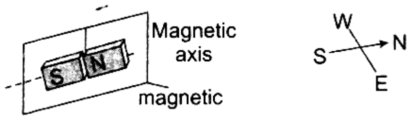
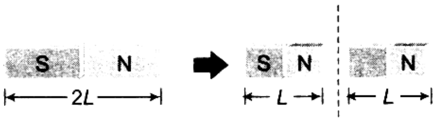
WEEKLY TEST MEDICAL PLUS - 01 & 02 B
SOLUTION Date 19 -01-2020

[PHYSICS]

1. **(a)**



2. **(c)**

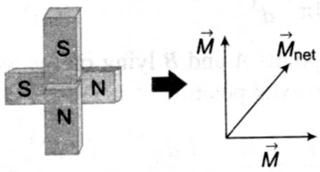


Pole strength of each part = m

Magnetic moment of each part

$$= M' = m'L' = mL = \frac{M}{2}$$

3. **(b)**

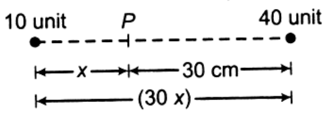


$$\Rightarrow \quad M_{net} = \sqrt{M^2 + M^2} = \sqrt{2}M$$

4. **(b)** Number of lines of force passing through per unit area normally is intensity of magnetic field, hence option (c) is incorrect. The correct option is (b).

5.

(b) Suppose magnetic field is zero at point P. Which lies at a distance x from 10 unit pole. Hence, at P



$$\frac{\mu_0}{4\pi} \cdot \frac{10}{x^2} = \frac{\mu_0}{4\pi} \cdot \frac{40}{(30-x)^2} \Rightarrow x = 10 \text{ cm}$$

So from stronger pole distance is 20 cm.

6.

(b) Magnetic intensity on end side on position is twice the broad side on position.

7.

(d) For a magnet $B = \frac{\mu_0}{4\pi}.\frac{2M}{x^3}$ (Nearly)

$\Rightarrow \frac{B_1}{B_2} = \left(\frac{x_1}{x_2}\right)^3 = \left(\frac{x}{2x}\right)^3 = \frac{1}{8}$ (Approx.)

8. **(c)** $B_1 = \frac{2M}{d^3}.B_2 = \frac{M}{d^3}$; $\therefore \frac{B_1}{B_2} = 2:1$

9. **(c)** For null deflection $\frac{M_1}{M_2} = \left(\frac{d_1}{d_2}\right)^3 = \left(\frac{40}{50}\right)^3 = \frac{64}{125}$

10. **(b)** $B_{\text{equatorial}} = \frac{\mu_0}{4\pi}\frac{M}{r^3}$

11.

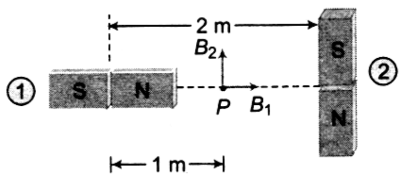
(b) Magnetic moment of circular loop carrying current

$$M = IA = I(\pi R^2) = I\pi\left(\frac{L}{2\pi}\right)^2 = \frac{IL^2}{4\pi} \Rightarrow L = \sqrt{\frac{4\pi M}{I}}$$

12.

(b) With respect to 1st magnet, P lies in end side-on position

$\therefore B_1 = \frac{\mu_0}{4\pi}\left(\frac{2M}{d^3}\right)$ (RHS)



With respect to 2nd magnet. P lies in broad side on position.

$\therefore B_2 = \frac{\mu_0}{4\pi}\left(\frac{M}{d^3}\right)$ (Upward)

$B_1 = 10^{-7} \times \frac{2\times1}{1} = 2\times10^{-7}T, B_2 = \frac{B_1}{2} = 10^{-7}T$

As B_1 and B_2 are mutually perpendicular, hence the resultant magnetic field

$B_R = \sqrt{B_1^2 + B_2^2} = \sqrt{(2\times10^{-7})^2 + (10^{-7})^2}$

$= \sqrt{5}\times10^{-7}T$

13. **(c)** In C.G.S. $B_{\text{axial}} = 9 = \frac{2M}{x^3}$ ... (i)

$B_{\text{equaterial}} = \frac{M}{\left(\frac{x}{2}\right)^3} = \frac{8M}{x^3}$ ... (ii)

From equations (i) and (ii) $B_{\text{equaterial}} = 36$ Gauss

14. **(a)** Torque $\tau = MB_H \sin\theta$

$= 0.1\times10^{-3}\times4\pi\times10^{-3}\times\sin30^o = 10^{-7}\times4\pi\times\frac{1}{2}$

$= 2\pi\times10^{-7}\,N\times m$

15. **(a)** $W = MB(\cos\theta_1 - \cos\theta_2) = MB(\cos0° - \cos60°)$

$= MB\left(1-\frac{1}{2}\right) = \frac{MB}{2}$

and $\tau = MB\sin\theta = MB\sin60° = MB\frac{\sqrt{3}}{2}$

$\therefore\ \tau = \left(\frac{MB}{2}\right)\sqrt{3} \Rightarrow \tau = \sqrt{3}\,W$

16. **(d)** $W = MB(\cos\theta_1 - \cos\theta_2);\ \theta_1 = 0°$ and $\theta_2 = 360°$

$\Rightarrow\ W = 0$

17. **(b)** $W_1 = MB(\cos0° - \cos90°) = MB(1-0) = MB$

$W_2 = MB(\cos0° - \cos60°) = MB\left(1-\frac{1}{2}\right) = \frac{MB}{2}$

$\therefore\ W_1 = 2W_2 \Rightarrow n = 2$

18. **(b)** $\tau = MB\sin\theta$

$\tau = 200\times0.25\times\sin30° = 25\,N\times m.$

19. **(b)** $\vec{\tau} = \vec{M}\times\vec{B} \Rightarrow \vec{\tau} = 50\hat{i}\times(0.5\hat{i}+3\hat{j})$

$= 150(\hat{i}\times\hat{j}) = 150\,\hat{k}N\times m.$

20. **(c)** $\tau = MB\sin\theta \Rightarrow \tau \propto \sin\theta$

$\Rightarrow\ \frac{\tau_1}{\tau_2} = \frac{\sin\theta_1}{\sin\theta_2} \Rightarrow \frac{\tau}{\tau/2} = \frac{\sin90°}{\sin\theta_2}$

$\Rightarrow\ \sin\theta_2 = \frac{1}{2} \Rightarrow \theta_2 = 30°$

$\Rightarrow$ Angle of rotation $= 90° - 30 = 60°$

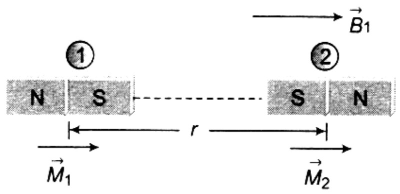
21.

(b) $W = MB(1-\cos\theta)$; where $\theta = 180°$

$\Rightarrow\ W = 2MB \Rightarrow W = 2\times2\times5\times10^{-3} = 2\times10^{-2}\,J$

22.

(d)



Both the magnets are placed in the field of one another, hence potential energy of dipole (2) is

$$U_2 = -M_2B_1\cos 0 = -M_2B_1 = M_2 \times \frac{\mu_0}{4\pi}.\frac{2M_1}{r^3}$$

By using $F = -\frac{dU}{dr}$, force on magnet (2) is

$$F_2 = -\frac{dU_2}{dr} = -\frac{d}{dr}\left(\frac{\mu_0}{4\pi}.\frac{2M_1M_2}{r^3}\right) = -\frac{\mu_0}{4\pi}.6\frac{M_1M_2}{r^4}$$

23. (C)
24. (D)
25. (C)

26. **(d)** $B_H = \sqrt{3}\, B_V$, also $\tan\theta = \frac{B_V}{B_H} = \frac{1}{\sqrt{3}} \Rightarrow \theta = 30°$

27.

(c)

$$\tan 30° = \frac{\tan\delta}{\cos\theta} \text{ or } \cos\theta = \frac{\tan\delta}{\tan 30°} = \sqrt{3}\tan\delta$$

Again, $\tan 45° = \frac{\tan\delta}{\sin\theta}$ or $\sin\theta = \tan\delta$

Now, $\sin^2\theta + \cos^2\theta = 1$

$\therefore\ \tan^2\delta + 3\tan^2\delta = 1$

or $\tan^2\delta\,\frac{1}{4}$ or $\tan\delta = \frac{1}{2}$

or $\frac{1}{\cot\delta} = \frac{1}{2}$ or $\delta = \cot^{-1}(2)$.

28. **(a)** Frequency $\nu \propto \sqrt{B_H}$
29. **(A)**
30. **(A)**
31.

$$\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2 \text{ or } \frac{v_1^2}{v_2^2} = \frac{m_2}{m_1} = 9 \text{ or } \frac{v_1}{v_2} = 3$$

$$\therefore\ \frac{p_1}{p_2} = \frac{m_1v_1}{m_2v_2} = \frac{1}{9}\times 3 = \frac{1}{3}.$$

32.

Work done by the upward lifting force relative to him will be zero because displacement relative to him is zero.

33.

Weight of overhanging part of the chain $= \frac{mg}{6}$

The weight acts at the centre of gravity of the overhanging part, *i.e.*, $\frac{l}{12}$ below the surface of the table.

Gain in potential energy $= \frac{mg}{6} \times \frac{l}{12} = \frac{mgl}{72}$

$\therefore$ Work done = gain in potential energy $= \frac{mgl}{72}$.

34.

Loss of KE = Gain in elastic PE

$$\frac{1}{2}mv^2 = \frac{1}{2}Kx^2$$

or $$0.5 \times (1.5)^2 = 50 \times x^2$$

$\therefore$ $$x^2 = \frac{0.5 \times (1.5)^2}{50} = \frac{(1.5)^2}{100}$$

$\therefore$ $$x = \frac{1.5}{10} = 0.15 \text{ m.}$$

35.

Initial kinetic energy of the body $= \frac{1}{2}mv^2 = \frac{1}{2}m(4)^2 = 8m$

Let at height h, the kinetic energy reduces to half, *i.e.*, it becomes $4m$. It is also equal to potential energy. Hence,

$$mgh = 4m \quad \text{or} \quad h = \frac{4}{g} = \frac{4}{10} = 0.4 \text{ m.}$$

36.

Kinetic energy $= \frac{1}{2}mv^2$

Further, $v^2 = u^2 + 2as = 0 + 2ad$

or $v^2 = 2\left(\frac{F}{m}\right)d$

$\therefore$ $\text{KE} = \frac{1}{2}m \times 2\frac{F}{m}d = Fd \quad \therefore \text{ KE} \propto d$

i.e., kinetic energy is independent of mass.

37.

Speed of the car, $v = 72 \text{ km/h} = 72 \times \frac{5}{18} = 20 \text{ m s}^{-1}$

$$\text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times 800 \times 400 = 400 \times 400 \text{ J}$$

$\therefore$ $$P = \frac{\text{KE}}{\text{time}} = \frac{400 \times 400}{32} = 5000 \text{ W} = 5 \text{ kW}.$$

38.
39.

$$\text{Stopping distance} = \frac{\frac{1}{2}mv^2}{\mu mg}$$

$$= \frac{\frac{1}{2m} \times m^2v^2}{\mu mg} = \frac{p^2}{2\mu m^2 g}.$$

40.

$$dU = -dW$$

dU = Change in potential energy

dW = Work done by conservative forces

Hence, work done by conservative forces on a system is equal to the negative of the change in potential energy.

41.

Tension in the string is along the radius of circular path adopted by the bob, while displacement of the bob is along the circumference of the path; hence again $\vec{F}$ and $\vec{s}$ are at 90° and so $W = 0$.

42.
43.
44.

At the highest point, $v = u\cos 45° = u/\sqrt{2}$

Because vertical component of the velocity of projection becomes zero at this point.

$$\therefore \ (\text{KE})_{\text{Highest point}} = \frac{1}{2}m\left(\frac{u}{\sqrt{2}}\right)^2 = \frac{1}{2}\left(\frac{1}{2}mu^2\right) = \frac{E}{2}$$

45.

We know that;

$$p = \sqrt{2mK} \quad \text{or} \quad K \propto p^2$$

$$\therefore \quad \frac{K_2}{K_1} = \frac{p_2^2}{p_1^2}$$

$$\text{or} \quad \frac{K_2 - K_1}{K_1} \times 100 = \left(\frac{p_2^2 - p_1^2}{p_1^2}\right) \times 100$$

$$\therefore \quad \% \text{ increase} = \left[\frac{(150)^2 - (100)^2}{(100)^2}\right] \times 100$$

$$= \frac{250 \times 50}{100} = 125\%$$

[CHEMISTRY]

46. The order of acid strength is RCOOH > HOH > ROH > HC≡CH
Electron-releasing alkyl group R in ROH makes it lesser acidic than H_2O.

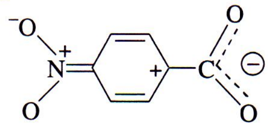
47. Nearer the chlorine to the —COOH group, stronger the acidity. Hence, the correct order is
$CH_3CH_2CHClCOOH > CH_3CHClCH_2COOH > CH_2ClCH_2CH_2COOH$

48. Larger the electronegativity of halogen, stronger the acidity. Hence, the correct order is
$FCH_2COOH > BrCH_2COOH > ICH_2COOH$

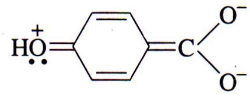
49. Tollens reagent gives white precipitate with methanoic acid and not with ethanoic acid.

50. Electron-releasing group makes benzoic acid a weaker acid while electron-attracting group makes it a stronger acid. Stronger the acid, lesser the value of pK_a°. Hence, the correct order is
$$pK_a^\circ(p\text{-}O_2NC_6H_4COOH) < pK_a^\circ(C_6H_5COOH) < pK_a^\circ(p\text{-}HOC_6H_4COOH)$$

51. The nitro group interacts with the phenyl ring and thereby induces some positive charge on the ring bearing the COO^- causing a strong electron-withdrawing inductive effects on COO^- group. This effect is base-stabilizing and thus acid strengthening.



52. At *para* position, —OH places negative charge on the carboxylate group and thus making it



weaker than bezoic acid. This effect predominates over its electron-withdrawing acid strengthening inductive effect. However, at *meta* position, there is no such resonance effect and only inductive effect operates and because of its nearness to the COOH group, *meta* isomer is stronger acid than its *para* isomer.

53. *Meta* hydroxy is stronger than *para* isomer (see Q.52). Because of the *ortho effect*, *ortho* isomer is the strongest acid.

54. Increasing crowdiness near the site of esterification decreases the rate of esterification. Hence, the correct order is $1° > 2° > 3°$.

55. Same as Q 54 The correct order is $RCH_2COOH > R_2CHCOOH > R_3CCOOH$

56. α-Hydrogen is replaced by chlorine. The product is $CH_3CH(Cl)COOH$.

57. Heating calcium formate along with calcium benzoate produces benzaldehyde.

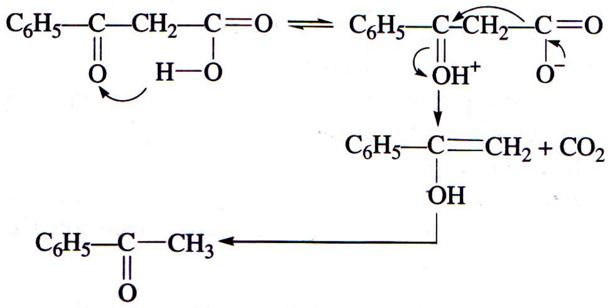
58. The products are CO and H_2O. $HCOOH \xrightarrow{\text{Conc. } H_2SO_4} CO + H_2O$.

59. The Hell-Volhard-Zelinsky reaction is used in the synthesis of α-haloacids.

60. In $p\text{-}CH_3COC_6H_4COOH$, the CO group is also reduced by $LiAlH_4$.

61. Succinic acid ($HOOCCH_2CH_2COOH$) gives cyclic anhydride on heating.

62. *β*-Ketoacids are unstable acids. These readily undergo decarboxylation through a cyclic transition state.



63.

64. Bromine is lesser electronegative than fluorine. Bromine attached to β-carbon will cause least enhancement in the dissociation of halo substituted propanoic acid.

65. Carboxylic acids have relatively high boiling points because of hydrogen bonds. Their boiling points are somewhat higher than those of alcohols of comparable molar masses. Since there exists no hydrogen bondings in aldehydes, their boiling points are lower than those of corresponding alcohols.

66. BH_3/THF followed by H_3O^+ reduces only —COOH group without affecting —CO— group. $LiAlH_4$ reduces only —COOH group without affecting C=C group.

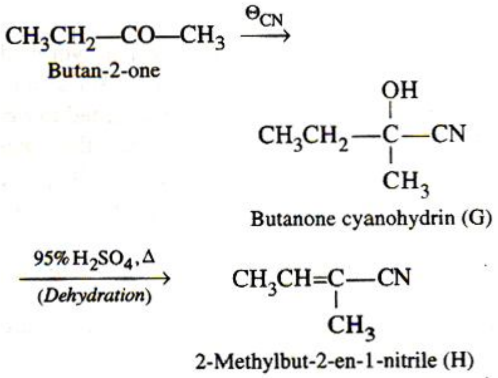
67. The order of reactivity is acid chloride > anhydride > ester.

68. The correct order is $Cl^- < RCOO^- < RO^-$.

69. The correct order is $Cl^- < RO^- < NH_2^-$.

70. Electron-withdrawal group increasing reactivity of hydrolysis while the electron-releasing group decreases reactivity. The correct order is p-$O_2NC_6H_4COCl$ > $PhCOCl$ > p-$CH_3OC_6H_4COCl$.

71. (a)
72. (a)
73. (b)
74. (b)
75. (a)
76.



Please note that hydrolysis of cyanides to carboxylic acids requires addition of a molecule of H_2O. *Since 95% H_2SO_4 cannot supply H_2O, therefore, dehydration of (G) occurs to give (H).*

77.

Due to ortho-effect, o-nitrobenzoic acid is the strongest acid. Further since electron-withdrawing groups such as NO_2 increase while electron-donating groups such as OH decrease the acid strength *w.r.t.* parent acid, therefore, the overall acidity increases in the order : C < D < B < A, *i.e.*, option (*d*) is correct.