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Please check that this question paper contains 33 question and 13 printed pages.

D.A.V. INSTITUTIONS, CHHATTISGARH

SAMPLE QUESTION PAPER I -2023-24

Class - XII

SUBJECT: PHYSICS

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

General Instruction

1. All questions are compulsory. There are 33 questions in all.

2. This question paper has five sections: Section A, Section B, Section C, Section D and section E.

3. All the sections are compulsory.

4. SECTION A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of one mark each, SECTION B contains five questions of two marks each, SECTION C contains seven questions of three marks each, SECTION D contains two case study based questions of four marks each and SECTION E contains three long answer questions of five marks each.

5. There is no overall choice. However, an internal choice has been provided in one question in Section B, One question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

6. You may use the following values of physical constants wherever necessary.

$c = 3 \times 10^8 m/s$

$h = 6.63 \times 10^{-34} Js$

$e = 1.6 \times 10^{-19} C$

$\mu_0 = 4\pi \times 10^{-7} TmA^{-1}$

$\varepsilon_0 = 8.854 \times 10^{-12} C^2N^{-1}m^{-2}$

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2C^{-2}$

$m_e = 9.1 \times 10^{-31} kg$

$mass\ of\ neutron = 1.675 \times 10^{-27} kg$

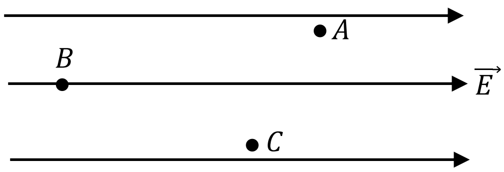
$mass\ of\ proton = 1.673 \times 10^{-27} kg$

Avogadro's number = *6.023*$\times 10^{23} per\ gram\ mole$

$Boltzmann\ constant = 1.38 \times 10^{-23} JK^{-1}$

Section –A

Q.1. A, B and C are three points in a uniform electric field. The electric potential is



a) Same all the three points A, B and C

b) Maximum at A

c) Maximum at B

d) Maximum at C.

Q.2. If the net electric flux through a closed surface is zero, then we can infer

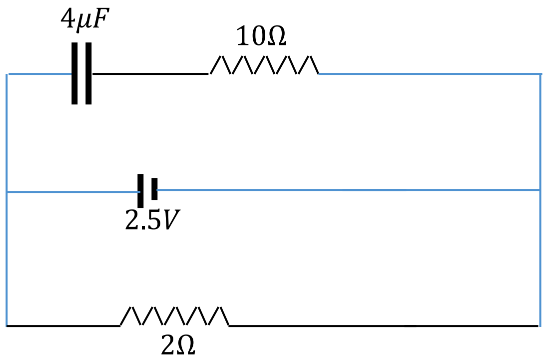
a) No net charge is enclosed by the surface

b) Uniform electric field exists within the surface

c) Electric potential varies from point to point inside the surface

d) Charge is present inside the surface.

Q.3. A capacitor of $4\mu F$ is connected as shown in the circuit (Fig.). The resistance of the battery is 0.5Ω. The amount of charge on the capacitor plates will be

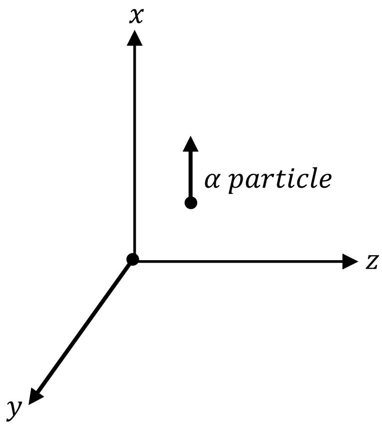


a) 0
b) $4\mu C$
c) $16\mu C$
d) $8\mu C$

Q.4. An ammeter reads up to $1A$. Its internal resistance is 0.81Ω. To increase the range to $10A$, the value of the required shunt is

a) 0.03Ω
b) 0.09Ω
c) 0.3Ω
d) 0.9Ω

Q.5. A beam of α particles projected along $+x$ axis experience a force due to a magnetic field along $+y$ axis. What is the direction of magnetic field?



a) $+Z$

b) $-Z$

c) $+Y$

d) $-Y$

Q.6. The self-inductance$L$ of a solenoid of length l and area of cross-section A, with a fixed number of turns N increases as

a) l and A increase

b) l decreases and A increases

c) $l$increases and Adecreases

d) Both l and Adecrease

Q.7. A horizontal straight wire $10m$ long extending from east to west is falling with a speed of $5.0ms^{-1}$, at right angles to the horizontal component of the earth's magnetic field, $0.30 \times 10^{-4}Wbm^{-2}$. The induced emf across ends will be

a) $1.5 \times 10^{-3}V$

b) $5.1 \times 10^{-3}V$

c) $0.15 \times 10^{-3}V$

d) $0.31 \times 10^{-3}V$.

Q.8. A pair of adjacent coils has a mutual inductance of $1.5H$. If the current in one coil changes from 0 to $20A$ in $0.5s$, What is the change of flux linkage with the other coil?

a) $30Wb$

b) $20Wb$

c) $10Wb$

d) $40Wb$

Q.9. Which of the following statements is false for the properties of electromagnetic waves?

a) Both electric and magnetic field vectors attain the maxima and minima at the same place and same time.

b) The energy in electromagnetic wave is divided equally between electric and magnetic vectors.

c) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave

d) These waves do not require any material medium for propagation.

Q.10. In young's double slit experiment, a monochromatic light of wavelength $5400Å$ produces a fringe width of 3mm. If this source is replaced by another source of monochromatic light of wavelength $6300Å$, then fringe width is

a) $0.18mm$

b) $1.37mm$

c) $3.5mm$

d) $2.4mm$

Q.11. The Bohr model of atoms

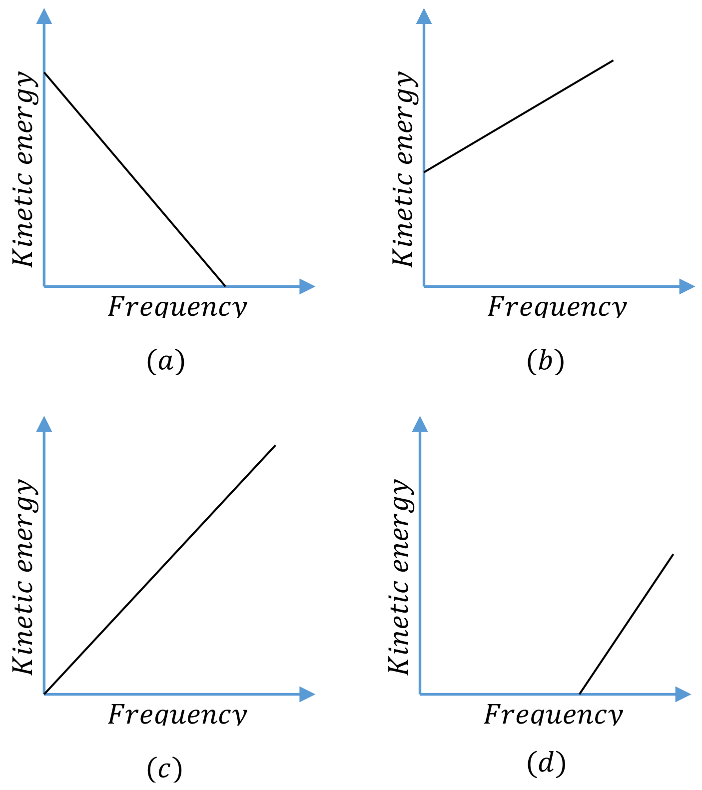
a) Assumes that the angular momentum of electrons is quantized.

b) Uses Einstein's photoelectric equation.

c) Predicts continuous emission spectra for atoms.

d) Predicts the same emission spectra for all types of atoms.

Q.12. According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is



In Q.13. to Q.16., two statement are given one labeled Assertion (A) and other labeled Reason (R). Select the correct answer to these questions from the options as gives below.

(a) If both Assertion and reason are true and Reason is the correct explanation of Assertion.

(b) If both Assertion and reason are true but reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

(d) If both Assertion and Reason are false.

Q.13. **Assertion (A):** The threshold frequency of photoelectric effect supports the particle nature of light.

Reason (R): If frequency of incident light is less than the threshold frequency, electrons are not emitted from metal surface.

Q.14. **Assertion (A):** In young's double slit experiment, the interference pattern disappears when one of the slits is closed.

Reason (R): Interference occurs due to the superposition of light waves from two coherent sources.

Q.15. **Assertion (A):** The electrons in the conduction band have higher energy than those in valance band of semiconductor.

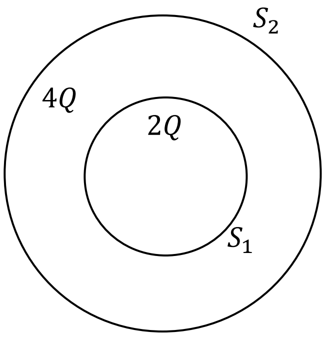
Reason (R): The conduction band lies above the energy gap and valence band lies below the energy gap.

Q.16. **Assertion (A):** Inside a current carrying conductor, electric field is zero.

Reason (R): Electric shielding refers to presence of electric field in the volume of any conductor.

Section –B

Q.17. Consider two hollow concentric spheres, S_1 and S_2 enclosing charges $2Q$ and $4Q$ respectively as shown in fig.



i) Find out the ratio of the electric flux through them.

ii) How will the flux through S_1 change if medium of dielectric constant ε_r is introduced in the space inside S_1in place of air.

Q.18. Show diagrammatically the behavior of magnetic field lines in presence of i) Para-magnetic and ii) Diamagnetic substance.

Q.19. Gamma rays and radio waves travel with the same velocity in free space. Distinguish between them in terms of their origin and the main application.

Q.20. a) Draw a labeled ray diagram of a compound microscope.

b) Why is objective of a microscope is of short aperture and short focal length? Give reason.

Q.21. Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicated the regions in which the nuclear force is

i) Attractive ii) Repulsive.

Write two important conclusions which you draw regarding the nature of nuclear force.

OR

Calculate the binding energy per nucleon of ${}^{40}_{20}Ca$ nucleus.

Give $m(^{40}_{20}Ca = 39.962589U)$

$m_n = 1.008665U,$ $m_p = 1.007825U,$ $1U = 931Mev/c^2$

Section –C

Q.22. The ground state energy of hydrogen atom is $-13.6eV$.

i) What is the potential energy of an electron in the 3rd excited state?

ii) If the electron jumps to the ground state from the 3rd excited state, calculate the wavelength of the photon emitted.

Q.23. Explain giving reasons for the following:

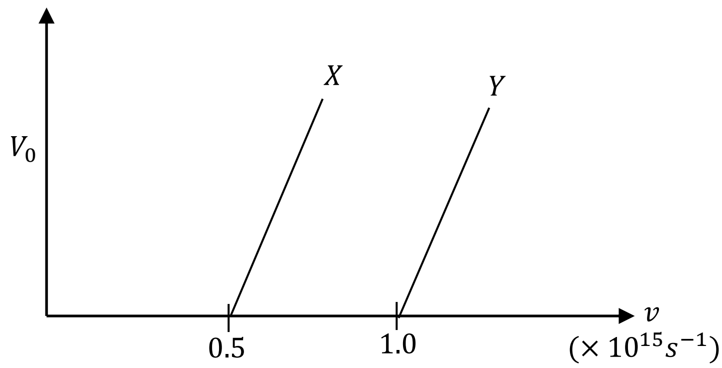
a) Photoelectric current in a photocell increase with the increase in the intensity of the incident radiation.

b) The stopping potential (V_0) varies linearly with the frequency (υ) of the incident radiation for a given photosensitive surface with the slope remaining the same for different surfaces.

c) Maximum kinetic energy of the photoelectrons is independent of the intensity of incident radiation.

OR

The following graph shows the variation of stopping potential V_0 with the frequency υ of the incident radiation for two photosensitive metals X and Y:

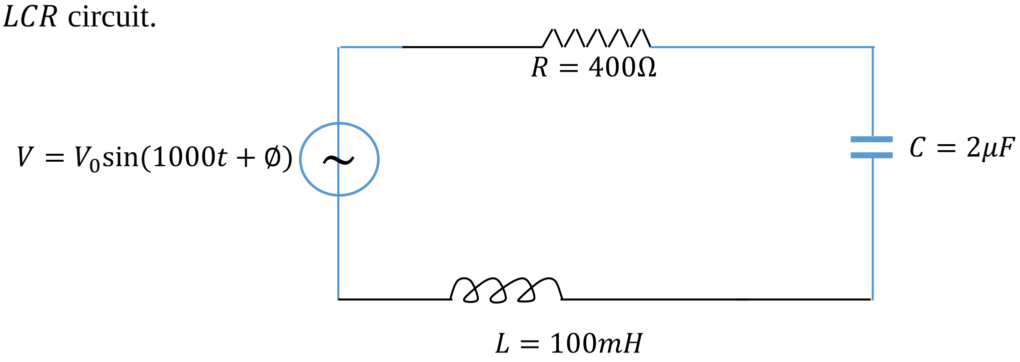


i) Which of the metals has larger threshold wavelength? Give reason.

ii) Explain, giving reason, which metal gives out electrons, having larger kinetic energy, for the same wavelength of the incident radiation.

iii) If the distance between the light source and metal X is halved, how will the kinetic energy of electrons emitted from it change? Give reason.

Q.24. a) Determine the value of phase difference between the current and the voltage in the given series LCR circuit.



b) Calculate the value of the additional capacitor which may be joined suitably to the capacitor C that would make the power factor of the circuit unity.

OR

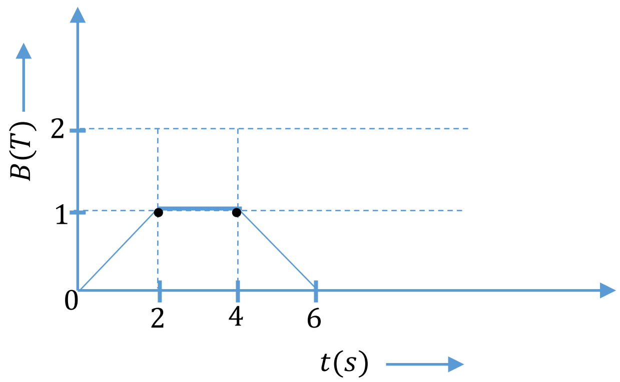
The primary coil of an ideal step-up transformer has 100turns and transformation ratio is also 100. The input voltage and power are 220V and 1100W respectively, calculate

a) The number of turns in the secondary coil.
b) The current in the primary coil.
c) The voltage across the secondary coil.
d) The current in the secondary coil.
e) The power in the secondary coil.

Q.25. a) Write the expression for the magnetic force acting on a charged particle moving with velocity v in the presence of magnetic field B.

b) A neutron, an electron and an alpha particle moving with equal velocities, enter a uniform magnetic field going into the plane of the paper as shown. In which direction they will experience force? Trace their path in the field and write expression for radius of their path.

Q.26. The magnetic field through a circular loop of wire $12cm$ in radius and 8.5Ω resistance, changes with time as shown in figure

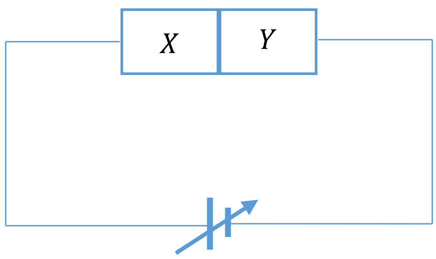


The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop and plot it as a function of time.

Q.27. A point object is placed on the principal axis of a convex spherical surface of radius of curvature R which separates two media of refractive indices n_1 and n_2 $(n_2 > n_1)$. Draw the ray diagram and deduce the relation between the object distance (u), image distance (v) and radius of curvature (R) for refraction to take place at the convex spherical surface from rarer to denser medium.

Q.28. a) Why the current under reverse bias almost independent of applied potential up to a critical voltage?

b) Two semiconductor materials X and Y shown in the given figure are made by doping germanium crystal with indium and arsenic respectively. The two are joined end to end and connected to a battery as shown.Will the junction be forward biased or revers biased? Explain.



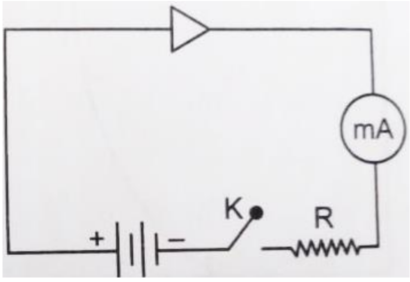
Section – D

Case Study Based Questions

Q.29. **Read the paragraph and answer the following questions.**

The potential difference created across the p-njunction due to the diffusion of electrons and holesis called potential barrier. It may be pointed outthat across the junction a very large electric fieldis set-up due to potential difference developedacross it.

When a p-type semiconductor is brought into aclose contact with n-type, we get a p-n junctionwith a barrier voltage $0.5\ V$ and width of depletion region is $10^{-6}m$. This junction is forward biased with a voltage of $4V$ and negligible internal resistance, in series with a resistor of resistance R,ideal milliameter and a key as shown in figure.When key is pressed, a current of $35\ mA$ passesthrough the diode.



(i) Find the intensity of the electric field in the depletion region when p-n junction is unbiased.

a) $5 \times 10^5 Vm^{-1}$ b) $2 \times 10^5 Vm^{-1}$

c) $25 \times 10^{25} Vm^{-1}$ d) $2.5 \times 10^{25} Vm^{-1}$

(ii) The potential difference across R is:

a) 0 b) $3.5V$

c) $0.5V$ d) $2.0V$

(iii) Resistance of resistor R will be:

a) 500Ω b) 1000Ω

c) 10Ω d) 100Ω

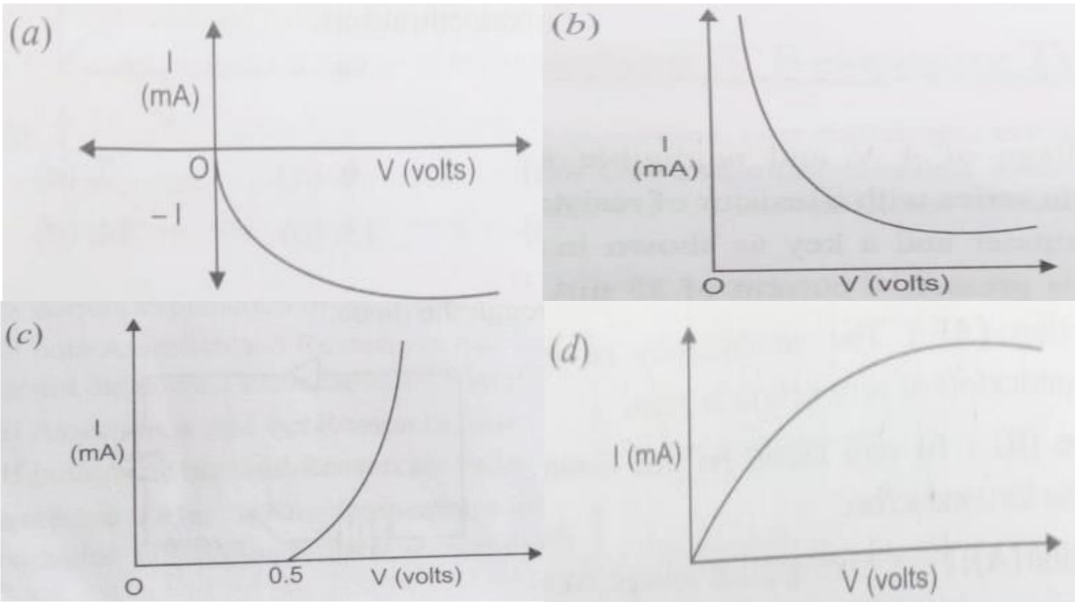
OR

A semiconductor is cooled from $T_1 K$ to $T_2 K$. Its resistance:

a) Will increase b) Will decrease

c) Will not change d) Will first decrease and then increases.

(iv) Which of the following I-Vcharacteristic for a given p-n junction diode is correct.



Q.30. **Read the following paragraph and answer the questions that follows:**

In 1801, the English scientist Thomas young performed a historic experiment that demonstrated the wave nature of light by showing that two overlapping light waves interfered with each other. He was also able to determine the wavelength of light from his measurements. The distance between two successive maxima or minima is called fringe width as given as

$$\beta = \frac{\lambda D}{d}$$

Where $\beta =$ Fringe width

$\lambda =$ Wavelength

$D =$ Distance between source and screed

$d =$ Distance between two sources.

Young's double slit experiment is performed inside water of refractive index $\mu = {}^{4}/_{3}$ with a light of frequency $6 \times 10^{14} Hz$. If the slits are separated by $0.2mm$ and screen is kept $1m$ from the slits.

(i) Find the wavelength of given light of frequency $6 \times 10^{14} Hz$ in air.

a) $5 \times 10^{-7} m$

b) $5 \times 10^{7} m$

c) $5 \times 10^{-4} m$

d) $5 \times 10^{-14} m$

(ii) Find the wavelength of light of same frequency ($6 \times 10^{14} Hz$) in water of refractive index ${}^{4}/_{3}$

a) $4.9 \times 10^{7} m$

b) $3.75 \times 10^{-7} m$

c) $5.75 \times 10^{-7} m$

d) $37.5 \times 10^{-7} m$

(iii) Find the fringe width, if the experiment is performed in air using the same set-up.

a) $25m$

b) $25mm$

c) $25cm$

d) $2.5mm$

(iv) Find the fringe width, if the experiment is performed in water.

a) $1.87m$

b) $1.87cm$

c) $1.87mm$

d) $2.5m$

OR

In Young's double slit experiment, the maximum intensity is I_0, when one slit is closed, the intensity becomes:

a) I_0

b) ${}^{I_0}/_{4}$

c) ${}^{I_0}/_{3}$

d) ${}^{I_0}/_{2}$

Section –E

Q.31. a) What are coherent sources of light? Two slits in young's double slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed?

b) Write the condition for getting dark and bright fringes in young's experiment. Hence write the expression for the fringe width.

c) If s is the size of the source and d is its distance from the plane of the two slits. What should be the criterion for the interference fringes to be seen?

OR

a) State Huygen's principle. Using this principle draw a diagram to show how a plane wave front incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence verify Snell's law of refraction.

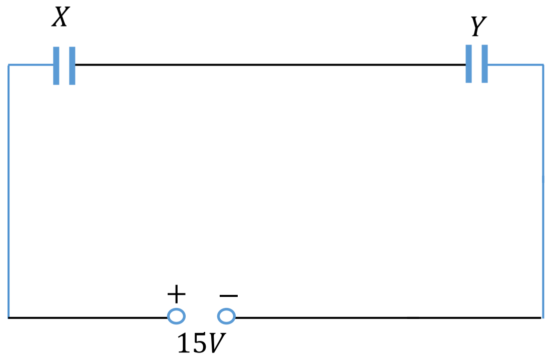
b) When monochromatic light travels from a rarer to a denser medium, explain the following, giving reasons:

i) Is the frequency of reflected and refracted light same as the frequency of incident light?

ii) Does the decrease in speed imply a reduction in the energy carried by light wave?

Q.32. a) A parallel plate capacitor, each of plate area A and separation 'd'between the two plates, is charged with charges $+Q$ and $-Q$ on the two plates. Deduce the expression for the energy stored in capacitor.

b) Two parallel plate capacitor X and Y have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric of $\varepsilon_r = 4$.



i) Calculate capacitance of each capacitor if equivalent capacitance of the combination is $4\mu F$.

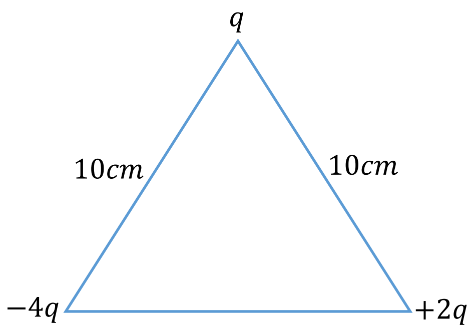
ii) Calculate the potential difference between the plates of X and Y.

iii) Estimate the ratio of electrostatic energy stored in X and Y.

OR

a) Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points with positions r_1 and r_2 respectively, in presence of external electric field E.

b) Calculate the work done to dissociate the system of three charges placed on the vertices of a equilateral triangle as shown given in the figure. (Here, $q = 1.6 \times 10^{-10} C$.)

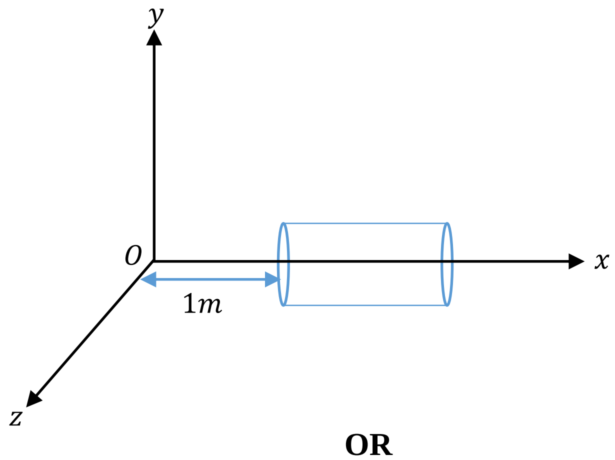


Q.33. a) Define electric flux. Write its S.I. unit. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason.

b) A hollow cylindrical box of length 1m and area of cross-section $25cm^2$ is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 50x\hat{\imath}$, where E is in NC^{-1} and x is in metres. Find

i) Net flux through the cylinder.

ii) Charge enclosed by the cylinder.



OR

a) State Gauss's law.

b) A thin straight infinitely long conducting wire of linear charge density 'λ' is enclosed by a cylindrical surface of radius 'r' and length 'l'. Its axis coinciding with the length of the wire. Obtain the expression for the electric field, indicating its direction, at a point on the surface of the cylinder.

c) Consider a uniform electric field $\overrightarrow{E} = 3 \times 10^3 \hat{\imath} N/C$. Calculate the flux of this field through a square surface of area $10cm^2$ when

i) Its plane is parallel to the $y - z$ plane

ii) The normal to its plane makes a 60^0 angle with the x-axis.