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Simplifying Test Prep

CBSE Class 12th
Physics Solved Question Paper 2016

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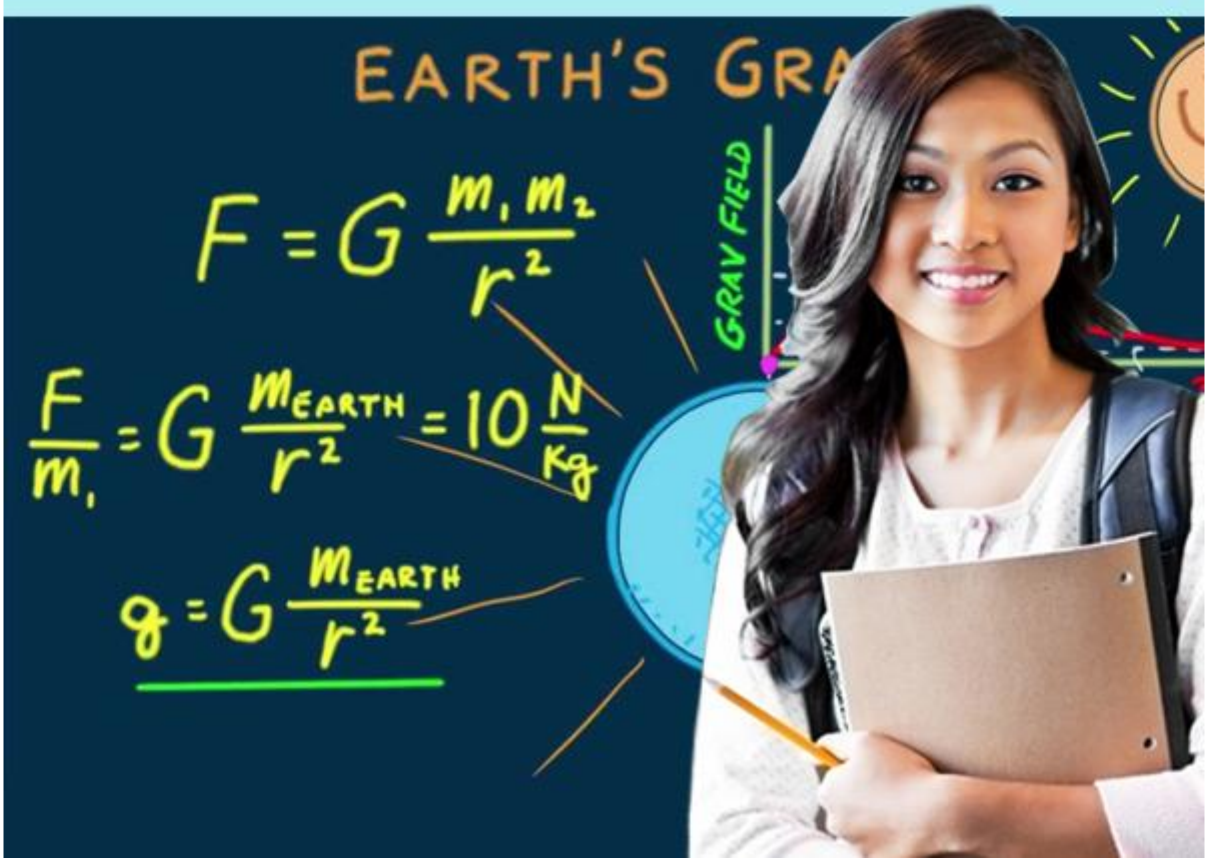
- Completely Solved paper
- Unique Solutions



Solved Question Paper
2016
Class – XII
Subject – Physics (Theory)
All India: Set – III

Time allowed: 3 hours **Maximum Marks: 70**

General Instructions:

(a) All questions are compulsory.

(b) There are 26 questions in all. Question number 1 to 5 carry one mark each, question number 6 to 10 carry two marks each, question number 11 to 22 carry three marks each, question number 23 carry four marks and question number 24 to 26 carry 5 marks each.

(c) There is no overall choice. However, internal choices have been provided in some questions.

(d) You may use the following values of physical constants wherever necessary:

$$c = 3\times10^{8}\text{m/s}$$
$$h = 6.63\times10^{-34}\text{Js}$$
$$e = 1.6\times10^{-19}\text{C}$$
$$\mu_0 = 4\pi\times10^{-7}\ \text{T m A}^{-1}$$
$$\varepsilon_0 = 8.854\times10^{-12}\ \text{C}^2\text{N}^{-1}\text{m}^{-2}$$
$$\frac{1}{4\pi\varepsilon_0} = 9\times10^{9}\ \text{N m}^2\text{C}^{-2}$$
$$m_e = 9.1\times10^{-31}\ \text{kg}$$
$$\text{Mass of neutron} = 1.675\times10^{-27}\ \text{kg}$$
$$\text{Mass of proton} = 1.673\times10^{-27}\ \text{kg}$$
$$\text{Avogadro's number} = 6.023\times10^{23}\ \text{per gram mole}$$
$$\text{Boltzmann constant} = 1.38\times10^{-23}\ \text{JK}^{-1}$$

Question1: Why does sun appear red at sunrise and sunset?

Sol:

At the time of sun rise and sun set, light from the sun has to pass maximum distance through the earth’s atmosphere. As, wavelength of red colour is maximum in comparison of other colours of visible spectrum and amount of scattering is inversely proportional wavelength of light, therefore red colour is scattered least and enter our eyes.

Question2: Name the essential components of a communication system.

Sol:

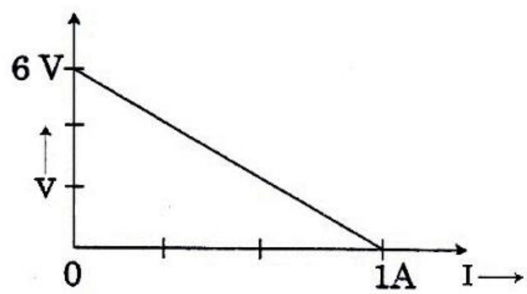
Essential components of a communication system are:
Information source, transmitter, communication channel, receiver,

Question3: In what way is the behavior of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field?

Sol:

When diamagnetic substances are placed in external magnetic field, are feebly magnetized opposite to the direction of magnetic field.
When paramagnetic substances are placed in external magnetic field, are feebly magnetized in the direction of magnetic field.

Question4: The plot of the variation of Potential difference across a combination of three identical cells in series, versus current is shown below. What is the emf and internal resistance of each cell?



Sol:

Let E and r be the emf and internal resistance of the combination of cell and E' and r' be the emf and internal resistance of each cell.

If V is the terminal potential difference then,

$V = E - I\,r$ …(i) [where I is the current]

When, $I = 0$ then $E = V$,

From the graph, when $I = 0$, $E = 6$ V.

As, there are three cells so,

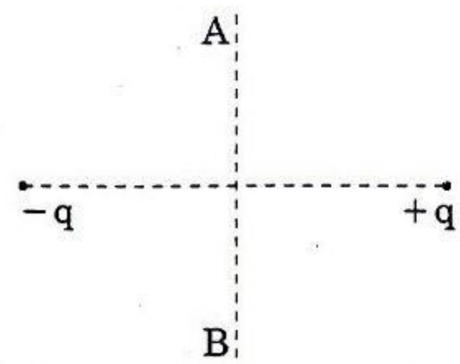
$E = 3\,E' \Rightarrow E' = 2$ V.

When, $V = 0$ then, $E = I\,r \Rightarrow r = E/I \Rightarrow r = 6/1 = 6\ \Omega$.

It is given that cells are connected in series, therefore the combined resistance of the cells is given by: $r' = r/3 \Rightarrow r' = 6/3 = 2\ \Omega$.

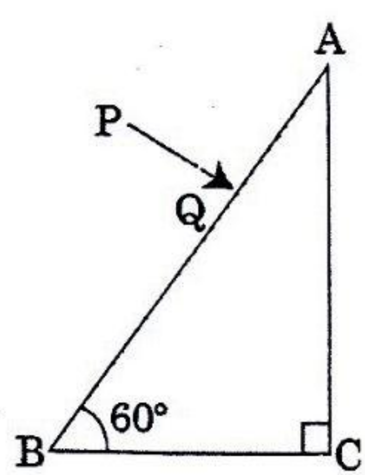
Therefore, emf of each cell is 2 V and internal resistance of each cell is 2 Ω.

Question5: A charge 'q' is moved from a point A above a dipole of dipole moment 'p' to a point B below the dipole in equatorial plane without acceleration. Find the work done in the process.



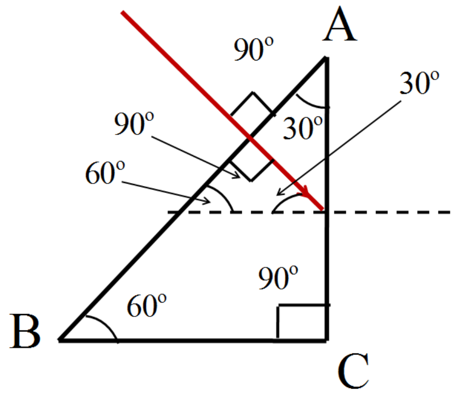
Sol:
Net potential (ΔV) at any point on equatorial plane of a dipole is zero.
As, AB lies in the equatorial plane of the dipole, therefore the work done in moving charge (q) from A to B without acceleration is q(ΔV) = 0.

Question6: A ray PQ incident normally on the refracting face BA is refracted in the prism BAC made of material of refractive index 1.5. Complete the path of ray through the prism. From which face will the ray emerge? Justify your answer.



Sol:

Here, ray PQ is falling normally on face BA of the prism. Therefore, the ray will not deviate while passing from face BA of the prism as shown in the figure given below.



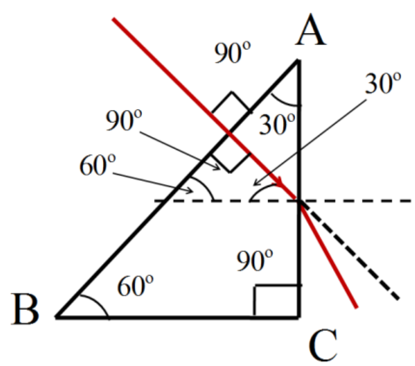
After passing through face AB ray falls on face AC making an angle $30^o$with the normal. In this case, there is a possibility that the ray may suffer total internal reflection.

So, let i_c be the critical angle, then

$$\sin i_c = \frac{1}{\mu} \Rightarrow \sin i_c = \frac{1}{1.5} \Rightarrow \sin i_c = \frac{10}{15} \Rightarrow \sin i_c = 0.66 \quad ...(i)$$

Now, angle of incidence (i) of ray is 30^0 and $\sin i = \sin 30^o = 0.5 \Rightarrow \sin i = 0.5$ …(ii)

Now, $\sin i < \sin i_c \Rightarrow i < i_c$, therefore total internal reflection will not occur and will pass from face AC of the prism. The final figure is shown below.



Question7: Calculate the de-Broglie wavelength of the electron orbiting in the $n = 2$ state of hydrogen atom.

Sol:

For a electron present in n^{th} orbit of a hydrogen atom, $mvr_n = \frac{nh}{2\pi} \quad ...(i)$

So, 2^{nd} orbit of hydrogen, $mvr_2 = \frac{2h}{2\pi} \Rightarrow mvr_2 = \frac{h}{\pi} \Rightarrow mv = \frac{h}{\pi r_2} \quad ...(ii)$

From ....(i) and ....(ii), we have $\lambda = \pi r_2$

Now, radius of n[th] orbit of hydrogen atom is given by, $r_n = n^2 \times 5.29 \times 10^{-11}$ m.

$\therefore r_2 = (2)^2 \times 5.29 \times 10^{-11}$m = 2.1×10^{-10} m.

Therefore, $\lambda = \pi r_2 = \frac{22}{7} \times 2.1 \times 10^{-10}\text{m} = 6.6 \times 10^{-10}\text{m}$.

Question8: Define modulation index. Why is it kept low? What is the role of a bandpass filter?

Sol:

Modulation Index indicates the depth of modulation. The modulation index (μ) of an amplitude modulated wave is defined as the ratio of the amplitude of modulating signal (A_m) to the amplitude of carrier wave (A_c) i.e., $\mu = \frac{A_m}{A_c}$.

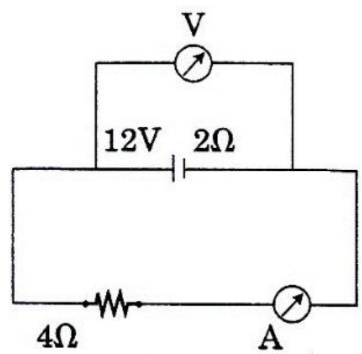
In order to avoid distortion modulation index is always kept low (less than 1).

A band pass filter rejects low and high frequencies and allows a band of frequencies to pass through.

Question9: A battery of emf 12V and internal resistance 2 Ω is connected to a 4 Ω resistor as shown in the figure.

(*a*) Show that a voltmeter when placed across the cell and across the resistor, in turn, gives the same reading.

(*b*) To record the voltage and the current in the circuit, why is voltmeter placed in parallel and ammeter in series in the circuit?



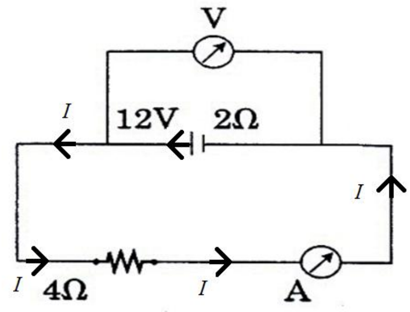
Sol:

(*a*) If V is the potential difference of the cell and E is the total emf of the cell, r is the internal resistance of the cell and I is the current drawn from cell then, $V = E - Ir$.

Here, E = 12 V, r = 2 Ω, ∴ V = 12 – 2I … (*i*)

When voltmeter is connected across the cell then, V =12

On ideal voltmeter does not draw any current from the circuit,



Applying Kirchhoff's law, we have

$12 - 4I - 2I = 0 \Rightarrow I = 2\text{ A} \ldots(ii)$

When voltmeter is connected across the cell then the reading in voltmeter will be

$V_1 = 12 - 2\,(2) \Rightarrow V_1 = 8$ V.

Now when voltmeter will be connected across the resistor then,

$V_2 = IR = 2 \times 4 = 8$ V.

Clearly both the positions will give same reading.

(*b*) A voltmeter has very high resistance, due to which it is placed parallel to the load so that it does not affect the current flowing through the circuit.

Ammeter has very little resistance due to which it is connected in series to the circuit so that all the current flows through it and it can measures the value of current accurately.

Question10: Define ionization energy.

How would the ionization energy change when electron in hydrogen atom is replaced by a particle of mass 200 times that of the electron but having the same charge?

Sol:

Ionization energy is the minimum amount of energy required to remove an electron from the outermost orbit of a neutral atom in its ground state.

(Ionization energy of hydrogen atom) ∝ (mass of electron), and mass of electron is constant. But here, electron in hydrogen atom is replaced by a particle having mass 200 times of electron. Therefore, ionization energy will be increase 200 times.

OR

Question10: Calculate the shortest wavelength of the spectral lines emitted in Balmer series. [Given Rydberd constant, R = 10^7 m^{-1}].

Sol:

The wavelength (λ) of different spectral lines of Balmer series is given by: $\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$

For shortest wavelength of Balmer, $n_2 = \infty$.

$$\therefore \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] = \frac{R}{4} \Rightarrow \lambda = \frac{4}{R} \Rightarrow \lambda = 4 \times 10^{-7}\,\text{m}$$

Question11: For a CE-transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 2 V. Suppose the current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is 1 kΩ.

Sol:

Here,

Output voltage, V_o = 2V, output resistance, R_o = 2 kΩ, base resistance, R_i = 1 kΩ, current amplification factor, β = 100.

Input signal voltage = $\frac{V_o}{V_i} = \frac{R_o}{R_i} \times \beta \Rightarrow \frac{2}{V_i} = \frac{2}{1} \times 100 \Rightarrow V_i = 10\text{ mV}$

Now, collector current, $I_C = \frac{V_o}{R_o} = \frac{2}{2} = 1\text{ mA}$

Base current, $I_B = \frac{I_C}{\beta} = \frac{1\text{ mA}}{100} = 10\ \mu\text{A}.$

Question12: (i) State law of Malus.

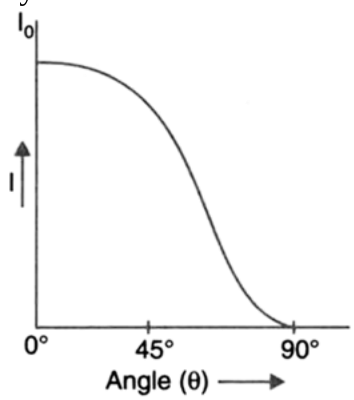
(ii) Draw a graph showing the variation of intensity (I) of polarised light transmitted by an analyser with angle (θ) between polariser and analyser.

(iii) What is the value of refractive index of a medium of polarising angle 60^0?

Sol:

(i) According to the Law of Malus, when a beam of completely plane polarised light is incident on an anlyser, the resultant intensity of light (I) transmitted from the analyser varies directly as the square of cosine of the angle (θ) between the plane of analyser and polariser i.e. $I \propto \cos^2\theta$.

(ii) Graph showing the variation of intensity (I) of polarised light transmitted by an analyser with angle (θ) between polariser and analyser.



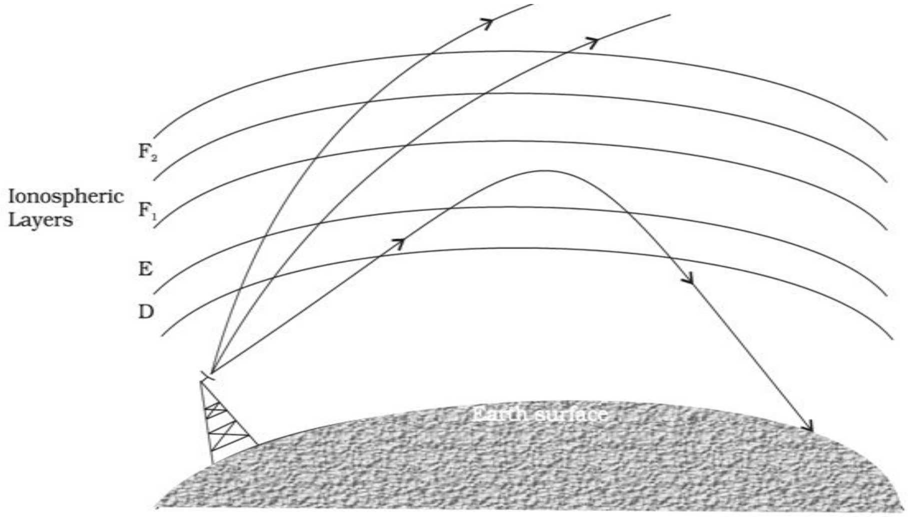
(iii) Here, polarising angle = i_p

Refractive index of the medium = $\mu = \tan i_p = \tan 60^o = 1.73$.

Question13: (i) Which mode of propagation is used by shortwave broadcast services having frequency range from a few MHz upto 30 MHz? Explain diagrammatically how long distance communication can be achieved by this mode.
(ii) Why is there an upper limit to frequency of waves used in this mode?

Sol:

(i) Sky wave propagation is used to by short wave broadcast service having frequency range from a few MHz upto 30 MHz.

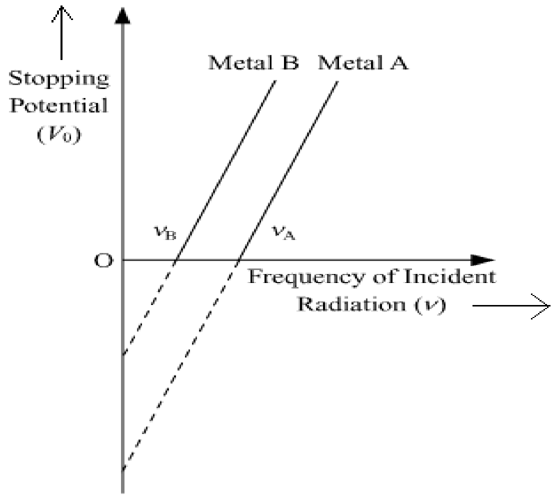


The ionosphere is so called because of the presence of a large number of ions or charged particles. It extends from a height of ~ 65 Km to about 400 Km above the earth's surface. Ionisation occurs due to the absorption of the ultraviolet and other high-energy radiation coming from the sun by air molecules. The ionosphere is further subdivided into D, E, F_1 and F_2 layers. The electromagnetic waves of different frequencies sent to the atmosphere are reflected back from different layers of ionosphere.
In a single reflection from the ionosphere, the radio-waves covers a distance of about 4000 km and in this way globe communication is possible with the help of sky wave propagation.
(ii) For every layer of ionosphere, there is certain maximum frequency of electromagnetic wave (called critical frequency), above which the wave is not reflected back and gets refracted through that layer. Due to this reason there is an upper limit to frequency of waves used in this mode.

Question14: Sketch the graphs showing variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B having threshold frequencies $\nu_A > \nu_B$.
(i) In which case is the stopping potential more and why?
(ii) Does the slope of the graph depend on the nature of the material used?
Explain.

Sol:

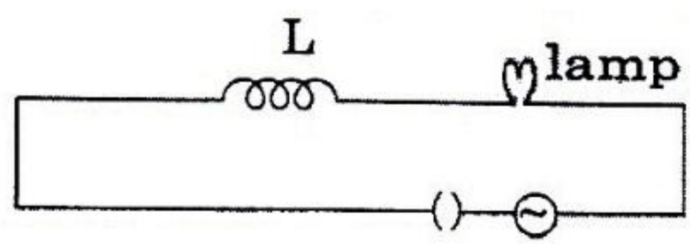
The required graph is shown below



(i) The stopping potential is inversely proportional to the threshold frequency. Therefore, the stopping potential is higher for metal B.

(ii) The slope of the graph does not depend on the nature of the material used because the slope of the graph is given by $\frac{h}{e}$ where, h is Planck's constant and e is the charge on the electron, which does not depend on the nature of the metal.

Question15: (i) When an AC source is connected to an ideal inductor show that the average power supplied by the source over a complete cycle is zero.
(ii) A lamp is connected in series with an inductor and an AC source. What happens to the brightness of the lamp when the key is plugged in and an iron rod is inserted inside the inductor? Explain.

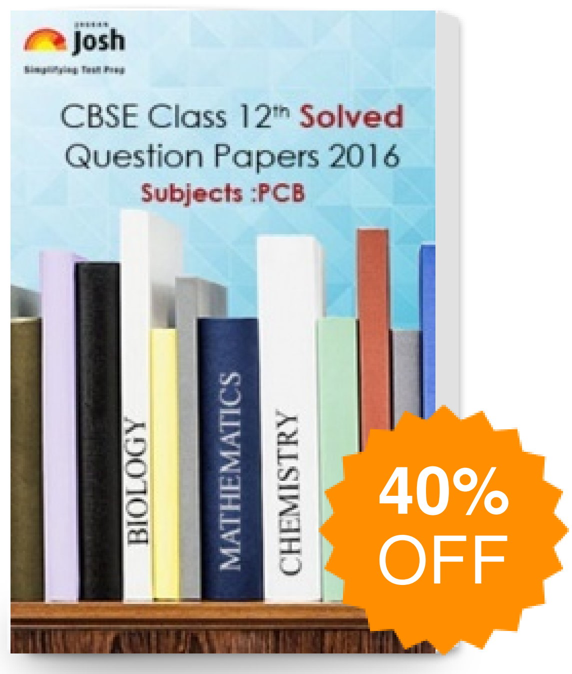


Sol:
(i) The average power supplied by an AC source is given by, $P = V\,I\cos\phi$, where $\cos\phi$ is called power factor.

For pure inductive circuit, the phase difference between current and voltage is $\pi/2$.

$\therefore \cos\phi = \cos\frac{\pi}{2} = 0 \Rightarrow$ Average power dissipated is zero.

CBSE Class 12th Solved Question Papers PCB



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