SAMPLE PAPER-04

PHYSICS (Theory)

Class – XII

Time allowed: 3 hours Maximum Marks: 70

Solutions

1. To store the charge and electricity.

2. $v_d = \frac{i}{nAe} = v$

$v_d' = \frac{2i}{n(4A)e} = \frac{1}{2}\frac{i}{nAe} = \frac{v}{2}$

3. The next nucleus can decay any time.

4. Zero

5. The both the surfaces of sun glasses are curved. Also, $R_1 = R_2$

As $P = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

P = 0.

6. The electric dipole moment is defined as the product of either cahrge and the distance between the two charges.

$\vec{p} = q \times 2\vec{a}$, where 2a is the seperation between the two charges
It is a vector quantity.

7. (i) Electric field is due to charges at rest as well as in motion, whereas magnetic field is due to a magnet or current flowing through a conductor.

(ii) The strength of electric field at a point decreases with the dielectric medium but the strength of magnetic field increases when a prmeable medium is inserted there.
(iii) The electric lines of force representing the electric field do not form a closed path, whereas the magnetic lines of force form a close path.

8. v = 2 × 10^8 m/s, c = 3 × 10^8 m/s

$\mu = \frac{c}{v} = \frac{3\times10^8}{2\times10^8} = 1.5$

Real depth, x = 6.0 cm, Apparent depth, y = ?

$\mu = \frac{x}{y}$

$y = \frac{x}{\mu} = \frac{6}{1.5} = 4$ cm

Rise in the position of the dot = x – y = 6 – 4 = 2 cm

9. 9: $E = h\nu - \phi_0$

$2\ eV = 8\ eV - \phi_0$

Or, $\phi_0 = 8 - 2 = 6\ eV$

Now, $E` = h\nu` - \phi_0 = h \times 1.25\nu_0 - \phi_0 = 1.25 \times 8 - 6 = 4\ eV$.

10. In FM transmission, message is in the form of frequency variation of carrier waves. During the process of modulation, noise gets amplitude modulated, changing the amplitude of carrier waves. Obviously, the message signal, in the form of frequency variations, is not affected. That is why FM signal is less susceptible to noise than an AM signal.

11. (a) It is defined as the total energy stored per unit volume of the capacitor.

Expression:

$$u = \frac{\text{total energy(U)}}{\text{volume(V)}} = \frac{\frac{1}{2}CV^2}{Ad} = \frac{1}{2}\left(\frac{\epsilon_0 A}{d}\right)\left(\frac{E^2 d^2}{Ad}\right)$$

$$u = \frac{1}{2}\epsilon_0 E^2$$

(b) C = 2 Farad, d = 0.5 cm = 5×10^{-3} m, $\epsilon_0 = 8.85 \times 10^{-12}\ C^2N^{-1}m^{-2}$, A = ?

$$C = \frac{\epsilon_0 A}{d}$$

$$A = \frac{Cd}{\epsilon_0} = \frac{2 \times 5 \times 10^{-3}}{8.85 \times 10^{-12}} = 1.13 \times 10^9\ m^2.$$

12. (a) As we know that the numbers for yellow, red and orange are 4, 2 and 3. Gold represents tolerance of ± 5%.

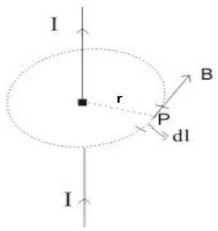
Thus, the value of resistance is $42 \times 10^3\ \Omega \pm 5\%$.

(b) A thermistor is a heat sensitive device whose resistivity changes very rapidly with change of temperature.

13. It states that the line integral of magnetic field induction $\vec{B}$ around a closed path in vacuum is equal to μ_0 times the total current I threading the closed path.

Expression for the magnetic field:

Consider an infinite long straight wire lying in the plane of paper. Let I be the current flowing through it from X to Y. A magnetic field is produced which is has the same magnitude at all the points that are at the same distance from the wire, i.e., the magnetic field has cylindrical symmetry around the wire.



Let P be a point at a perpendicular distance r from the straight wire and $\vec{B}$ be the magnetic field at point P. Now consider an ampereian loop as a circle of radius r, perpendicular to the plane of paper with centre on the wire such that point P lies on the loop. The magnitude of the magnetic field is same at all points on this loop. The magnetic field is tangential to the circumference of the circular loop. The line integral $\vec{B}$ round the closed loop is:

$$\oint \vec{B}.d\vec{l} = \oint B\,dl\,Cos0° = B\oint dl = B\,2\pi r$$

Now by using the Ampere's circuital law

$$\oint \vec{B}.d\vec{l} = \mu_0 I$$

$$B\,2\pi r = \mu_0 I$$

or $$B = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0}{4\pi}\frac{2I}{r}$$,

14. (a) It is the defect of human eye by virtue of which the eye can see clearly the far off objects but the nearby objects cannot be seen clearly. In case of hypermetropia, the near point shifts away from the eye.

The main causes of this defect is:
(i) contraction in the size of the eye ball (ii) increase in the focal length of eye lens.
To correct this defect, the person has to use the spectacles with convex lens of suitable focal length.
(b) u = - 25 cm, v = - 100 cm, f = ?
By using lens equation,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f} = \frac{1}{25} - \frac{1}{100} = \frac{3}{100}$$

f = 100/3 = 33.3 cm
P = 100/f = 100/(100/3) = 3 D.

15. Since

$$\sin i_e = \frac{1}{n} = \frac{1}{1.5} = 0.6667$$

$$i_e = 41.8^0$$

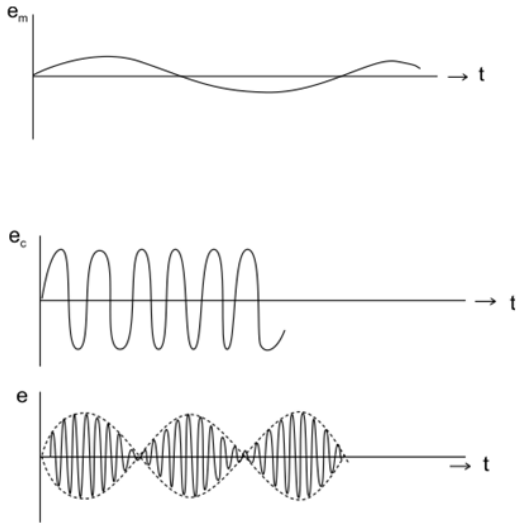
Deviation = $90^0 - i_c = 90^0 - 41.8^0 = 48.2^0$

This is the maximum attainable deviation in refraction.

In reflection deviation = $180^0 - 2i$

Therefore $i = 45^0$

16.



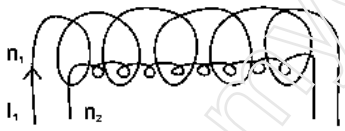
Advantages:

(i) For speech transmission

(ii) Short range distance communication.

17. During the formation of a nucleus, the protons and neutrons come closer to a distance of 10^{-14} m. The energy required for the purpose is spent by the nucleons at the expense of their masses. So mass of the nucleus formed is less than the sum of the masses of the individual nucleons.

18. Mutual inductance is numerically equal to the induced emf produced in coil when the rate of change of current is unity in the neighbouring coil.



Derivation:

Let n_1 = number of turns per unit length in first and

n_2 = number of turns unit length in secondary coil

$\varphi_{21} = M_{21} I_1$

$= N_2BA$

$= N_2 (\mu_0 n_1 I_1) A$

$M_{21}I_1 = \mu_0 N_1N_2I_1 A/L$

$M_{21} = \mu_0 n_1 n_2 AL$

Similarly $M_{12} = n_1 n_2 AL$

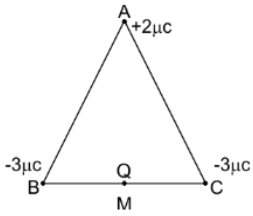
19.

a. The link, which transfers information from the information source to the destination, is called transmission medium.

b. The radio waves in the frequency range 500 kHz to 1500 kHz is called medium wave band while those in the frequency range from a few MHz to 30 MHz is called short wave band.

c. A device which converts energy in one form to another is called a transducer.

20. For equilibrium of charges A, the nature of charge at M must be



$\vec{F}_{AB} + \vec{F}_{AC} + \vec{F}_{AM} = 0$

$\Rightarrow \vec{F}_{AB} + \vec{F}_{AC} = -\vec{F}_{AM}$

$$\left|\vec{F}_{AB} + \vec{F}_{AC}\right| = \sqrt{F^1 + F^2 + 2FF\cos 60} = F\sqrt{3}$$

$$= \frac{9 \text{ x } 10^9 \text{ x } 3 \text{ x } 10^{-6} \text{ x } 2 \text{ x } 10^{-6}}{400 \text{ x } 10^{-4}} N$$

$$= \frac{9 \text{ x } 10^9 \text{ x } 3 \text{ x } 10^{-6} \text{ x } 2 \text{ x } 10^{-6}}{400 \text{ x } 10^{-4}} \sqrt{3}$$

$$\frac{^3 9 \text{ x } 10^9 \text{ x } Q \text{ x } 2 \text{ x } 10^{-6}}{300 \text{ x } 10^{-4}}$$

$$\Rightarrow \frac{\sqrt{3}}{4} \text{ x } 10^{-6} Q$$

$$Q = 0.43 \mu C$$

21.

a. The actual length of a magnet is called the geometric length of the magnet. The distance between the poles of a magnet is called the magnetic length of the magnet.

b. The geometric length of the magnet is nearly 8/7 times the magnetic length of the magnet.

c. It is the angle made by the direction of earth's total magnetic field with the horizontal direction.

22. $B = B_0 \sin(\omega t + bx)$

$B_Y = 8 \times 10^{-5} \sin(2 \times 10^{11} t + 300\pi x)$

$\Omega = 2 \times 10^{11}$ rad/s , $K = 300\pi = 2\pi/\lambda$

$= 2\pi / 300 = 1/.150m = 0.006$

Then, $E_Z = E_0 \sin(\omega t + kx)$

Where $E_0 = CB_0 = 3 \times 108 \times 8 \times 10^{-5} = 2400 N/C$

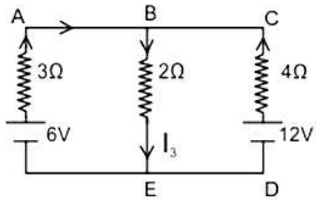
$E_Z = 2400 \sin(2 \times 10^{11} t + 300\pi x)$

23.

a. Ram is a very active and smart person. He has a scientific temperament. He is not easily discouraged. He applies his mind to solve a problem.

b. The positive and negative of the battery charger should be connected to the positive and negative respectively of the battery to be charged.

24. The circuit is written as follows:



In loop ABEFA

$2I_3 + 3I_1 = 6$

$2I_1 + 2I_2 + 3I_1 = 6$

$5I_1 + 2I_2 = 6$ --(i)

In loop BEDCB

$2I_1 + 6I_2 = 12$

$I_1 + 3I_2 = 6$ --(ii)

$13I_2 = 24$

$\therefore I_2 = \frac{24}{13} A$

Using eqn 2,

$$I_1 + 3 \text{ x } \frac{24}{13} I_2 = 6$$

$$I_1 = 6 - \frac{72}{13} = \frac{6}{13} A$$

$$I_1 = \frac{6}{13} A, I_2 = \frac{24}{13} A, I_3 = \frac{30}{13} A$$

Or

a) Potentials at both the points P and Q are positive. P is nearer to the source charge than Q. we know that the electrostatic potential at a point is inversely proportional to the distance of the point from the charge.

Therefore, $V_P > V_Q$

Potentials at both the points A and B are negative. Point B is farther from the charge than the point A. So, potential at B is less negative than at A.

Therefore, $V_B > V_A$

b) $(P.E)_Q - (P.E)_P > 0$; $(P.E)_A - (P.E)_B > 0$.

c) When a small positive charge is moved from Q to P, the electric force and displacement are oppositely directed. So, the work done by the field is negative.

d) When the negative charge is at B, it will experience a force of repulsion away from the source charge. The external agency shall have to apply a force towards the charge. Since both the force and displacement will be in the same direction therefore, the work done will be positive.

e) In going from B to A, the negative charge has to perform work against force of repulsion. So, the K.E decreases.

25. The focal length f = - 15/2 cm =- 7.5 cm

i. The object distance u = -10 cm. Then,

$$\frac{1}{v} + \frac{1}{-10} = \frac{1}{-7.5}$$

$$v = \frac{10 \text{ x } 7.5}{-2.5} = -30\text{cm}$$

The image is 30 cm from the mirror on the same side as the object.

$$\text{Magnification} = -\frac{v}{u} = -3$$

The image is magnified, real and inverted.

ii. The object distance u = - 5 cm. Then,

$$\frac{1}{v}+\frac{1}{-5}=\frac{1}{-7.5}$$

$$v = \frac{5 \text{ x } 7.5}{(7.5 - 5)} = 15 \text{ cm}$$

The image is formed at 15 cm behind the mirror. It is a virtual image.

$$\text{Magnification} = -\frac{v}{u} = 3$$

The image is magnified, virtual and erect.

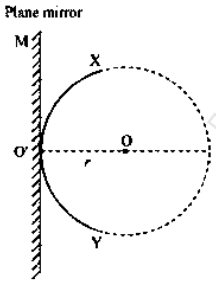
Or

a) The virtual image produced by a spherical mirror or a lens act as a virtual object for the eye lens which produce a real image on the retina. Hence there is no such contradiction.

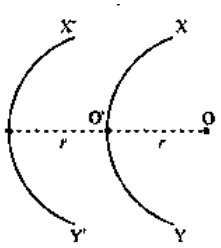
b) A lens of short focal length is not easy to manufacture. Further, a lens of shorter focal length would be quite thick at centre and such a lens disperses the white light and a multi-coloured image is formed. This defect in a lens is called chromatic aberration.

c) The eye-piece produces the image of the object lens itself. This image is called eye ring. An important point about it is all the rays from an object and refracted from the object lens pass through it. The eye would receive all the rays from object if it is placed in a position of the eye ring provided area of pupil of the eye is greater than or at least equal to the area of the eye ring.

26. Let an object at O be placed in front of a plane mirror MO at a distance r



A circle is drawn from the centre (O) such that it just touches the plane mirror at point O', according to Huygens' principle XY is the wave front of incident light. If the mirror is absent, then a similar wave front X'Y' as (XY) would from behind O' at distance r



X'Y' can be considered as a virtual reflected ray for the plane mirror. Hence point object placed in from of the plane mirror produces a virtual image whose distance from the mirror is equal to the object distance(r).

Or

(a) In a single slit diffraction experiment, if the width of the slit is made double the original width, then the size of the central diffraction band reduces to half and the intensity of the central diffraction band increases up to four times.

(b) The interference pattern in a double – slit experiment is modulated by diffraction from each slit. The pattern is the result of the interference of the diffracted wave from each slit.

(c) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the shadow of the obstacle. This is because light waves are diffracted from the edge of the circular obstacle. Which interferes constructively at the centre of the shadow? This constructive interference produces a bright spot.

(d) Bending of waves by obstacle by a large angle is possible when the size of the obstacle is comparable to the wavelength of the waves.

On the other hand, the wave length of the light is too small in comparison to the size of the obstacle. Thus the diffraction angle will be very small. Hence the students are unable to see each other. On the other hand, the size of the wall is comparable to the wavelength of the sound waves. Thus the bending of the waves takes place at a large angle. Hence the students are able to hear each other.

(e) The justification is that in ordinary optical instruments the size of the aperture involved is much larger than the wavelength of the light used.