WEEKLY TEST OYM TEST - 33 RAJPUR
SOLUTION Date 22-12-2019

[PHYSICS]

6. To find the relative velocity of bird w.r.t. train, superimpose velocity $-\vec{V}_T$ on both the objects. Now as a result of it, the train is at rest, while the bird possesses two velocities, $\vec{V}_B$ towards north and $-\vec{V}_T$ along west.

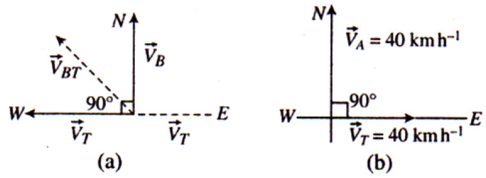


Fig. S3.22

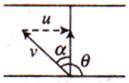
$$|\vec{V}_{BT}| = \sqrt{|\vec{V}_B|^2 + |-\vec{V}_T|^2} \qquad \text{[By formula, } \theta = 90°\text{]}$$

$$= \sqrt{40^2 + 40^2} = 40\sqrt{2} \text{ km h}^{-1} \text{ north–west}$$

7. Relative velocity of boat with respect to water is

$$\vec{v}_b - \vec{v}_w = 3\hat{i} + 4\hat{j} - (-3\hat{i} - 4\hat{j}) = 6\hat{i} + 8\hat{j}$$

8. Relative velocity of bird with respect to train is



$$V_{BT} = V_B + V_T = 5 + 10 = 15 \text{ ms}^{-1}$$

[Because they are going in opposite directions]

Time taken by the bird to cross the train is $\frac{150}{5} = 10$ s

9. The time taken to reach the ground depends on the height from which the bullets are fired when the bullets are fired horizontally. Here height is same for both the bullets, and hence the bullets will reach the ground simultaneously.

10. $$\frac{R}{T^2} = \frac{u^2 \sin 2\theta / g}{4u^2 \sin^2 \theta / g^2} = \frac{g}{2}\cot\theta$$

i.e., $gT^2 = 2R\tan\theta$

If T is doubled, then R becomes 4 times.

11. For the person to be able to catch the ball, the horizontal component of velocity of the ball should be same as the speed of the person, i.e.,

$$v_0 \cos\theta = \frac{v_0}{2} \quad \text{or} \quad \cos\theta = \frac{1}{2} \quad \text{or} \quad \theta = 60°$$

12. Let $u_x = 3\ \text{m s}^{-1}$, $a_x = 0$

$v_y = u_y + a_y t = 0 + 1 \times 4 = 4\ \text{m s}^{-1}$

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{3^2 + 4^2}$$

Angle made by the resultant velocity w.r.t. direction of initial velocity, i.e., x-axis, is

$$\beta = \tan^{-1}\frac{v_y}{v_x} = \tan^{-1}\frac{4}{3}$$

13. Range $= 150 = ut$ and $h = \frac{15}{100} = \frac{1}{2} \times gt^2$

or $t^2 = \frac{2 \times 15}{100 \times g} = \frac{30}{1000}$ or $t = \frac{\sqrt{3}}{10}$

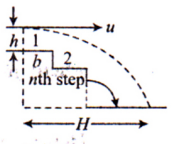
$$u = \frac{150}{t} = \frac{150 \times 10}{\sqrt{3}} = 500\sqrt{3}\ \text{m s}^{-1}$$

14. $$\frac{R}{T^2} = g\frac{\sin 2\theta}{4\sin^2\theta} = \frac{g}{2}\cot\theta = 5\cot\theta$$

Given $\frac{R}{T^2} = 5$; Hence, $5 = 5\cot\theta$ or $\theta = 45°$

15. If the ball hits the nth step, then horizontal distance traversed $= nh$. Here, velocity along horizontal direction $= u.n = ut$ (i)

Initial velocity along vertical direction is 0.



$$nh = 0 + \frac{1}{2}gt^2 \qquad \text{(ii)}$$

16. Suppose the angle made by the instantaneous velocity with the horizontal be α. Then

$$\tan\alpha = \frac{v_y}{v_x} = \frac{u\sin\theta - gt}{u\cos\theta}$$

Given that $\alpha = 45°$, when $t = 1$ s; $\alpha = 0°$, when $t = 2$ s

This gives $u\cos\theta = u\sin\theta - g$ (i)

and $u\sin\theta - 2g = 0$ (ii)

Solving Eqs. (i) and (ii), we find $u\sin\theta = 2g$ and $u\cos\theta = g$.

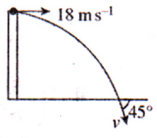
Squaring and adding,

$$u = \sqrt{5}g = 10\sqrt{5}\ \text{m s}^{-1}$$

17. $v\cos 45° = u = 18\ \text{m s}^{-1}$

$\Rightarrow \quad v = 18\sqrt{2}\ \text{m s}^{-1}$

Vertical component



$$v\sin 45° = 18\sqrt{2} \times \frac{1}{\sqrt{2}} = 18\ \text{m s}^{-1}$$

18. $v_x = u_x = 100\ \text{m s}^{-1}$, $v_y = u_y + a_y t = 0 + 10 \times 10$

$$\tan\theta = \frac{v_y}{v_x} = \frac{100}{100} = 1 \quad \Rightarrow \quad \theta = 45^\circ$$

19. $u_x = 16\cos 60^\circ = 8\ \text{m s}^{-1}$

Time taken to reach the wall = 8/8 = 1 s

Now $u_y = 16\sin 60^\circ = 8\sqrt{3}\ \text{m s}^{-1}$

$$h = 8\sqrt{3} \times 1 - \frac{1}{2} \times 10 \times 1 = 13.86 - 5 = 8.9\ \text{m}$$

20. Given $\frac{\sqrt{3}u}{2} = u\cos\theta$ = speed at maximum height

or $\cos\theta = \frac{\sqrt{3}}{2}$ or $\theta = 30^\circ$ (i)

Given that $PH_{max} = R$ (ii)

We know $H_{max} = \frac{R\tan\theta}{4}$

$$P = \frac{R}{H_{max}} = \frac{4}{\tan\theta} = \frac{4}{\tan 30^\circ} = 4\sqrt{3}$$

[CHEMISTRY]

21. **(b)** Associated colloids or micelles are formed by macro ions

22. D

23. **(c)**
$$t_{1/4} = \frac{2.303}{k}\log\frac{[A]_0}{3[A]_0/4}$$
$$= \frac{2.303}{k}[\log 4 - \log 3]$$
$$= \frac{2.303}{k}[0.6021 - 0.4771]$$
$$= \frac{2.303 \times 0.125}{k}$$
$$= \frac{0.2878}{k} \approx \frac{\mathbf{0.29}}{\boldsymbol{k}}$$

24. **(c)** When the volume of vessel is halved, the concentrations go doubled up.

$$\frac{r_{new}}{r} = \frac{k[2A][2B]^2}{k[A][B]^2} = 2 \times 2^2 = \mathbf{8}$$

25. **(d)** **w. r. t. P :**

$t_{75\%} = 2t_{50\%} \Rightarrow 1^{st}$ order kinetics

w. r. t. Q :

Graph between concentration and time is straight line with $-ve$ slope $\Rightarrow$ Zero order kinetics

Overall order = 1 + 0 = **1**.

26. D

27. **(d)** For weak acid, $\alpha = \frac{i-1}{n-1}$

$\Rightarrow \quad 0.3 = \frac{i-1}{2-1} \Rightarrow i = 1.3$

$\Delta T_f = iK_f m = 1.3 \times 1.86 \times 0.1 = 0.24°\,C$

Freezing point of solution = 0 – 0.24 = **– 0.24°C**

28. **(a)** $4r = \sqrt{2}\,a$

$2r = \frac{\sqrt{2}}{2} \times 408 =$ **288.5 pm**

29. **(b)** One Sr^{2+} creates one vacancy at site of $Na^{\oplus}$.

100 moles of $Na^{\oplus} = 10^{-4}$ mole vacancies (= moles of $Sr^{2\oplus}$)

1 mol of $Na^{\oplus} = \frac{10^{-4}}{100} \times 6.02 \times 10^{23} =$ **6.02×10^{17} mol^{-1}**.

30. **(b)** Let $Fe^{3+} = x$ number

so, $Fe^{2+} = 0.93 - x$

Balancing charge, $3x + 2\,(0.93 - x) = 2 \quad \Rightarrow \quad x = 0.14$

Fe^{3+}% by weight $= \frac{(0.14 \times 56) \times 100}{(0.93 \times 56) + 16} = \frac{784}{68.08} =$ **11.52%**

31. **(a)** One unit cell in NaCl lattice has 4 NaCl formula units.

4×58.5 g NaCl = 6.02×10^{23} unit cells

1 g NaCl $= \frac{6.02 \times 10^{23}}{4 \times 58.5} =$ **2.57×10^{21} unit cells**

32. **(d)** Higher the reduction potential, easier is the gain of electrons.

33. A

34. B

35. **(c)** On adding equations (i) and (ii)

$$Cu^{2+} + e^- \longrightarrow Cu^+$$
$$\underline{Cu^+ + e^- \longrightarrow Cu}$$
$$\underline{Cu^{2+} + 2e^- \longrightarrow Cu}$$

or $\quad Cu^{2+} \xrightarrow{e^-_{(i)}} Cu^+ \xrightarrow{e^-_{(ii)}} Cu$, with $2e^-_{(iii)}$ from Cu^{2+} to Cu

$(-nFE)_{iii} = (-nFE)_i + (-nFE)_{ii}$

$2 \times E^0_{iii} = 1 \times 0.15 + 1 \times 0.50$

$E^0_{iii} = \frac{0.65}{2} =$ **0.325 V**

36. **(a)** O.N. of Mn in MnO_4^{2-} and MnO_4^- are respectively +6 and +7 involving loss of $1e^-$.
1 mol of MnO_4^{2-} requires 1F or 96500C, 0.1 mol of MnO_4^{2-} requires 96500×0.1C or 9650 C.

37. B

38. **(d)** $\text{Molarity} = \dfrac{10 \times x\% \times d}{M_B} = \dfrac{10 \times 98 \times 1.8}{98} = 18$

$$V = \frac{M'V'(\text{dilute})}{M(\text{conc.})} = \frac{1000 \times 0.1}{18} = \mathbf{5.55\ mL}$$

39. **(c)** 1000 mL of 0.5 M $K_4[Fe(CN)_6] = 0.5 \times 6$ mole N atoms
$= 3 \times 6.02 \times 10^{23}$ N atoms

$$100 \text{ mL of the same solution} = \frac{3 \times 6.02 \times 10^{23} \times 100}{1000}$$
$$= \mathbf{1.806 \times 10^{23}\ N\ atoms}$$

40. **(a)** $k = Ae^{-\frac{E_a}{RT}}$

For $T_1 = T_2 = T$ and $k_1 = k_2$, we have

$$10^{15} e^{-\frac{1000}{T}} = 10^{16} e^{-\frac{2000}{T}}$$

$$e^{-\frac{1000}{T}} = 10e^{-\frac{2000}{T}}$$

$$10 = (e^{-\frac{1000}{T}})/(e^{-\frac{2000}{T}}) = [e]^{\left(-\frac{1000}{T}\right)+\left(\frac{2000}{T}\right)}$$

$$(e)^{2.303} = (e)^{\frac{1000}{T}} \Rightarrow T = \frac{\mathbf{1000}}{\mathbf{2.303}}\mathbf{K}$$