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Please check that this question paper contains 33 question and 11 printed pages.

D.A.V. INSTITUTIONS, CHHATTISGARH

SAMPLE QUESTION PAPER III -2023-24

Class - XII

SUBJECT: PHYSICS

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

General Instruction

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.

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

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

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

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

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

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

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

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

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

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

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

Section –A

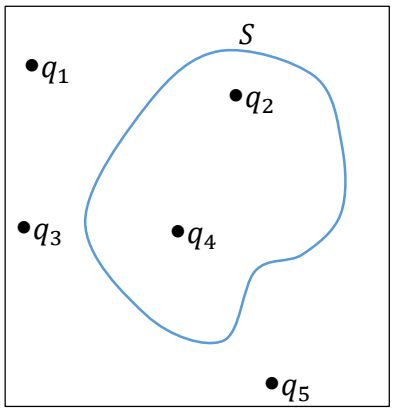
Q.1. The electric field required to keep a water drop of mass m just to remains suspended, when charged with one electron of charge e (take g as acceleration due to gravity) is

a) mg b) $^{mg}/_{e}$ c) emg d) $^{me}/_{g}$

Q.2. Two point charges $+8q$ and $-2q$ are located at $x = 0$ and $x = L$ respectively. The point on $x-$axis at which net electric field is zero due to these charges is

a) $8L$ b) $4L$ c) $2L$ d) L

Q.3. Five charges $q_1,\ q_2,\ q_3,\ q_4$ and q_5 are fixed at their positions as shown in figure, S is a Gaussian surface. The Gauss's law is given by $\int \vec{E}.\vec{ds} = {}^{q}/_{\varepsilon_0}$. Which of the following statement is correct?



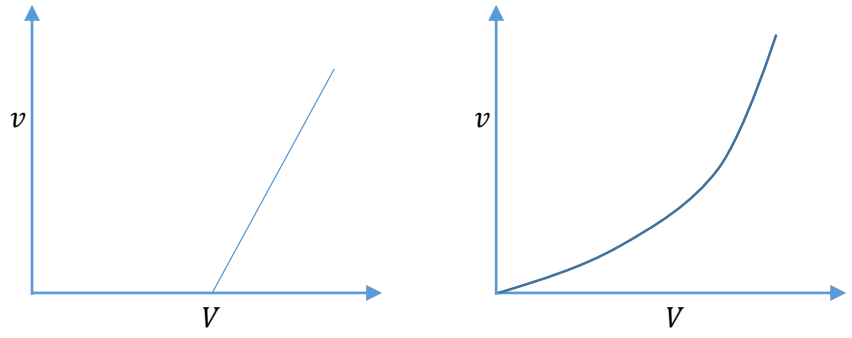
a) $\vec{E}$ $on\ LHS$ of the above equation will have a contribution from $q_1,\ q_5$ and q_3 while q on RHS will have a contribution from q_2 and q_4 only.

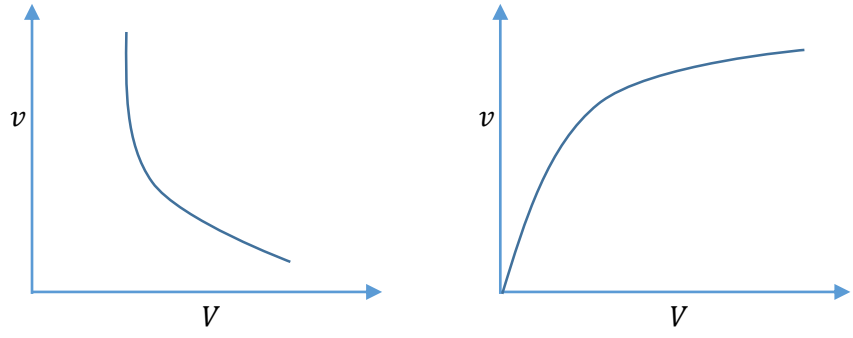
b) $\vec{E}$ $on\ LHS$ of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_4 only.

c) $\vec{E}$ $on\ LHS$ of the above equation will have a contribution from all charges while q on the RHS will have a contribution from $q_1,\ q_3$ and q_5 only.

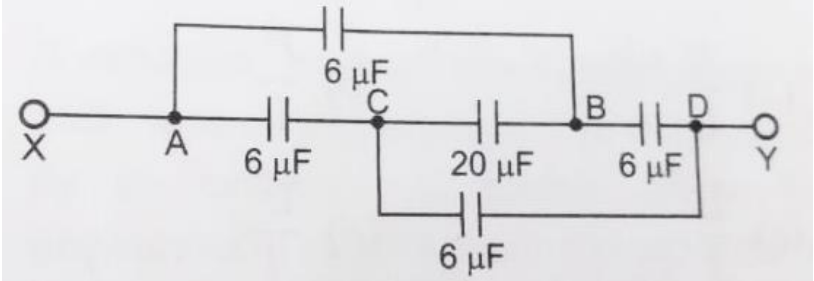
d) Both $\vec{E}$ $on\ LHS$ and q on the RHS will have contribution from q_2 and q_4 only.

Q.4. The velocity v acquired by an electron starting from rest and moving through a potential difference V is shown by which of the following graphs?





Q.5. What is the effective capacitance between points X and Y?



(a) $24\mu F$ b) $18\mu F$ (c) $12\mu F$ (d) $6\mu F$

Q.6. Two parallel wires in free space are $0.1\ m$ apart and each carries a current of $10^4 mA$ in the same direction. The force exerted by one wire on the other (per metre length) is

(a) $2 \times 10^{-4} N$ (attractive) (b) $2 \times 10^{-7} N$ (attractive)

(c) $2 \times 10^{4} N$ (attractive) (d) $2 \times 10^{-7} N$ (repulsive)

Q.7. Which of the following statement is true about the magnetic susceptibility x_m of paramagnetic substance?

(a) Value of x_m is directly proportional to the absolute temperature of the sample

(b) x_m is positive at all temperature

(c) x_m is negative at all temperature

(d) x_m does not depends on the temperature of the sample

Q.8. The flux linked with a circuit is given by $\emptyset = t^3 + 5t + 5$. The graph between induced emf (y-axis) and time (x-axis) will be

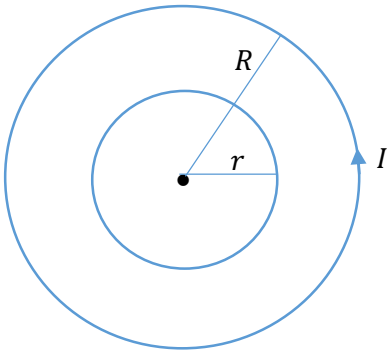
(a) Straight line through the origin

(b) Straight line with positive intercept

(c) Parabola through the origin

(d) Parabola not through the origin

Q.9. A small circular loop of wires of radius r is placed inside a large circular loop of wire of radius R ($R \gg r$). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to:



(a) r/R (b) r^2/R (c) R/r (d) R^2/r

Q.10. If λ_y, λ_x and $\lambda_m$represent the wavelengths of visible light. X-rays and microwaves respectively, then

(a) $\lambda_m > \lambda_x > \lambda_y$

(b) $\lambda_y > \lambda_m > \lambda_x$

(c) $\lambda_y > \lambda_x > \lambda_m$

(d) $\lambda_m > \lambda_y > \lambda_x$

Q.11. A lens of refractive index $n$is put in a liquid ofrefractive index n'. If focal length of lens in air is$f$,its focal length in liquid will be:

(a) $\frac{fn'(n-1)}{n'-n}$

(b) $\frac{f(n'-n)}{n'(n-1)}$

(c) $\frac{n'(n-1)}{f(n'-n)}$

(d) $\frac{fn'n}{n-n'}$

Q.12. In Young's double slit experiment, the separation between the slits is halved and the distance between the slits and screen is doubled. The width of fringe:

(a) Unchanged (b) Halved

(c) Doubled (d) Quadrupled.

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):** Most of α-particles pass through thin metal foils without deflections.
Reason (R): Large space in an atom is empty.

Q.14. **Assertion (A):** An ideal junction diode offers zero resistance, when forward biased.
Reason (R): When diode is forward biased, the width of depletion layer decreases.

Q.15. **Assertion (A):** To increase the range of anammeter, we must connect a suitable high resistance in series to it.
Reason (R): The ammeter with increased range should have high resistance.

Q.16. **Assertion (A):** Current density is a vector quantityand current is a scalar quantity.
Reason (R): Electric current through a cross-section may be assumed as flux of electric current density through that area.

Section –B

Q.17. Plot a graph showing the variation of de-Broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where V is accelerating potential for two particles. A and B carrying same charges but masses m_1, m_2 $(m_1 > m_2)$. Which one of the two represents a particle of smaller mass and why?

Q.18. Two cells of $emfs$ $1.5V$ and $2.0V$ having internal resistances 0.2Ω and 0.3Ω respectively are connected in parallel, calculate the emf and internal resistance of the equivalent cell.

Q.19. A nucleus with a mass number $A = 240$ and $\frac{BE}{A} = 7.6MeV$ breaks into two fragments each of $A = 120$ with $\frac{BE}{A} = 8.5MeV$. Calculate the released energy.

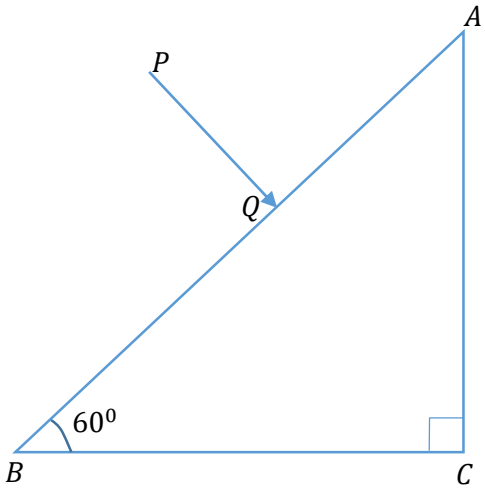
OR

Calculate the energy in fusion reaction:

${}_1H^2 + {}_1H^2 \longrightarrow {}_2He^3 + n$, where BE of ${}_1H^2 = 2.23MeV$ and of ${}_2He^3 = 7.73MeV$.

Q.20. A circular coil of 'N' turns and diameter 'd' carries a current 'I'. It is unwound and rewound to make another coil of diameter '$2d$' current 'I' remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil.

Q.21. 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.

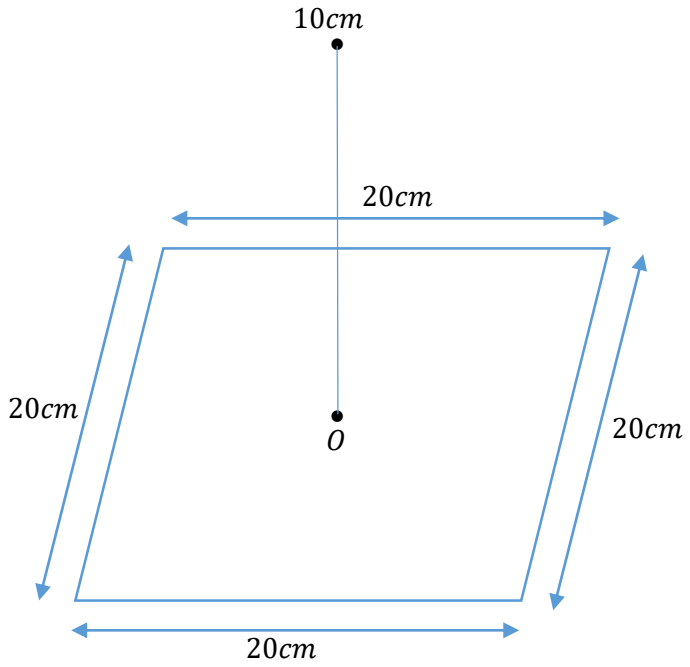


Section –C

Q.22. State the Principle on which AC generator works.

Derive expression for maximum emf produced. Explain its alternating nature with the help of graph.

Q.23. A point charge of 10 pC is a distance of 10 cm directly above the centre of a square of side 20 cm, as shown in figure. What is the magnitude of the electric flux through the square?



Q.24. The electron in a given Bohr orbit has a total energy of $-1.5eV$. calculate its:

i) Kinetic energy

ii) Potential energy

iii) Wavelength of radiation emitted, when this electron makes a transition to the ground state.

(Given energy in the ground state $= -13.6eV$ and Rydberg's constant $= 1.09 \times 10^{7} m^{-1}$)

OR

a) If the frequency of incident radiation on the cathode of a photocell is doubled, how the following changes:

i) kinetic energy of the electrons

ii) Photoelectric current

iii) Stopping potential.

b) If light of wavelength $\lambda = 4 \times 10^{-7} m$ and intensity $10^{2} W/m^{2}$ incident on a metal plate of threshold frequency $55 \times 10^{13} Hz$. What will be the maximum kinetic energy of photoelectron?

Q.25. Explain how one observes inconsistency where Ampere's law is applied to the process of charging a capacitor. How this contradiction gets removed by introducing the concept of an additional current known as displacement current.

OR

A capacitor, made of two parallel plates each of plate area A and separation d is being charged by an external AC source. Show that the displacement current inside the capacitor is same as the current charging the capacitor.

Q.26. Use Bio Savart's law to derive a relation for magnetic field on axial point of a current carrying circular coil. Also prove that a current carrying circular coil behaves like a magnetic dipole.

Q.27. Define magnifying power of a astronomical telescope. Explain the construction and working of astronomical telescope. Hence, derive an expression for the magnifying power of a astronomical telescope when the image is formed at least distance of distinct vision.

Q.28. Draw a circuit diagram of a full-wave rectifier. Explain its working and draw input and output waveform.

Section – D

Case Study Based Questions

Q.29. Read the following paragraph and answer the questions that follow:

A Faraday shield is an enclosure made of conducting material. The fields within a conductor cancel out with any external fields, so the electric field within the enclosure is zero. These cages actas big hollow conductors you can put, laptops, cell phones into shield them from electric fields. Any electrical shocks the cage receives, pass harmlessly around the outside of the cage.

(i) The electric field inside a Faraday cage when it isstruck by lightning will be:

(a) ∞

(b) zero

(c) may be zero or ∞

(d) none of these

(ii) The charge which appears on the surface of the Faraday cage when an isolated point charge - q isplaced inside the cage will be

(a) $-\ q$

(b) $2q$

(c) $+q$

(d)zero

(iii) When an electric dipole is placed at the centre of Faraday cage. Then the total flux coming out of the surface will be

(a) zero

(b) $\frac{2q}{\varepsilon_0}$

(c) $\frac{-2q}{\varepsilon_0}$

(d) $\frac{q}{\varepsilon_0}$

OR

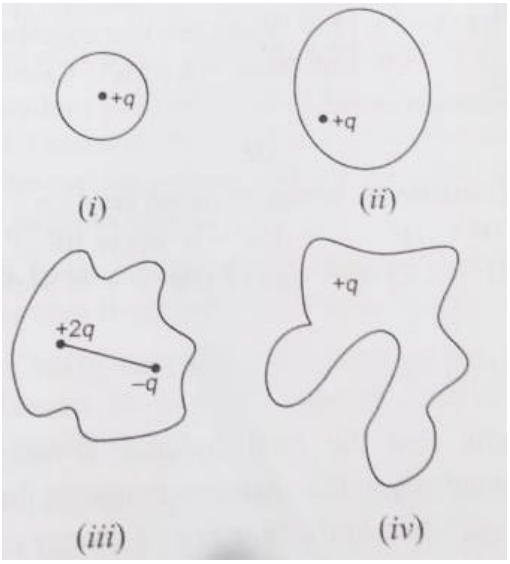
The electric flux through the surface:

(a) in fig (iv) is the largest

(b) in fig. (iii) is the least

(c) in fig. (ii) is same as fig. (iii) but is smaller than fig. (iv)

(d) is the same for all the figures.



(iv) Dimensional formula of electric flux and units are:

(a) $M^1L^3T^{-3}A^{-1}, Nm^2C^{-1}$

(b) $ML^2T^2A^{-1}, Nm^2C^2$

(c) $ML^3T^2A^2, N^{-1}m^2C^{-2}$

(d) $ML^2T^3A^{-1}, Nm^2C$

Q.30. Read the following paragraph and answer thequestions that follow:

The total internal reflection of the light is used inpolishing diamond to create a sparking brilliance.

By polishing the diamond with specific cuts, it is adjusted so that the most of the light rays approaching the surface are incident with anangle of incident more than critical angle. Hence, they suffer multiple reflection and ultimately comes out of diamond from the top. This givesthe diamond a sparking brilliance, so it works on the principle of total internal reflection of light.

(i) What will be the speed of light in diamond if its refractive index is 2.42°?

(a) $1.25 \times 10^8 ms^{-1}$ (b) $1.25 \times 10^9 ms^{-1}$

(c) $2.25 \times 10^8 ms^{-1}$ (d) $3 \times 10^8 ms^{-1}$

(ii) Why light cannot easily escape a diamond without multiple reflection?

(a) Because its critical angle with reference to air is too small

(b) Because its critical angle with reference to air is too large

(c) Because its critical angle with reference to air is equal

(d) None of these

(iii) If a diamond is immersed in a liquid with a refractive index greater than water. Then what will happens to the critical angle for TIR.

(a) It will decrease (b) It will increase

(c) It will remains same (d) None of these

OR

Which of the following principle is responsible for sparking brilliance of a diamond?

(a) Total internal refraction of light (b) Total internal reflection of light

(c) Scattering of light (d) None of these

(iv) The critical angle for TIR from medium to vacuum is 30°. What is the refractive index of medium?

a) 2.5 b) 1

c) √2 d) 2

Section – E

Q.31. (i) Find an expression for the electric field strength at a distant point situated along the equatorial line of an electric dipole.

(ii) Two parallel uniformly charged infinite plane sheets, '1' and '2', have charge densities $+\sigma$ and -2σ respectively. Give the magnitude and direction of the net electric field at a point:

(a) in between the two sheets and

(b) out side near the sheet '1'.

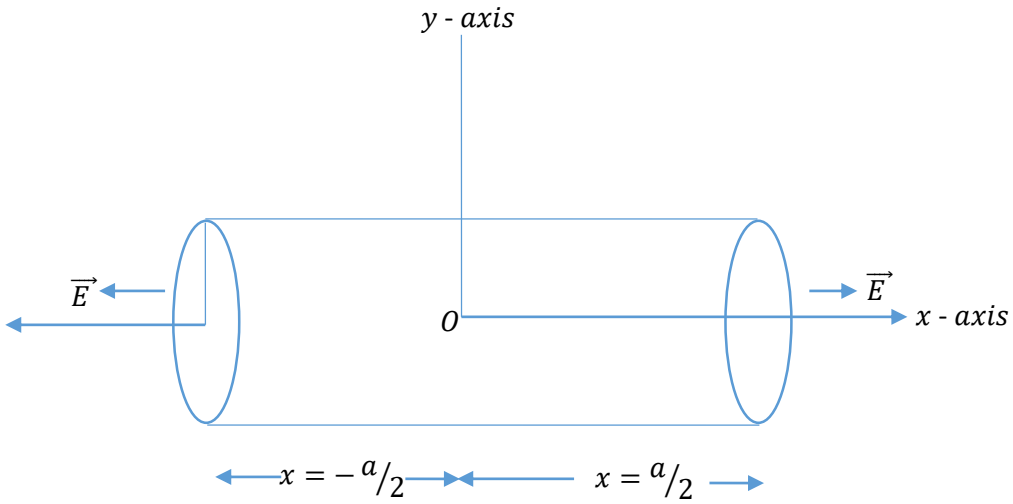
OR

(i) (a) Define electric flux. Write its SI unit.

(b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of thedistance from it.

(c) How is the field directed if, (I) the sheet ispositively charged, (II) negatively charged?

(ii) A right circular cylinder of length 'a' and radius'r' has its centre at the origin and its axis along the x-axis so that one face is at $x = +{}^{a}/_{2}$ and theother at $x = -{}^{a}/_{2}$, as shown in the figure. A uniform electric field is acting parallel to the$x$-axis such that $\vec{E} = E_0\hat{\imath}$ for $x > 0$ and $\vec{E} = -E_0\,\hat{\imath}$ for $x < 0$.



Find out the flux (a) through the flat faces,(b) through the curved surface of the cylinder. What is the net outward flux through the cylinder and the net charge inside the cylinder?

Q.32. (i) State the condition for maximum current in series $LCR\ AC$ circuit and write an expression for applied frequency.

(ii) Draw a plot showing the variation of the peak current (I_m) with frequency of the AC source used.

(iii) A $1000mH$ inductor, a $20\mu F$ capacitor and 100Ω resistor are connected in series to a $100V\ AC$ source. Calculate

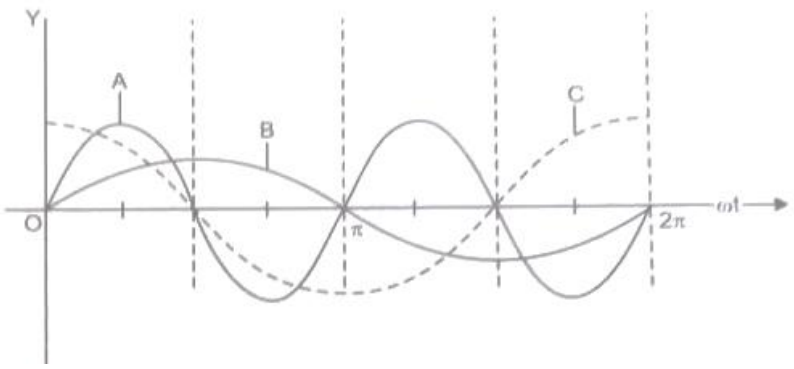
i) Impedance for maximum power dissipation

ii) Maximum current in circuit

iii) Frequency of source for maximum current.

OR

A device 'X' is connected to an AC source$V = V_0 sin\omega t$. The variation of voltage, current and power in one cycle is shown inthe following graph:



(i) Identify the device 'X'.

(ii) Which of the curves, A, B and C representthe voltage, current and the power consumed in the circuit? Justify your answer.

(iii) How does its impedance vary with frequency of the AC source? Show graphically.

(iv) Obtain an expression for the current inthe circuit and its phase relation with ACvoltage.

Q.33. (i) Draw the ray diagram for the formation of image of an object by a convex mirror and use it (along with the sign convention) to derive the mirror formula.

(ii) A converging lens has a focal length of $20cm$ in air. It is made of material of refractive index 1.6. If immersed in a liquid of refractive index 1.3, what will be its new focal length?

How does the nature of lens change, if the lens is immersed in a liquid of refractive index 1.8?

OR

a) A plain wave front approaching a plane surface separating two media. If medium one is optically denser and medium two is optically rarer. Construct the refracted wave front using Huygen's principle. Hence prove Snell's law.

b) Find the ratio of intensities of two points P and Q on screen in a Young's double slit experiment when waves from source S_1 and S_2 have phase difference of 0^0 and $\pi/2$ respectively.