{a-0.999a}$
 $= \frac{2.303}{k} \log 10^3 = \frac{3 \times 2.303}{2.303} \times 16$
 $= 48 \text{ min.}$

60. (b) : 0.08 mol L⁻¹ to 0.01 mol L⁻¹ involves 3 half-lives.

61. (d) : $k = \frac{2.303}{t} \log \frac{a}{a-x}$
 or $\log \frac{a}{a-x} = \frac{kt}{2.303} = \frac{2.2 \times 10^{-5} \times 60 \times 90}{2.303}$
 $= 0.0516.$

$$\text{Hence, } \frac{a}{a-x} = \text{antilog } 0.0516 = 1.127.$$

$$\text{or } \frac{a-x}{a} = 0.887 \text{ or } 1 - \frac{x}{a} = 0.887$$

$$\text{or } \frac{x}{a} = 0.113 = 11.3\%.$$

$$62. (c) : t_{90\%} = \frac{2.303}{k} \log \frac{a}{a - 0.9a}$$

$$= \frac{2.303}{k} \log 10 = \frac{2.303}{k}$$

$$t_{1/2} = \frac{2.303}{k} \log \frac{2}{a - a/2}$$

$$= \frac{2.303}{k} \log 2 = \frac{2.303}{k} \times 0.3010$$

$$\therefore t_{90\%}/t_{1/2} = \frac{1}{0.3010} = 3.3$$

i.e., $t_{90\%} = 3.3$ times $t_{1/2}$.

63. (a) : Decrease in concentration from 0.8 M to 0.4 M in 15 minutes means $t_{1/2} = 15$ minutes. Time taken for decrease in concentration from 0.1 M to 0.25 M means two half-lives, *i.e.*, $= 2 \times 15 \text{ min} = 30 \text{ min}$.

64. (c) : $t_{1/2} \propto \frac{1}{a^{n-1}}$ For $n = 2$, $t_{1/2} \propto \frac{1}{a}$

65. (c) : At the point of intersection, $[A] = [B]$, *i.e.*, half of the reactant has reacted. Hence, it represents $t_{1/2}$.

66. (a) : It P_t is the pressure after time t ,

$$k = \frac{2.303}{t} \log \frac{P_0}{P_t}$$

$$\therefore 3.38 \times 10^{-5} \text{ s}^{-1} = \frac{2.303}{600 \text{ s}} \log \frac{500 \text{ atm}}{P_t}$$

$$\text{or } \log \frac{500}{P_t} = 0.0088 \text{ or } \frac{500}{P_t} = 1.021$$

$$\text{or } P_t = 490 \text{ atm}$$

67. (a) : $[A]$ is kept constant, $[B]$ is doubled, rate is doubled. So rate $\propto [B]$.

$[B]$ is kept constant, $[A]$ is tripled, rate becomes 9 times, so rate $\propto [A]^2$.

Hence, rate law is

$$\text{rate} = k [A]^2 [B]$$

68. (a) : $t_{1/2} \propto a^{1-n}$. Hence, $t_{1/2} \propto 1/a^3$ only when $n = 4$.

69. (c) : In presence of acid, hydrolysis of ethyl acetate is a pseudo-unimolecular reaction but the actual value of k depends upon the concentration of H^+ ion. As H_2SO_4 is stronger acid than HCl and moreover H^+ ions produced from 0.05 M H_2SO_4 are double than those produced from 0.05 M HCl , therefore $k_2 > k_1$ or $k_1 < k_2$.



$$70. (b) : k = \frac{2.303}{t} \log \frac{V_{\infty}}{V_{\infty} - V_t}$$

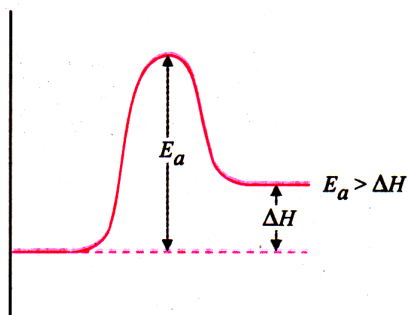
gives constant value of k .

Hence, it is 1st order reaction.

71. (b) : With increase in temperature, number of activated molecules increases.

72. (b) : As $k' > k''$, $E_a' < E_a''$ (Greater the rate constant, less in the activation energy).

73. (c) :



74. (d) : Lower the activation energy, faster is the reaction. Hence, relative ease of P , Q and R will be $R > Q > P$.

75. (d) : All the given statements are correct according to collision theory.

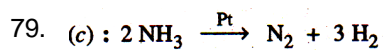
76. (d) : Activation energy of a particular reaction is constant temperature.

77. (c) : Small increase in $e^{-E/RT}$ resulting in large increase in k is due to high value of A .

$$78. (d) : \% \text{ of B} = \frac{k_1}{k_1 + k_2}$$

$$= \frac{1.26 \times 10^{-4}}{1.26 \times 10^{-4} + 3.8 \times 10^{-5}} \times 100$$

$$= \frac{1.26 \times 10^{-4}}{10^{-4}(1.26 + 0.38)} \times 100 = 76.83\%$$



$$\text{Rate} = -\frac{1}{2} \frac{d[\text{NH}_3]}{dt} = \frac{d[\text{N}_2]}{dt}$$

$$= \frac{1}{3} \frac{d[\text{H}_2]}{dt} = k = 2.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

Rate of production of H_2 ,

$$\frac{d[\text{H}_2]}{dt} = 3 \times 2.5 \times 10^{-4}$$

$$= 7.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$



80. (a) : In case I, fraction of A reacted = $\frac{0.6}{0.8} = \frac{3}{4}$

In case II, fraction of A reacted = $\frac{0.675}{0.9} = \frac{3}{4}$

For a first order reaction, time taken for the same fraction of reaction is independent of initial concentration.

81. (c) : The reaction occurring in two steps has two activation energy peaks.

The first step, being fast needs less activation energy. The second step, being slow, needs more activation energy. Therefore, second peak will be higher than the first.

82. (b) : Rate = $k [\text{NOBr}_2] [\text{NO}]$

From step I, $K_{eq} = \frac{[\text{NOBr}_2]}{[\text{NO}] [\text{Br}_2]}$

or $[\text{NOBr}_2] = K_{eq} [\text{NO}] [\text{Br}_2]$

Substituting in eqn. (i), we get

Rate = $k K_{eq} [\text{NO}]^2 [\text{Br}_2] = k' [\text{NO}]^2 [\text{Br}_2]$

Hence, order with respect to NO is 2.

83. (c) : 10.8 g of $\text{N}_2\text{O}_5 = \frac{10.8}{108}$ mole = 0.1 mole

No. of half-lives in 9.6 h = $\frac{9.6}{2.4} = 4$

Amount left after 4 half-lives

= $\frac{1}{2^4} \times 0.1 = \frac{0.1}{16}$ mole

Moles of N_2O_5 decomposed

= $0.1 - \frac{0.1}{16} = \frac{1.5}{16}$ mole

Moles of O_2 formed = $\frac{1}{2} \times \frac{1.5}{16} = \frac{1.5}{32}$

Volume of O_2 at STP = $\frac{1.5}{32} \times 22.4$ L = 1.05 L

84. (b) : $r = K [A]^\alpha = k a^\alpha$

$1.837 r = k (1.5 a)^\alpha$

Dividing, $1.837 = (1.5)^\alpha$

On solving, we get $\alpha = 1.5$

Hence order = 1.5

85. (a) : Half-life of a first order reaction does not depend upon initial concentration. It is equal to $\ln 2/k$.

86. (c) : Diagram (c) represents endothermic reaction with

$E_a = 200 - 150 = 50$ kJ and

$\Delta H = 50 - 150 = -100$ kJ.

87. (d) : If $E_a = 0$, $k = A e^{-E_a/RT} = A e^0 = A$. Hence, k becomes independent of T .

88. (d) : Given $\log k = 6 - \frac{2000}{T}$

$$\text{Comparing with } \log k = \log A - \frac{E_a}{2.303 RT}$$

$$\log A = 6, \text{ i.e., } A = 10^6$$

$$\text{and } \frac{E_a}{2.303 R} = 2000$$

$$\text{or } E_a = 2000 \times 2.303 \times 8.314 \text{ J mol}^{-1} \\ = 38294 \text{ J mol}^{-1} \approx 38.3 \text{ kJ mol}^{-1}$$

89.

90. (c) : t_{\max} represents time corresponding to maximum concentration of the intermediate R_2

The value of t_{\max} is given by the relation

$$t_{\max} = \frac{2.303}{(k_1 - k_2)} \log \frac{k_1}{k_2}$$

$$k_1 = 4.0 \times 10^{-2}$$

$$\therefore k_2 = 4.0 \times 10^{-2} \times 0.15 = 6 \times 10^{-3}$$

$$\therefore t_{\max} = \frac{2.303}{(4 - 0.6) 10^{-2}} \log \frac{4 \times 10^{-2}}{6 \times 10^{-3}}$$

$$= \frac{2.303}{3.4 \times 10^{-2}} \times 0.82 = 55.6 \text{ min}$$