# CBSE
# Class XII – Physics
# Sample Paper 3–Solution

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## Section B

**1.** W

**OR**

Infinite

**2.** 1027°C

Resistance at room temperature, $R_{27} = 100\ \Omega$

$R_t = 117\ \Omega$

$R_t = R_{27}\ [1+\alpha\ (t-27)]$

$117 = 100\ [1+ 1.70 \times 10^{-4}\ (t - 27)]$

$t = 1000 + 27 = 1027°C$

**3.** We know

$$\tan\phi = \frac{X_L}{R}$$

$$\text{Thus}, \phi = \tan^{-1}(1) = 45°$$

**4.** b) Light waves should have different wavelength.

Light waves should have the same wavelength for the sustained interference of light.

**5.** In n-type semiconductors, $n_e >> n_h$, i.e. electrons are majority carriers and holes are minority carriers.

**6.** $KU_0$

$$U_0 = \frac{1}{2}C_0V_0^2$$

Thus, change in energy stored is given as,

$$U = \frac{1}{2}(KC_0)V_0^2 = KU_0$$

**7.** d) $\frac{\mu_0 nI}{2}$

The magnetic field due to a current-carrying solenoid is $\frac{\mu_0 nI}{2}$.

**OR**

b) $\frac{2\pi m}{Bq}$

**8.** $\left[L^{-2}A\right]$

Current density, j = I/A

**9.** $(1.84)^{1/3}$

We know

$R \approx A^{1/3}$

$$\therefore \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{197}{107}\right)^{1/3} = (1.84)^{1/3}$$

**OR**

$$E = \frac{hc}{\lambda}$$

$$E = \frac{6.6\times10^{-34}\times3\times10^{8}}{450\times10^{-9}}$$

$$4.4\times10^{-19}J$$

**10.** Decreases Fringe width 'β' is inversely proportional to frequency of the source 'υ'.

**OR**

No interference pattern is observed as there is no constant phase difference between the waves emitted by two sources.

**11.** (A) Both assertion and reason are true and the reason is the correct explanation of the assertion Capacitive reactance XC=1/ωC. When capacitance increases, the capacitive reactance decreases. Due to decrease in its values, the current in the circuit will increases and hence brightness of source (or electric lamp) will also increases

**12.** (B) Both assertion and reason are true but reason is not the correct explanation of assertion.

Bohr postulated that electrons in stationary orbits around the nucleus do not radiate. This is the one of Bohr's postulate. According to this the moving electrons radiate only when they go from one orbit to the next lower orbit

**13.** (B) If both assertion and reason are true but reason is not the correct explanation of the assertion.

On increasing temperature of wire the kinetic energy of free electrons increase and so they collide more rapidly with each other and hence their drift velocity decreases. Also when temperature increases, resistivity increase and resistivity is inversely proportional to conductivity of material.

**14.** (A) Both assertion and reason are correct and reason is the correct explanation for assertion A photon is an imaginary particle which is believed to have rest mass zero. But it has some mass when in motion, this mass an be calculated by using einstein's special theory of relativity. Thus using E=mc$^2$, we have $m = \frac{E}{C^2}$. Also momentum is defined as the mass multiplied by velocity. So momentum =mc. Therefore p=E/C.

## Section B

**15.** 1. ii Capacitive
2. i Inductive
3. ii. $\omega = \frac{1}{\sqrt{LC}}$
4. Maximum
5. The sharper the resonance

**16.** 1.ii Doubled

Since

$$V_d = \frac{I}{neA} = \frac{V}{R(neA)}$$

$$= \frac{V}{\frac{\rho l}{A}(neA)} = \frac{V}{ne\rho l}$$

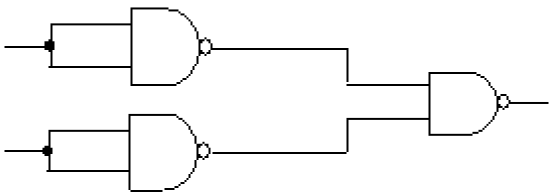
2.i. Half. Length is doubled the velocity gets halved
3.iv. Remain Unchanged. Since V is independent of D, drift velocity remain unchanged
4.i. $\mu = \frac{e\tau}{m}$
5. Decreases.
As the temperature increases, the thermal agitation of the electrons increases thereby, increasing the number of collision. Hence, drift velocity of the electrons decreases.

## Section C

**17.**

| Interference | Diffraction |
|---|---|
| Interference is due to superposition of two distinct waves com-ing from two coherent sources. | Diffraction is due to super-position of the secondary wavelets coming from dif-ferent parts of the same wavefront. |
| The intensity of minima is generally zero. | The intensity of minima is never zero. |
| All bright fringes are of uniform intensity. | All bright fringes are not of uniform intensity. |

**18.** The NAND gate is called a universal gate because it can be used to obtain other basic gates like AND, NOT and OR gates. NAND gates can be combined (as shown below) to realise a basic OR gate.



**19.** Some characteristics of the carrier signal are varied in accordance with the modulating or message signal. This is called modulation.

Amplitude modulation, frequency modulation and phase modulation of waves are the different types of modulation.

**OR**

In amplitude modulation (AM), the amplitude of the modulated (carrier) wave varies in accordance with the amplitude of the information (signal) wave. When amplitude of the information wave increases, the amplitude of modulated wave also increases and *vice versa*.

In frequency modulation (FM), the frequency of modulated wave varies in accordance with the frequency of the signal wave. In this case, the amplitude of the modulated wave is fixed.

**20.** Nuclear density of iron will be 2.3x10$^{17}$ kg/m$^3$.

Nuclear density is independent of mass number A, so iron also has the same nuclear density as hydrogen.

**21.** On introducing a dielectric in the capacitor, its capacitance will increase.

The total impedance of the circuit will decrease as $Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$.

Hence, the current in the circuit increases and the brightness of the lamp increases.

**OR**

The capacitive reactance is

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(50)(15.0\times10^{-6})} = 212\Omega$$

The rms current is

$$i = \frac{V}{X_C} = \frac{220}{212} = 1.04\,A \quad (1/2)$$

The peak current $\sqrt{2}$ $i = \sqrt{2}(1.04) = 1.47\,A$

If the frequency is doubled, the capacitive reactance is halved and the current gets doubled.

**22.** Here, $l$ =0.2 m, A = 1mm$^2$ = $10^{-6}$ m$^2$ , V =4 V , μ = 4.5 x $10^{-6}$ m$^2$ V$^{-1}$ s$^{-1}$, e = 1.6 x $10^{-19}$ C, n= 8.5 x $10^{28}$ m$^{-3}$

E = V / $l$ = 4/ 0.2 = 20 V/m

Current through wire,

I = n A e $v_d$ = n A eμ E = 8.5 x $10^{28}$ x $10^{-6}$ x 1.6 x $10^{-19}$ x 4.5 x $10^{-6}$ x 20 = 1.22 A

**23.** Internal resistance of cells depends on

a) the nature, concentration and temperature of the electrolyte
b) the nature of electrodes
c) the distance between the electrodes
d) the area of electrodes immersed in the electrolyte

**24.** Intensity is I= 4$I_0$ $\cos^2 \Phi/2$

When path difference is λ, phase difference is 2π.

I= 4$I_o$ $\cos^2\pi$ = 4 $I_o$= K (given)

When path difference is Δ = λ /3, then the phase difference will be

Φ'=2π Δ / λ

=2 π × λ/3λ = 2π/3

Hence, the intensity at a point where the path difference is λ/3 is

I'=4$I_0$ $\cos^2$ 2π /6 (since K = 4$I_0$)

= K $\cos^2$ π/3= K x {1/2}2 = (¼) K

**25.** The de Broglie wavelength is

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}$$

For the electron, proton and α-particle, λ is same

$$m_e K_e = m_p K_p = m_\alpha K_\alpha = \text{constant}$$

As mass of the electron is minimum, its kinetic energy will be maximum.

As mass of the alpha particle is maximum, its kinetic energy is minimum.

**OR**

According to Einstein's photoelectric equation,

$(1/2)\ mv^2_{max} = h\ f - h\ f_0$

wherem = mass of the electron

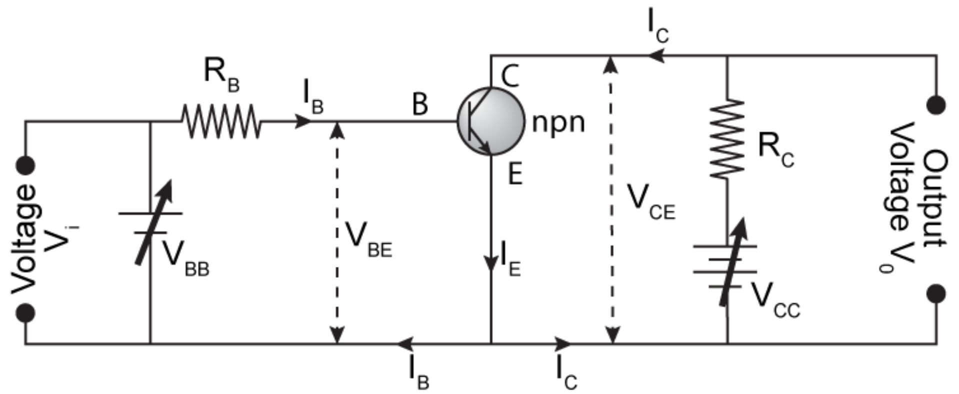
f = frequency of incident radiation

$f_0$ = threshold frequency

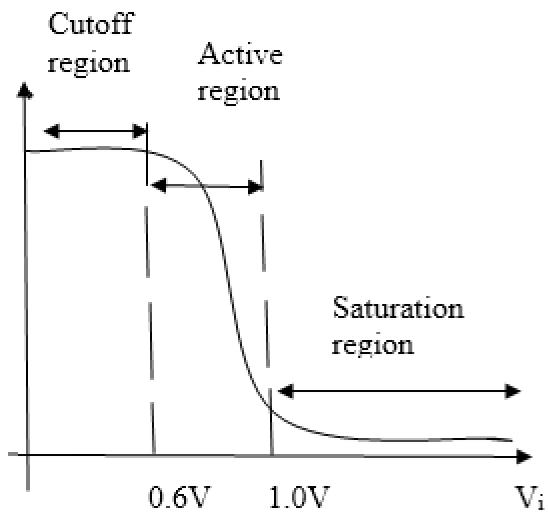
If the frequency of incident radiation is less than the threshold value ($f < f_0$), the KE of the emitted electron is negative, i.e. photoelectric emission will not take placeno matter how large the intensity of incident radiation.

## Section D

**26.**




(i) When $V_i \geq 1.0$ V, the variation of $V_i$ and $V_0$ is non-linear, as with increase in $V_i$, $V_0$ is found to decrease towards zero but never becomes zero. In this case, collector current $I_c$ becomes maximum and transistor is in the saturation state.




(ii) If we plot a graph of $V_0$ and $V_i$, then we get a curve as shown in the figure.

(iii) From this graph, we understand that as long as $V_i$ is low, $V_0$ is high.
(=$V_{cc}$) and $I_c$ is nearly equal to zero. Here, the transistor is in the cut-off state (switched-off state).

(iv) When $V_i$ is high, $V_0$is low and is nearly equal to maximum or saturated. Now, the transistor is fully conducting. Here, the transistor is said to be in the switched-on state.

(v) Thus, if we define low and high input states as below and above certain voltage levels corresponding to the cut-off and saturation state of the transistor, then we say that low input state switches the transistor off and high input state switches it on. This indicates that a transistor acts as a switch.

**27.** Let R be the radius of the circular loop. Then $A = \pi r^2$ or $R = \sqrt{A/\pi}$

Magnetic field of induction at the centre of the circular loop carrying current is

$$B = \frac{\mu_0}{4\pi}\frac{2\pi I}{R} \text{ or } I = \frac{2BR}{\mu_0}$$

$$M = IA = \frac{2BR}{\mu_0}A = \frac{2BA}{\mu_0}\sqrt{\frac{A}{\pi}}$$

**28.**

(i) E remains the same as it depends on the charge on the plates and the medium between the plates. Q remains the same as the charge does not change on the plates.

(ii) V = Ed, so as the distance is doubled, V also doubles.

(iii) C = Q/V and V is doubled, whereas Q remains the same. So, C is halved.

**29.**

$\alpha = 0.8$

$\beta = \alpha/(1-\alpha)$

$= 0.8/(1-0.8) = 4$

$\Delta I_c = \beta\Delta I_b = 6 \times 4 = 24\ mA$

**OR**

Here, the current gain is 75, i.e. >1.

Besides, there is a phase difference of $\pi$ between the signal at the input and the output.

Both these factors indicate that the amplifier is connected in the commonemitter mode.

**30.** Energy of the photon of wavelength $\lambda$ is $E = \frac{hc}{\lambda}$

Here, $\lambda$ = 620 nm = 620 x $10^{-9}$ m

$$E = \frac{hc}{\lambda} = \frac{6.62 x 10^{-34} x 3 x 10^{8}}{620 x 10^{-9}} J$$

$$= \frac{6.62 x 10^{-34} x 3 x 10^{8}}{620 x 10^{-9} x 1.6 x 10^{-19}} eV = 2 eV$$

Transition D will result in the emission of photons of wavelength 620 nm.

**OR**

amu = 931.5 MeV

$\Delta m = 2(2.015) - (3.017 + 1.009) = 0.004\ amu$

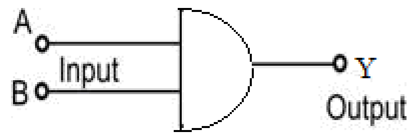
Hence, energy released per deuteron = (0.004 x 931.5)/2 = 1.863 MeV

The number of deuterons in 1kg $= N_A/2 = 6.023 \times 10^{26}/2$

Energy released = $(3.01 \times 10^{26})(1.863 \times 10^{6})(1.6\times10^{-19})$ J = $9.0\times10^{13}$ J

## Section E

**31.** The logic symbol of the AND gate is shown in the figure.

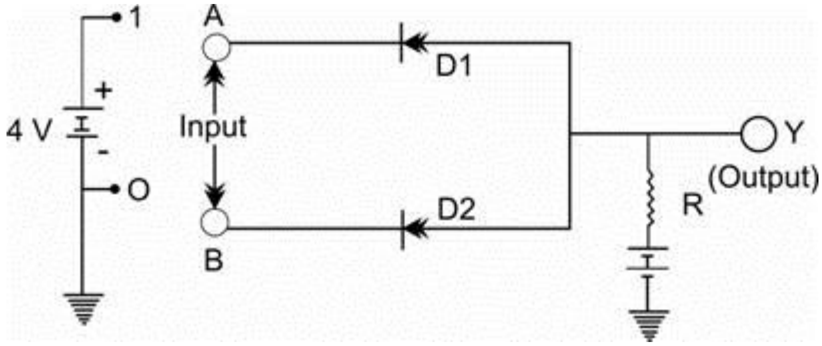



The truth table of the AND gate is given below:

| A | B | Output |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

**Realisation of the AND gate:**

To realise an AND gate having two inputs A and B, we complete the electrical circuit (as shown in the figure below) using two diodes $D_1$ and $D_2$.




**Operation:**

(i) When A = 0, B = 0, both diodes conduct and offer low(almost zero) resistance. Hence, the whole voltage drop is across resistor R and the net output voltage level at Y will be zero.

(ii) When A = 1, B = 0, diode $D_1$ does not conduct but $D_2$ conducts and provides a low resistive path. As a result, the output voltage level at Y is still zero.

(iii) When A = 0, B = 1, diode $D_1$ conducts and provides a low resistance path but $D_2$ does not conduct. Output voltage level at Y is even now zero.

(iv) When A = B = 1, none of the two diodes conduct, and there would be no drop in voltage across resistance R. Hence, voltage of Y will be 4V, i.e. Y will be at voltage level 1.

Thus, the output level is 1 only when both inputs A and B are at 1 level, which is the condition of the AND gate.

**OR**

(i) $\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2\ mA}{20\ \mu A} = 100$

(ii) The input resistance $R_{BE} = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{20\ mV}{20\ \mu A} = 1\ k\Omega$

(iii) Transconductance = $\frac{\Delta I_C}{\Delta V_{BE}} = \frac{2\ mA}{20\ mV} = 0.1\ mho$

(iv) The change in input voltage is $R_L \Delta I_C = (5\ k\Omega)(2\ mA) = 10\ V$

The applied signal voltage = 20 mV

Thus, the voltage gain is

$= \frac{10\ V}{20\ mV} = 500$

**32.**

(a) Lenz's law states that the polarity of the induced emf is such that it tends to produce a current which opposes the change in the magnetic flux that produces it. This law can be explained by the law of conservation of energy.

(b) Induced emf $= (1/2)\omega BR^2 = (1/2) \times 4\pi \times 0.4 \times 10^{-4} \times (0.5)^2 = 6.28 \times 10^{-5}\ V$

(c) Given

$R_1 = 10\ \Omega$, $N_1 = 30$, $A_1 = 3.6 \times 10^{-3}\ m^2$, $B_1 = 0.25\ T$

$R_2 = 14\ \Omega$, $N_2 = 42$, $A_2 = 1.8 \times 10^{-3}\ m^2$, $B_2 = 0.50\ T$

Current sensitivity is $\frac{\phi}{i} = \left(\frac{NAB}{K}\right)$

Thus, the ratio of current sensitivities is $= \frac{N_1}{N_2}\frac{A_1}{A_2}\frac{B_1}{B_2} = \frac{S_1}{S_2}$

$= \frac{30}{42}\left(\frac{3.6}{1.8}\right)\left(\frac{0.25}{0.50}\right)$

$= \left(\frac{5}{7}\right)$

Ratio of voltage sensitivities $= \left(\frac{S_1}{S_2}\right)\left(\frac{R_2}{R_1}\right)$

$= \left(\frac{5}{7}\right)\left(\frac{14}{10}\right) = 1$

**OR**

(a) Radius of the circular path in a magnetic field

$r = \frac{mv}{qB}$

Since $m_p > m_e$

Therefore, the radius of the proton's circle will be larger.

$\frac{r_p}{r_e} = \frac{m_p}{m_e} = \frac{1.67 x 10^{-37}}{9.1 x 10^{-31}} = 1835$

(b) Lorentz force on moving a charged particle in the magnetic field is always perpendicular to the velocity of the particle.
The work done by the magnetic force

$dW = \vec{F}.d\vec{\ell}$

$dW = Fd\ell\cos\theta$

$\text{but } \theta = 90^{o}$

$dW = 0$

Thus, on moving the charged particle in a uniform magnetic field, no work is performed. Hence, the kinetic energy of the charged particle will remain constant.

(c)
(i) the field is reduced to half
(ii) the field will be halved
(iii) the field will be perpendicular to the plane of the page, pointing downwards

**33.**

(i) Reflection and refraction arise through interaction of incident light with atomic constituents of matter which vibrate with the same frequency as that of the incident light. Hence frequency of reflected and refracted light both have the same frequency as the incident frequency.

(ii) No, energy carried by a wave depends on the amplitude of the wave and not on the speed of wave propagation.

(iii) For a given frequency, intensity of light in the photon picture is determined by the number of photons incident normally on crossing a unit area per unit time

(iv) R = -20cm and magnification , m = -2

$f = -R/2 = -10\text{cm}$

$m = \frac{-v}{u}$

$-2 = \frac{-v}{u}$

$v = 2u$

Using mirror formula

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{-10} = \frac{1}{2u} + \frac{1}{u}$

$u = -15\text{cm}$

$v = 2 \times -15 = -30\text{cm}$

(v)

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

Using dign convention , for convex mirror, we have

$f > 0, \mu < 0$

Therefore f is positive and μ is negative

v is always positive , hence image is always virtual

**OR**

Let $\mu_1$ be the refracting index of the rarer medium and $\mu_2$ be the refracting index of the spherical convex refracting surface XY of small aperture.

From A draw AM such that $AM \perp OI$

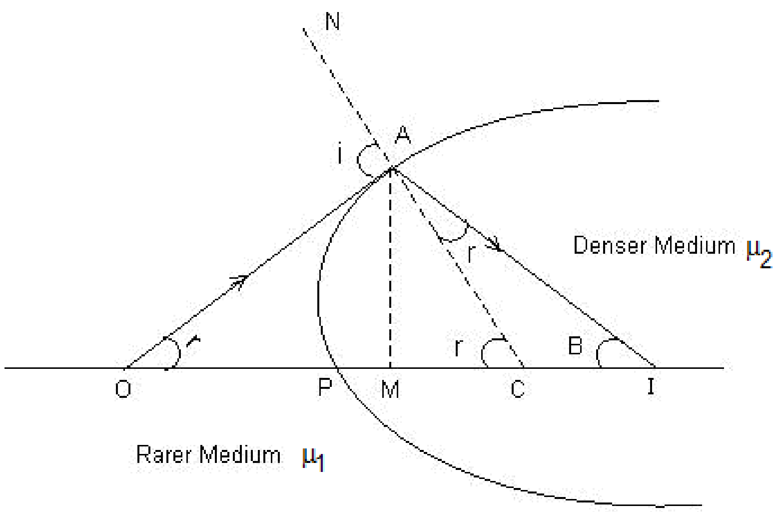
In $\Delta IAC$

$$r + B = \gamma \text{ (Exterior angle property)}$$

$$\therefore \quad r = \gamma - \beta$$

Similarly in $\Delta OAC$

$$i = \alpha + \gamma$$




According to Snell's law,

$$\frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r} \approx \frac{i}{r} \Rightarrow \mu_2 r = \mu_1 i$$

So, $\mu_1(\alpha + \gamma) = \mu_2(\gamma - \beta)$ ... (1)

Let $\alpha \approx \tan \alpha = \frac{AM}{OM} = \frac{AM}{PO}$

$$\beta = \tan\beta = \frac{AM}{MI} = \frac{AM}{PC}$$

As the spherical surface has a small aperture, we have

$$y = \tan\beta = \frac{AM}{MC} = \frac{AM}{PC}$$

Substituting the value in equation (1), we have

$$\frac{\mu_1}{PO} + \frac{\mu_2}{PI} = \frac{\mu_2 - \mu_1}{PC}$$

By sign convention, put

$PO = -u,\ PI = +v,\ PC = +R$

We get

$$\frac{\mu_1}{-u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$$

which is the required relation.