Meritnation
Class 1st to 12th
A Unit of Aakash

Board Paper of Class 12 Physics Term-II 2022 Delhi(SET 1) - Solutions

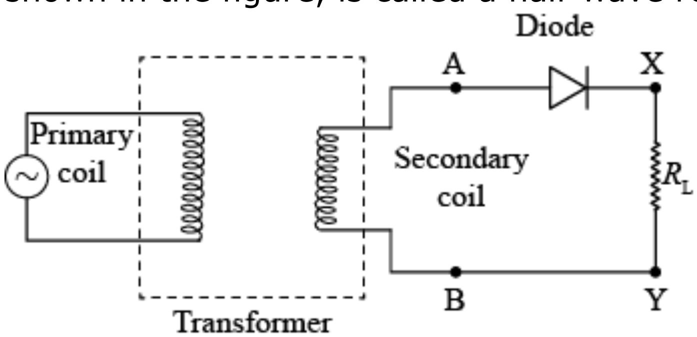
Total Time: 120

Total Marks: 35.0

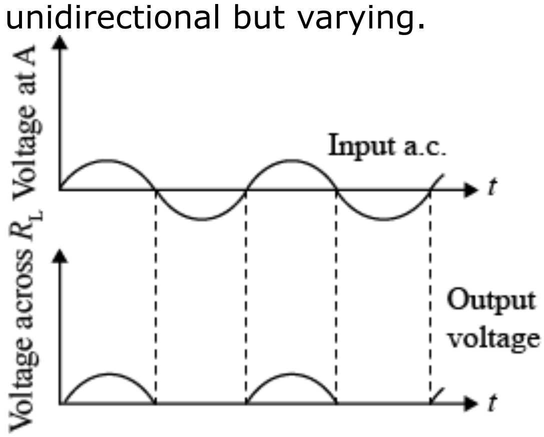
Section A

Solution 1

When an alternating voltage is applied across a diode in series with a load, a pulsating voltage will appear across the load only during the half cycles of the ac input during which the diode is forward biased. Such a rectifier circuit, as shown in the figure, is called a half-wave rectifier.



In the positive half cycle of a.c., the voltage at A is positive, the diode is forward biased and it conducts current.
In the negative half cycle of a.c., the voltage at A is negative, the diode is reversed biased and it does not conduct current.
Thus, we get output across R_L during positive half cycles only. The output is unidirectional but varying.



Solution 2

In the α-scattering experiment if a thin sheet of hydrogen is used in place of the gold foil then the scattering angle would be less.
Since the mass of the target nucleus is less than the mass of incident particles, the α-particle would not bounce back if a thin sheet of hydrogen is used.

OR

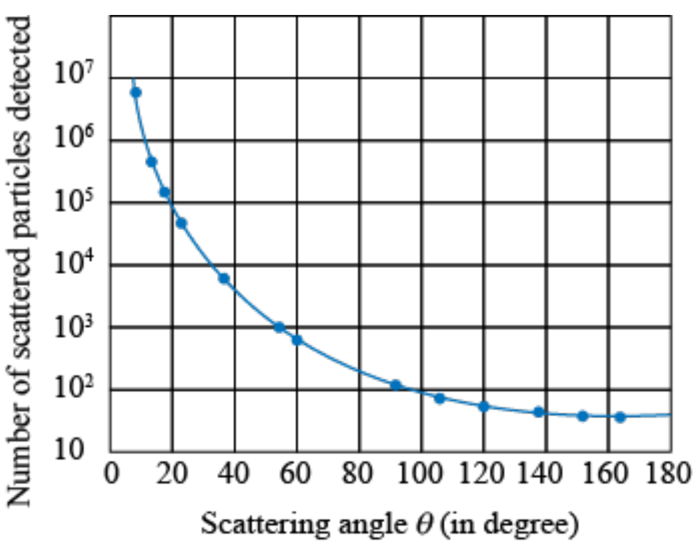
Frequency determines whether emission of photoelectrons will occur or not.
The change in the intensity of light will change the number of photons but there will be no change in the energy of photons. However, the change in frequency will change the energy of photons as $E = h\nu$ which can determine the emission of photoelectrons.

Solution 3

Photo-diodes convert incident light into electric current more effectively in reverse bias because the width of the depletion region increases on increasing the applied voltage across the diode in case of reverse-biased pn-junction. So, by applying a larger voltage, more number of incident photons will be converted to electric current. But in the case of reverse bias, the width of the depletion region reduces, so a small portion of photons will get converted to electric current. That is why photo-diode is operated in reverse bias.
Uses of photo-diodes:
(i) It is used as a photodetector to detect optical signals
(ii) It is used in compact disc players.

Section B

Solution 4



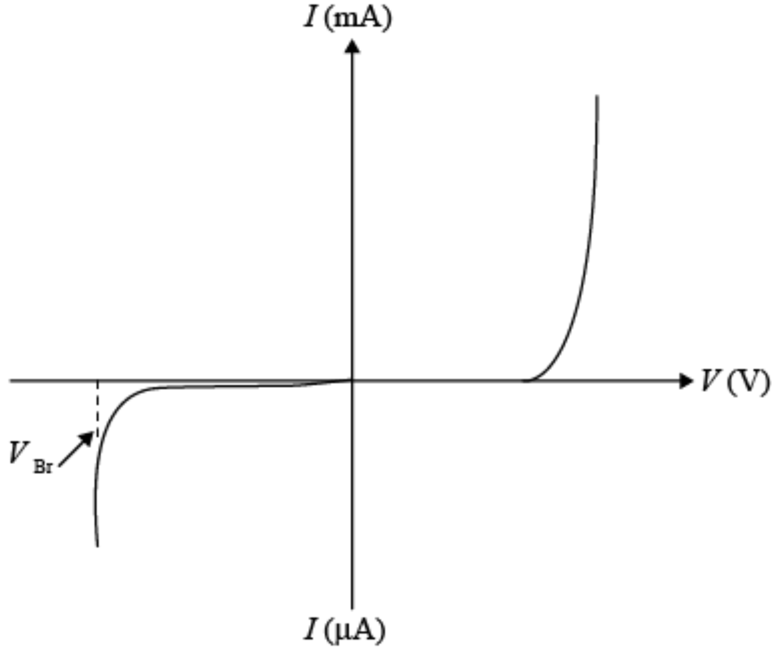
As the most space inside the atom is empty, so almost all the alpha particles passes un deflected. The size of nucleus is very small as compared to the size of atom, hence very few particles get scattered at θ > 90º.
Limitations of Rutherford's experiment

- Rutherford's model was inadequate to explain the stability of an atom.

- As per Rutherford's model, electrons revolve around the nucleus in a circular path. But particles that are in motion on a circular path would undergo acceleration, and acceleration causes radiation of energy by charged particles. Eventually, electrons should lose energy and fall into the nucleus.

Solution 5

(i) The V-I characteristics of p-n junction diode is shown below:



(ii) The forward voltage at which the current through the junction starts increasing rapidly, is known as the threshold voltage or cut-in voltage. However, the reverse voltage at which p-n junction of a diode breaks down with sudden rise in reverse current is known as break down voltage. In other words, the current under reverse bias is essentially voltage independent up to a critical reverse bias voltage, known as breakdown voltage (V_{br}). When $V = V_{br}$, the diode reverse current increases sharply. Even a slight increase in the bias voltage causes large change in the current.

(iii) When an alternating voltage is applied across a junction diode, then the current will flow only in the part where it is forward biased. This property of p-n junction diode is used to rectify alternating voltages. Rectifier is used for this purpose.

Solution 6

The fission process can be written:

$${}^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{140}_{58}Ce + {}^{99}_{44}Ru$$

$$Q = \left[m\left({}^{238}_{92}U\right) + m\left({}^{1}_{0}n\right) - m\left({}^{140}_{58}Ce\right) - m\left({}^{99}_{44}Ru\right)\right] \times 931.5 \text{ MeV}$$

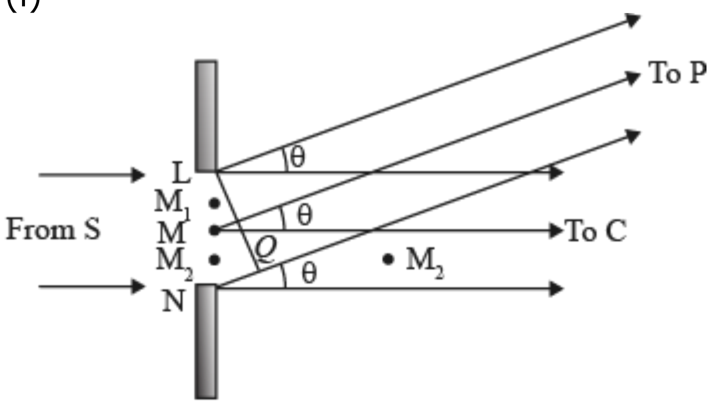
Putting the values we get,

Q = 231.1 MeV

Solution 7

In the case of double slit pattern, all the fringes are of equal width while in the case of single slit pattern the width of central maxima is maximum.
Also for double slit pattern the intensity remains same for all the fringes but for single slit pattern the intensity decrease as we move away from the centre on the both the sides.

(i)



The path difference NP – LP between the two edges of the slit,
NP – LP = NQ = a sin θ ≈ aθ
By dividing the slit into a n appropriate number of parts, we find that points P for which
$\theta = n\frac{\lambda}{a}$ are points of minima.
(ii) At the central point C on the screen, the angle θ is zero. All path differences are zero and hence all the parts of the slit contribute in phase. This gives maximum intensity at C. As indicates that the intensity has a central maximum at θ = 0 and other secondary maxima at
$\theta = (n+1)\frac{\lambda}{2a}$ are points of maxima

Solution 8

Given: Slit width, a = 0.6 mm
Wavelength, $\lambda_1 = 600\ \text{nm}\ \text{ and }\ \lambda_2 = 480\ \text{nm}$
(i) For second bright fringe, *n* = 2
Distance of the second bright fringe from the central maximum =
$\frac{n\lambda D}{a} = \frac{2\times600\times10^{-9}\times1}{0.6\times10^{-3}} = 2\ \text{mm}$

(ii) Let the n^{th} bright fringe for 600 nm and m^{th} bright fringe from 480 nm coincide.
Distance of n^{th} bright fringe from centre = *x* = Distance of m^{th} bright fringe from centre
$nD\frac{600\ \text{nm}}{a} = mD\frac{480\ \text{nm}}{a}$

$5n = 4m$

$\frac{n}{m} = \frac{4}{5}$

So, fourth bright fringe due to first source coincide with the fifth bright fringe due to second source.

$x = \frac{4\times600\times10^{-9}\times1}{0.6\times10^{-3}} = 4\ \text{mm}$

OR

(i)The S.I unit of power of lens is Dioptre denoted by D.

$1\,\text{D} = \frac{1}{1\,\text{m}} = 1\,\text{m}^{-1}$

Thus 1D is basically the power of the lens having a focal length of 1m.

(ii) Given: Refractive index, $\mu = 1.5$

Radius of curvature of the curved surface, R_1 = 25 cm

Radius of curvature of the plane surface, $R_2 = \infty$

(a) Using lens maker formula:

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

$\Rightarrow f = \frac{R_1}{\mu-1}$

$\Rightarrow f = \frac{25}{1.5-1} = 50\ \text{cm}$

(b) Given: Object distance u = -50 cm (Using sign convention)

Using lens formula:

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

$\Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$\Rightarrow \frac{1}{v} = \frac{1}{50} - \frac{1}{50} = \frac{1-1}{50}$

$\Rightarrow v = \infty$

Hence, the image will form at infinity.

The nature of the image formed is real and inverted.

Solution 9

(a) Energy, $E = \frac{hc}{\lambda}$

$\Rightarrow E = \frac{6.6\times10^{-34}\times3\times10^{8}}{331.5\times10^{-9}} = 5.97\times10^{-19}\ \text{J}$

de-Broglie wavelength,

$\lambda = \frac{h}{p}$

$\Rightarrow p = \frac{h}{\lambda} = \frac{6.6\times10^{-34}}{331.5\times10^{-9}}$

$= 1.99\times10^{-27}\ \text{kg m/s}$

(b) Mass of 1 hydrogen atom, $m = 1.66\times10^{-27}\ \text{kg}$

so, its momentum:

$p=1.99\times10^{-27}\ \text{kg m/s}=\ m\times v$

$\Rightarrow v=\frac{1.99\times10^{-27}}{1.66\times10^{-27}}=1.19\ \text{m/s}$

Solution 10

(i) Applying Snell's law:
$\mu\sin r_2=1\sin 90^\circ$

$\Rightarrow \sin r_2=\frac{1}{\sqrt{2}}$

$\Rightarrow r_2=45^\circ$

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

$$\frac{\sin\left(\frac{60+D_{min}}{2}\right)}{\sin\frac{60}{2}}=\mu$$

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

$\sin\left(\frac{60+D_{min}}{2}\right)=\sin 45^o$

$D_{min}=30^o$

The minimum angle of deviation is 30^o

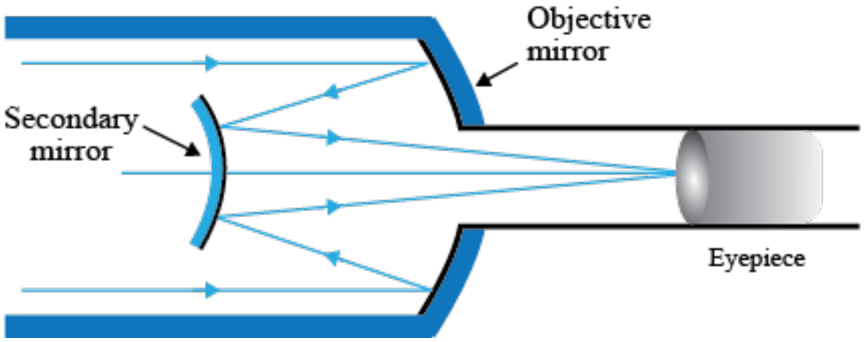
Solution 11

(i) Ascending order of e.m wave in terms of frequency,
Radio wave < Micro wave < X Ray < Gamma ray

(ii) Uses of X ray: X-rays are used as a diagnostic tool in medicine and as a treatment for certain forms of cancer.
Uses of Radio wave :Cellular phones use radio waves to transmit voice communication in the ultrahigh frequency (UHF) band.

OR

Diagram is as shown below:



Telescopes with mirror objectives are called reflecting telescopes. A reflecting telescope is also called a reflector. The convex secondary mirror to focus the incident light, which now passes through a hole in the objective primary mirror, which is shown in the above diagram.
Following are the advantages:
(i)There is no chromatic aberration as the objective is a mirror in reflecting type telescope.
(ii)Also the image is brighter compared to the one formed in refracting type telescope. It works by using signals or a collection of curved mirrors to reflect light and create an image.

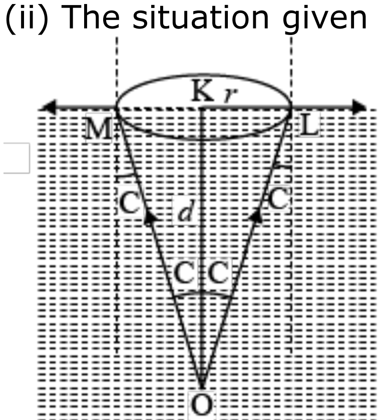
Section C

Solution 12

(i)
As the ray is travelling from denser to rarer medium and the angle of incidence is smaller than the critical angle, the ray will refract and will bend away from the normal.

Hence, the correct answer is option (a).

(ii) The situation given in the question can be illustrated by the given diagram:



Here,
sin C = $\frac{\text{KL}}{\text{OL}} = \frac{r^2}{\sqrt{r^2+d^2}}$

For total internal reflection, sin C = $\frac{1}{\mu}$ = $\frac{r^2}{\sqrt{r^2+d^2}}$

$\therefore\ r^2 + d^2 = \mu^2 r^2$

$or\ \frac{d^2}{(\mu^2-1)} = r^2$

Area, *A* = $\pi r^2 = \pi \left(\frac{d^2}{\mu^2-1}\right)$

Hence, the correct answer is option (b).

(iii) Critical angle, sin C = $\frac{1}{\mu}$

Of the given options, the value of refractive index of water is minimum.
Hence, the critical angle will be maximum for water air interface.
Hence, the correct answer is option C.
(iv) Critical angle, sin C = $\frac{1}{\mu}$
But, sin C $= \frac{1}{2}$
C = 30^o

Hence, the correct answer is option (b).

(v) Critical angle, sin C = $\frac{1}{\mu} = \frac{v}{c}$
or $v = c \sin C = 3 \times 10^8 \times \sin 30^o = 3 \times 10^8 \times \frac{1}{2}$
or *v* = 1.5×10^8 m/s

Hence, the correct answer is option (b).