**ANSWER KEY**

**Test # 02** **Test Pattern : BOARD**

**Class-XII**

## Physics

1. (a) Fig (i)
2. (a) 4 $\mu$C
3. (b) 1.7 eV
4. (d) The stability of atom was established by the model.
5. (d) The electron will continue to move with uniform velocity along the axis of the solenoid.
6. (b) $\frac{m}{\sqrt{2}}$
7. (d) high resistance in series
8. (b) $\frac{2}{3}\ Am^{-1}$
9. (a) $\frac{1}{\sqrt{2}}$ A
10. (a) X-rays
11. (c) $4B_0L^2$ Wb
12. (d) $\frac{1}{n^2}$
13. (d) (A) is false but (R) is true
14. (a) Both (A) and (R) are true and (R) is the correct explanation of (A)
15. (b) Both (A) and (R) are true but (R) is not the correct explanation of (A)
16. (a) Both (A) and (R) are true and (R) is the correct explanation of (A)
17. Rectification means conversion of ac into dc. A p-n diode acts as a rectifier because an ac changes polarity periodically and a p-n diode allows the current to pass only when it is forward biased. This characteristics property makes the diode suitable for rectification.

Difference between Half wave and Full wave rectifier

| | Half wave rectifier | Full wave rectifier |
|---|---|---|
| (i) | It converting the one half cycle of AC input to DC output | It converting both the half cycles or complete full cycle of AC input to DC output |
| (ii) | Ripple factor of a half-wave rectifier is more | Ripple factor of a full wave rectifier is less |
| (iii) | Single p-n junction diode is used for rectification. | At least two or four diode may used for rectification depending on the type of circuit |

18. Given $\lambda = 488$ nm $= 488 \times 10^{-9}$ m, $V_0 = 0.38$V,

Energy of incident photon, $E = \frac{hc}{\lambda}$

$$= \frac{6.63\times10^{-34}\times3\times10^{8}}{488\times10^{-9}} = 4.08\times10^{-19}\ J$$

$$= \frac{4.08\times10^{9}}{1.6\times10^{-9}} = 2.55\ eV$$

From Einstein's photoelectric equation,

$$\frac{hc}{\lambda} = \phi_0 + eV_0$$

Work function,

$$\phi_0 = \frac{hc}{\lambda} - eV_0 = 2.55\ eV - 0.38\ eV = 2.17\ eV$$

**19.** Refractive index of prism = 1.6 = $\frac{8}{5} = n_1$

Refractive index of surround by medium

$\frac{4\sqrt{2}}{5} = n_2$

Refractive index of prism w.r.t. surroundings

$$= n_{12} = \frac{n_1}{n_2} = \frac{\frac{8}{5}}{\frac{4\sqrt{2}}{5}} = \sqrt{2}$$

So, using the relation,

$$\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\frac{A}{2}}$$

A = angle of prism = 60°

$\delta_{min}$ = angle of minimum deviation

we get,

$$\sqrt{2} = \frac{\sin\left(\frac{60+\delta_{min}}{2}\right)}{\sin 30^\circ}$$

$$\frac{1}{\sqrt{2}} = \sin\left(\frac{60+\delta_{min}}{2}\right)$$

$$\frac{60+\delta_{min}}{2} = \sin^{-1}\frac{1}{\sqrt{2}} = 45^\circ$$

$60^\circ + \delta_{min} = 90^\circ$

$\delta_{min} = 30^\circ$

Hence, angle of minimum deviation of prism = 30°

**20.** Applying Kirchhoff's loop rule for loop ABEFA,

$-9 + 6 + 4 \times 0 + 2I = 0$

$I = 1.5$ A ....(i)

For loop BCDEB

$3 + IR + 4 \times 0 - 6 = 0$

$\therefore$ IR = 3

Putting the value of I from (i) we have

$$\frac{3}{2} \times R = 3 \Rightarrow R = 2\Omega$$

Potential difference between A and D through path ABCD,

$9 - 3 - IR = V_{AD}$

or $9 - 3 - \frac{3}{2} \times 2 = V_{AD} \Rightarrow V_{AD} = 3V$

**21.** (a) (i) When final image is formed at least distance of distinct vision, magnification

$$m = \frac{f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$$

(ii) Magnification in normal adjustment,

$$m = \frac{f_0}{f_e}$$

Clearly, for large magnification

$f_0 >> f_e$

(b) Reflecting telescope is preferred over refracting telescope because

(i) No chromatic aberration, because mirror is used.

(ii) Spherical aberration can be removed by using a parabolic mirror.

(iii) Image is bright because no loss of energy due to reflection.

(iv) Large mirror can provide easier mechanical support.

***OR***

(a) Focal length increases with increase of wavelength.

$$\frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\frac{2}{R}$$ as wavelength increases, $\frac{n_2}{n_1}$ decreases hence focal length increases.

(b) As $n_2 > n_1$, $\left(\frac{n_2}{n_1}-1\right)$ decreases so, focal length increases.

$$\frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\frac{2}{R}$$

**22.** (i) Saturation or short range nature of nuclear forces.

(ii) The radius (size) R of nucleus is related to its mass number (A) as

$R = R_0A^{1/3}$, where $R_0 = 1.1 \times 10^{-15}$ m

If m is the average mass of a nucleon, then mass of nucleus = mA, where A is mass number

$$\text{Volume of nucleus} = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi\left(R_0A^{1/3}\right)^3$$

$$=\frac{4}{3}\pi R_0^3 A$$

$\therefore$ Density of nucleus,

$$\rho_N=\frac{\text{mass}}{\text{volume}}=\frac{mA}{\frac{4}{3}\pi R_0^3 A}=\frac{m}{\frac{4}{3}\pi R_0^3}=\frac{3m}{4\pi R_0^3}$$

Clearly nuclear density $\rho_N$ is independent of mass number A.

***OR***

Intital binding energy,

$BE_1 = (2.23 + 2.23)$

$= 4.46$ MeV

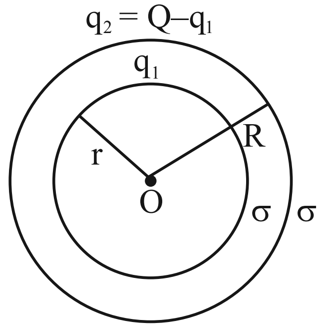
Final binding energy,

$BE_2 = 7.73$ MeV

$\therefore$ Energy released

$= BE_2 - BE_1 = (7.73 - 4.46)$ MeV $= 3.27$ MeV

**23.**




If charge $q_1$ is distributed over the smaller sphere and $q_2$ over the larger sphere, then

$Q = q_1 + q_2$ ...(i)

If $\sigma$ is the surface charge density of the two spheres, then

$$\sigma=\frac{q_1}{4\pi r^2}=\frac{q_2}{4\pi R^2}$$

or $q_1 = 4\pi r^2\sigma$ and $q_2 = 4\pi R^2\sigma$

From (i), we have

$Q = 4\pi r^2\sigma + 4\pi R^2\sigma$

$= 4\pi(r^2 + R^2)$

$$\text{or } \sigma=\frac{Q}{4\pi\left(r^2+R^2\right)}$$

The potential at a point inside the charged sphere is equal to the potential at its surface. So, the potential due to the smaller sphere at the common centre,

$$V_1 = \frac{1}{4\pi\varepsilon_0}.\frac{q_1}{r}$$

Also, the potential due to the larger sphere at the common centre,

$$V_2 = \frac{1}{4\pi\varepsilon_0}.\frac{q_2}{R}$$

$\therefore$ Potential at common centre,

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r}+\frac{q_2}{R}\right)$$

$$= \frac{1}{4\pi\varepsilon_0}\times\left[\frac{4\pi r^2\sigma}{r}+\frac{4\pi R^2\sigma}{R}\right]$$

$$= \frac{(r+R)\sigma}{\varepsilon_0} = \frac{1}{4\pi\varepsilon_0}\times\left[\frac{Q(r+R)}{r^2+R^2}\right]$$

(By putting the value of $\sigma$)

**24.** (i) The K.E. of the photoelectron becomes more than double of its original energy. As the work function of the metal is fixed, so incident photon of higher energy will impart more energy to the photoelectron.

(ii) The increase in frequency of incident radiation has no effect on photoelectric current. This is because of the incident photon of increased energy cannot eject more than one electron from the metal surface.

(iii) With the increase in frequency, the K.E. of the photoelectron increases, so the stopping potential also increases.

**25.** Resistance of heating element at room temperature $t_1 = 27$ ºC is

$$R_1 = \frac{V}{I_1} = \frac{230}{3.2}\Omega$$

Resistance of heating element at steady state temperature $t_2$ °C is

$$R_2 = \frac{V}{I_2} = \frac{230}{2.8}\Omega$$

Temperature coefficient of resistance

$$\alpha = \frac{R_2 - R_1}{R_1 \times (t_2 - t_1)}$$

$$\therefore\ t_2 - t_1 = \frac{R_2 - R_1}{R_1.\alpha} = \frac{\left(\frac{230}{2.8}\right)-\left(\frac{230}{3.2}\right)}{\frac{230}{3.2}\times 1.7\times 10^{-4}}$$

$$= \frac{3.2-2.8}{2.8\times 1.7\times 10^{-4}} = 840.3\ ºC$$

$\therefore$ Steady state temperature,

$t_2 = 840.3 + t_1 = 840.3 + 27 = 867.3$ ºC

**26.** Given that two identical coils are lying in perpendicular planes and having common centre. P and Q carry current I and $\sqrt{3}\ I$ respectively.

Now, magnetic field at the centre of P due to its current I,

$$\vec{B}_P = \frac{\mu_0 I}{2R}$$

And, magnetic field at centre of Q due to its current $\sqrt{3}\ I$,

$$\vec{B}_Q = \frac{\mu_0 \sqrt{3}\ I}{2R}$$

$$\therefore\quad |B_{net}| = \sqrt{B_P^2 + B_Q^2}$$

$$= \sqrt{\left(\frac{\mu_0 I}{2R}\right)^2 + \left(\frac{\mu_0 \sqrt{3}\ I}{2R}\right)^2} = \frac{\mu_0 I}{2R}\times 2 = \frac{\mu_0 I}{R}$$

For direction,

$$\therefore \quad \tan\theta = \frac{|\vec{B}_P|}{|\vec{B}_Q|} = \left(\frac{\left(\frac{\mu_0 I}{2R}\right)}{\left(\frac{\mu_0 \sqrt{3} I}{2R}\right)}\right) = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right) = 30^o$$

**27.** (a) (i) Radar Systems - Microwave

(ii) Water purifiers - Ultra Violet (UV)

(iii) Remote switches of TV-Infrared (IR)

(b)

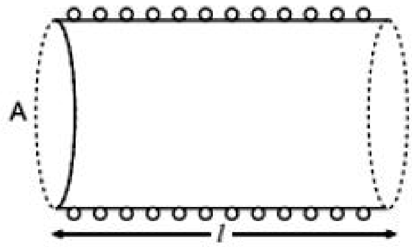
| EM-Waves | Source |
|---|---|
| (a) Microwave | Magnetrons or Gunn diodes |
| (b) Ultra violet (UV) | Inner shell electrons in atoms moving from one energy level to another |
| (c) Infrared (IR) | Hot bodies and molecules. |

**28.** Consider a long air solenoid having `n' number of turns per unit length. If current in solenoid is I , then magnetic field within the solenoid,

$B = \mu_0 n I$ ...(1)

where $\mu_0 = 4\pi \times 10^{-7}$ henry/metre is the permeability of free space.

If A is cross-sectional area of solenoid, then effective flux linked with solenoid of length '$l$' where $N = nl$ is the number of turns in length '$l$' of solenoid.




$\therefore \quad \phi = (n \ell BA)$

Substituting the value of B from (1)

$\phi = n\ell(\mu_0 n I)A = \mu_0 n^2 A \ell I$ ...(2)

$\therefore$ Self-inductance of air solenoid

$$L = \frac{\phi}{I} = \mu_0 n^2 A \ell \quad ...(3)$$

If N is total nubmer of turns in length $l$, then

$$n = \frac{N}{\ell}$$

$\therefore$ Self-inductance $L = \mu_0 \left(\frac{N}{\ell}\right)^2 Al$

$$L = \frac{\mu_0 N^2 A}{\ell}$$

**29.** (i) (c) The p-n diode is forward biased when p-side is at a higher potential than n-side.

(ii) (c)

(iii) (d) Forward bias resistance,

$$R_1 = \frac{\Delta V}{\Delta I} = \frac{0.8-0.7}{(20-10)\times 10^{-3}} = \frac{0.1}{10\times 10^{-3}} = 10$$

Reverse bias resistance,

$$R_2 = \frac{10}{1\times 10^{-6}} = 10^7$$

Then, the ratio of forward to reverse bias resistance,

$$\frac{R_1}{R_2} = \frac{10}{10^7} = 10^{-6}$$

***OR***

(d) In p-region the direction of conventional current is same as flow of holes.

In n-region the direction of conventional current is opposite to the flow of electrons.

(iv) (c) In the given circuit the junction diode is forward biased and offers zero resistance.

$\therefore$ The current, $I = \frac{2}{100} = \frac{1}{100}A$

**30.** (i) (b) real, virtual

(ii) (a) Magnifying power of compound microscope,

$M = \frac{v_0}{u_0}\left(1+\frac{D}{f_e}\right)$ [For final image formed at near point]

$M = \frac{L}{f_0}\left(\frac{D}{f_e}\right)$ [For final image formed at infinity]

Hence M does not depends upon the aperture of the objective and the eye-piece.

the aperture of the objective and the eye-piece

(iii) (d) The microscope can be used as a telescope by interchanging the two lenses.

(iv) (d) Magnifying power,

$M = m_0 \times M_e$

$= 10 \times 20 = 200$

***OR***

(c) Fiven $f_0 = 1.2$ cm, $f_e = 3.0$ cm,

$u_0 = -1.25$ cm

Using lens formula at objective lens.

$$\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0}$$

$$\Rightarrow \frac{1}{v_0} = \frac{1}{f_0} + \frac{1}{u_0} = \frac{1}{1.2} - \frac{1}{1.25}$$

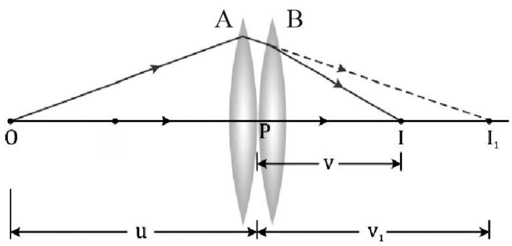
$$= \frac{1.25-1.2}{1.2\times1.25} = \frac{0.05}{1.2\times1.25} = \frac{1}{30}$$

$\therefore\ v_0 = 30$ cm

When final image formed at infinity,

$$M = -\frac{v_0}{u_0}\times\frac{D}{f_e} = \frac{-30}{-1.25}\times\frac{25}{3} = 200$$

**31.** (a)




Two thin lenses, of focal length $f_1$ and $f_2$ are kept in contact. Let O be the position of the object and let u be the object

distance. The distance of the image (which is at $I_1$), for the first lens is $v_1$

This image serves as object for the second lens. Let the final image be at I. We then have

$$\frac{1}{f_1} = \frac{1}{v_1} - \frac{1}{u}$$

$$\frac{1}{f_2} = \frac{1}{v} - \frac{1}{u_1}$$

Adding, we get

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$\therefore \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

$\therefore P = P_1 + P_2$

(b) A ray of light passing from the air through an equilateral glass prism undergoes minimum deviation. Thus, At a minimum deviation

$$r = \frac{A}{2} = 30^o$$

We are given that

$$\mu = \frac{\sin 45^o}{\sin 30^o} = \sqrt{2}$$

$\therefore$ Speed of light in the prism $= \frac{c}{\mu} = \frac{c}{\sqrt{2}}$

$= 2.1 \times 10^8 \ ms^{-1}$

***OR***

The light on passing through the narrow slit undergoes diffraction. A diffraction pattern consisting of alternate bright and dark bands is obtained on the screen.

(a) Angular width of principal maximum,

$$2\theta = \frac{2\lambda}{a}$$

It is not affected when screen is moved away (D increases) from the slit plane.

(b) Now linear width x of the central maximum is given by

$$x = \frac{2\lambda D}{a}$$

Thus if the screen is moved away the linear width of the central maximum will increase too.

Difference between interference and diffraction-

(a) In interference all the fringes will be of equal intensity but in diffraction the central maximum will have high intensity and in the rest of the fringes intensity falls rapidly.

(b) In interference all the fringes will be of equal width but in diffraction the central maximum will have the highest width and for the other fringes width will diminish fast.

**32.** The capacitance of an air-filled capacitor

$$C_0 = \frac{\varepsilon_0 A}{d} \qquad ...(i)$$

Capacitance with a dielectric slab of thickness t (< d) is

$$C = \frac{\varepsilon_0 A}{d - t + t/k} \qquad ...(ii)$$

(a) The charge on capacitor plates, when 200 V p.d. is applied, becomes

$q = C_0V_0 = 50 \times 10^{-12} \times 200 = 10^{-8}$ C

Even after the battery is removed, the charge of $10^{-8}$ C on the capacitor plates remains the same.

(b) On placing the dielectric slab, suppose the capacitance becomes C and potential difference V. Then $q = C_0V_0 = CV$

$$\text{or } C = \frac{C_0}{C} V_0 = \left(\frac{d - t + t/k}{d}\right) V_0$$

[Using (i) and (ii)]

(c) Final energy in the capacitor is

$$U = \frac{1}{2} qV = \frac{1}{2} \times 10^{-8} \times 125 = 6.25 \times 10^{-7} \text{ J}$$

(d). Energy loss $= U_0 - U = \frac{1}{2} q(V_0 - V)$

$$= \frac{1}{2} \times 10^{-8} (200 - 125) = 3.75 \times 10^{-7} \text{ J}$$

***OR***

Two capacitors are connected in parallel. Hence, the potential on each of them remains the same. So, the charge on each capacitor is

$Q_A = Q_B = CV$

Formula for energy stored $= \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$

Net capacitance with switch S closed = C + C = 2C

$\therefore$ Energy stored $= \frac{1}{2} \times 2C \times V^2 = CV^2$

After the switch S is opened, capacitance of each capacitor = KC

In this case, voltage only across A remains the same.

The voltage across B changes to $V' = \frac{Q}{C'} = \frac{Q}{KC}$

$\therefore$ Energy stored in capacitor $A = \frac{1}{2}KCV^2$

Energy stored in capacitor B =

$$\frac{1}{2}\frac{Q^2}{KC} = \frac{1}{2}\frac{C^2V^2}{KC} = \frac{1}{2}\frac{CV^2}{K}$$

$\therefore$ Total Energy stored

$$= \frac{1}{2}KCV^2 + \frac{1}{2}\frac{CV^2}{K}$$

$$\frac{1}{2}CV^2\left(K + \frac{1}{K}\right)$$

$$\frac{1}{2}CV^2\left(\frac{K^2+1}{K}\right)$$

Required ratio

$$= \frac{2CV^2.K}{CV^2\left(K^2+1\right)} = \frac{2K}{\left(K^2+1\right)}$$

**33.** (i) If an alternating voltage $V = V_0 \sin\omega t$ is applied across pure inductor of inductance L, then the magnitude of induced emf will be equal to the applied voltage,

$$E = L\frac{dI}{dt}$$

For the circuit, the magnitude of induced emf = applied voltage

$$L\frac{dI}{dt} = V_0 \sin\omega t$$

$$dI = \frac{V_0}{L} \sin\omega t \, dt$$

Integrating both the sides, we get

$$I = \frac{V_0}{L}\int \sin \omega t dt = \frac{V_0}{L}\left(\frac{-\cos \omega t}{\omega}\right)$$

$$I = -\frac{V_0}{\omega L}\cos \omega t = \frac{-V_0}{\omega L}\sin\left(\frac{\pi}{2} - \omega t\right)$$

$\sin(-\theta) = -\theta$ hence the equation is modified to

$$I = \frac{V_0}{X_L}\sin\left(\omega t - \frac{\pi}{2}\right)$$

thus the current in the circuit,

$$I = I_0 \sin \sin\left(\omega t - \frac{\pi}{2}\right)$$

this is the required expression.

(ii) The average power supplied by the source over a complete cycle is

$P_{av} = E_{rms} I_{rms} \cos\phi$

When the circuit carries an ideal inductor, then the phase difference between the current and voltage is $\frac{\pi}{2}$ In case of the pure inductive circuit,

$\phi = \frac{\pi}{2}$

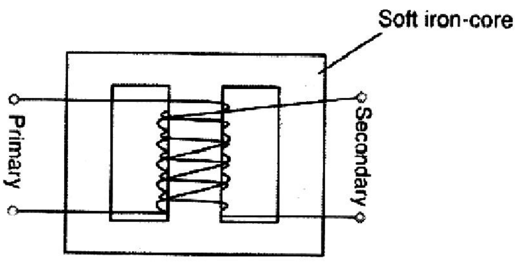
But $\cos\frac{\pi}{2} = 0$

So power dissipated = 0

Hence, when an ac source is connected to an ideal inductor, the average power supplied by the source over a complete cycle is zero.

***OR***

(a)




**Working principle-** Step-up transformer is made up of two or more coil wound on the iron core of the transformer. It works on the principle of magnetic induction between the coils. Whenever current in one coil changes an emf gets induced in the neighboring coil (Principle of mutual induction)

Voltage across secondary

$$V_s = e_s = -N_s \times \frac{d\phi}{dt}$$

Voltage across primary

$$V_p = e_p = -N_p \times \frac{d\phi}{dt}$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \left(\text{here, } N_s > N_p\right)$$

In an ideal transformer

Power Input - Power output

$I_p V_p = I_s V_s$

$$\therefore \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

(b) Input power, $P_i = I_i V_i = 15 \times 100 = 1500W$

Power output, $P_0 = P_i \times \frac{90}{100} = 1350 \text{ W}$

$\Rightarrow I_0 V = 1350 \text{ W}$

Output voltage, $V_0 = \frac{1350}{3} \text{ V} = 450 \text{ V}$