1. The electrostatic force on a small sphere 'A' having a charge 0.4 μc, due to another small sphere 'B' having charge -0.8 μC in air is $(0.2N)\hat{i}$. The fore on Sphere 'B' due to sphere 'A' is : 1

(a) $(0.4N)\hat{i}$ (b) $(0.4N)(-\hat{i})$

(c) $(0.2N)\hat{i}$ (d) $(0.2N)(-\hat{i})$

2. Which of the following statement is **NOT** correct for the charge : 1

(a) Change on a body is always given by, q = ne where n is any integer.

(b) The total charge of an isolated system is always conserved.

(c) Only non-metallic bodies can be charged on rubbing.

(d) Metallic and non-metallic bodies, both can be charged on rubbing.

3. The electrostatic potential energy of a system consisting of two charges 7 μC and –2μC (with no external electing field) placed at (–9 cm, 0, 0) and (9 cm, 0, 0) respectively is: 1

(a) -0.7 J (b) 0.7 J

(c) -700 J (d) 700 J

4. Which of the following is a non-ohmic conductor? 1

(a) Aluminium (b) Copper

(c) Iron (d) Germanium

5. A uniform magnetic field exists in a certain region along positive z-axis. An electron kept at a point in this magnetic field is given an impulsive force along positive x-axis. The electron will : 1

(a) Move along a straight line along positive x-axis

(b) Move along a circular path in XY plane

(c) Move along a circular path in XZ plane

(d) Move along a straight line along negative x-axis

6. Which of the following does **NOT** exhibit diamagnetism : 1

(a) Bismuth (b) Lead

(c) Calcium (d) Mercury cooled to 4.2 K

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7. A square loop of side 10 cm and resistance 0.5 Ω is placed vertically in east-west plane. A uniform magnetic field of 0.10 T is set up across the plane in north-east direction. The magnetic field is decreased to zero in 0.70 S at a steady rate. The magnitude of induced emf in the loop is : 1

(a) 1.0 mV (b) 100 V

(c) 0.7 mV (d) 1.0 V

8. The average power supplied to an a.c. circuit in one cycle is zero. The circuit consists of : 1

(a) An ideal inductor (b) An ideal capacitor

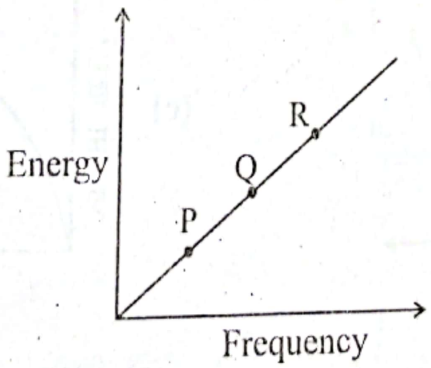
(c) An ideal resistor (d) both (a) and (b)

9. The amplitude of the magnetic field part of a harmonic electro-magnetic wave in vacuum is 510 nT. The amplitude of the electric field part of the wave is : 1

(a) 1.53×10^{11} N/C (b) 1.7×10^{10} N/C

(c) 153 N/C (d) 17 N/C

10. The given graph shows the relationship between the frequency of the electro-magnetic waves and energy of photon associated with them. Three points P, Q and R are marked on the graph may correspond respectively to : 1



(a) X-rays, microwaves, UV radiation

(b) X-rays, UV radiation, microwaves

(c) UV radiation, X-rays, microwaves

(d) Microwaves, UV radiation, X-rays

For Visually Impaired Students

If λ_1, λ_2 and λ_3 represent wavelengths of radio wave, gamma rays and infra red rays respectively, then which of the following represent increasing order of wavelengths : 1

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(a) $\lambda_1 < \lambda_2 < \lambda_3$ (b) $\lambda_2 < \lambda_1 < \lambda_3$

(c) $\lambda_3 < \lambda_2 < \lambda_1$ (d) $\lambda_2 < \lambda_3 < \lambda_1$

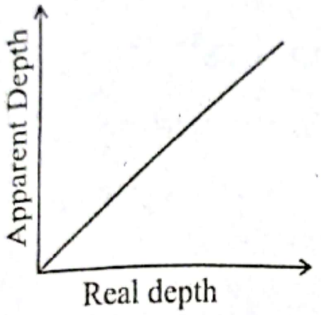
11. An object is placed 20 cm from a convex lens and its image is obtained on a screen 50 cm away from the object. The focal length of the lens used is : 1

(a) 14.3 cm (b) 12 cm

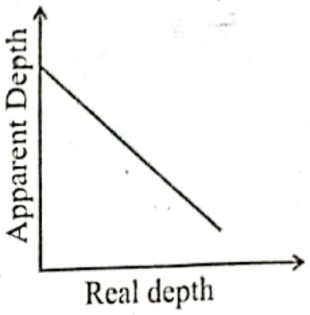
(c) 33.3 cm (d) 60 cm

12. A tank is filled with a transparent liquid to height H. A coin suspended by a thread in the liquid is gradually lowered till it touches the bottom. The apparent height is determined corresponding to different positions of the coin. Which of the following graph shows variation of apparent depth with the real depth of the coin : 1

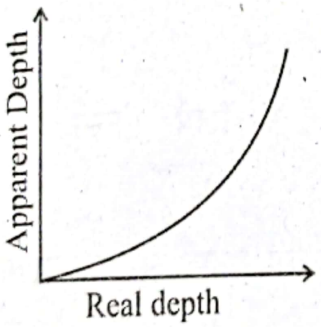
(a)



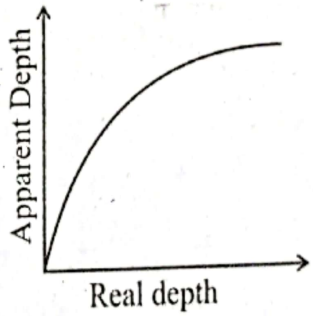
(b)



(d)



(c)



For Visually Impaired Students

A tank is filled with a transparent medium to a height 'H'. A coin is placed at the bottom of the tank. If apparent position of the coin is observed at height H/3 from the bottom, the refractive index of the transparent medium is : 1

(a) 3/2 (b) 2/3

(c) 3 (d) 1/3

For Questions 13 to 16, two statements are given – one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

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(a) **If both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).**

(b) **If both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).**

(c) **If Assertion (A) is true but Reason (R) is false.**

(d) **If both Assertion (A) and Reason (R) are false.**

13. **Assertion (A) :** A small test charge released at a point in an electric field will always travel along the field line passing through that point. 1

Reason (R): The tangent drawn at any point on the trajectory of a particle gives direction of acceleration of the particle.

14. **Assertion (A) :** The resistivity of a semiconductor decreases when its temperature is increased. 1

Reason (R): The temperature coefficient of resistivity of a semiconductor is always negative.

15. **Assertion (A):** The velocity of electromagnetic waves of different wavelength in free space is same. 1

Reason (R) : The velocity of electromagnetic waves in a medium depends on electric and magnetic properties of the medium.

16. **Assertion (A):** A simple microscope has a limited maximum magnification ($m \leq 9$) for realistic focal lengths. 1

Reason (R): The focal length of a lens increases when its curvature is decreased.

SECTION-B

17. Two conductors A and B of the same material have their lengths in the ratio 1:2 and radii in the ratio 2:3. If they are connected in parallel across a battery of voltage 10 V, calculate the ratio of currents passing through A and B. 2

18. (A) Two long and parallel straight wires A and B carrying currents of 8A and 5A in same direction are separated by a distance of 4.0 cm in air. Estimate the force on a 10 cm section of wire A. Is the force attractive or repulsive? 2

OR

(B) A 3.0 cm wire carrying a current of 10A is placed inside a solenoid perpendicular to its axis. The magnetic field inside the solenoid is 0.27 T. Calculate the magnetic force on the wire.

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19. The magnetic field lines form continuous closed loops unlike electric field lines. Write any two points (reasons) to justify this statement. 2

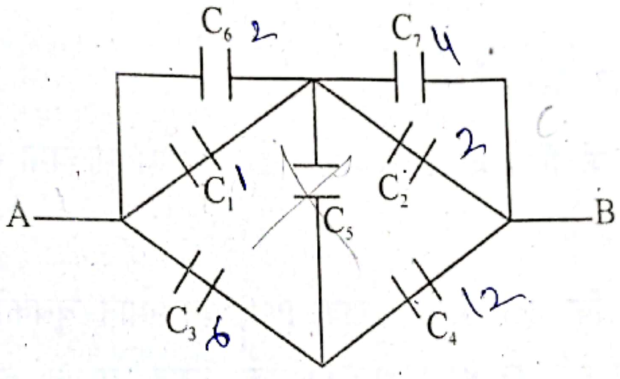
20. Write SI unit of self inductance. If the length of a long solenoid is doubled, keeping number of terms per unit length constant. How its self inductance will change? Explain your answer. 2

21. A resistor of 400 Ω, an inductor of $\left(\frac{5}{\pi}\right)$ H and a capacitor of $\left(\frac{50}{\pi}\right)\mu$F are joined in series across an a.c. source V = 140 sin (100 π) t volt. Find the impedence and r.m.s. current flowing in the circuit. (Use $\sqrt{2} = 1.4$)

SECTION-C

22. Using Gauss theorem, deduce an expression for electric field due to a uniformly charged infinite plane sheet. Mention the region, where electric field obtained for infinite plane sheet is valid for finite large planar sheet. 3

23. Calculate equivalent capacitance between point A and B in the given network of capacitors.



where, $C_1 = 1\ \mu F$, $C_2 = 2\ \mu F$, $C_3 = 6\ \mu F$, $C_4 = 12\ \mu F$, $C_5 = 10\ \mu F$,
$C_6 = 2\ \mu F$, $C_7 = 4\ \mu F$ 3

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Two capacitors of capacitance 6μF and 12 μF are connected with a source of 8V Calculate:

(i) Charge on each capacitor

(ii) Potential difference between the plates of each capacitor

24. (a) Obtain the relation $-\vec{V}_d = \frac{-e\vec{E}}{m}\tau$, where symbols have their usual meanings.

(b) When electrons drift in a conductor from lower potential to higher potential, does mean that all free electrons in the conductor are moving in same directio Explain.

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25. Name the electro magnetic waves which are used for - 3

(i) Detection of fracture in bones

(ii) Treatment muscular strain

(iii) LASIK eye surgery

(iv) Destruction of cancer cells

Arrange their wavelengths in increasing order.

26. Table given below shows ranges of magnetic susceptibility for three materials X, Y and Z. Identity these material as ferromagnetic, diamagnetic and paramagnetic materials. Write corresponding ranges for their magnetic permeability.

X	Y	Z
$-1 \le \chi < 0$	$0 < \chi < \epsilon$	$\chi >> 1$

3

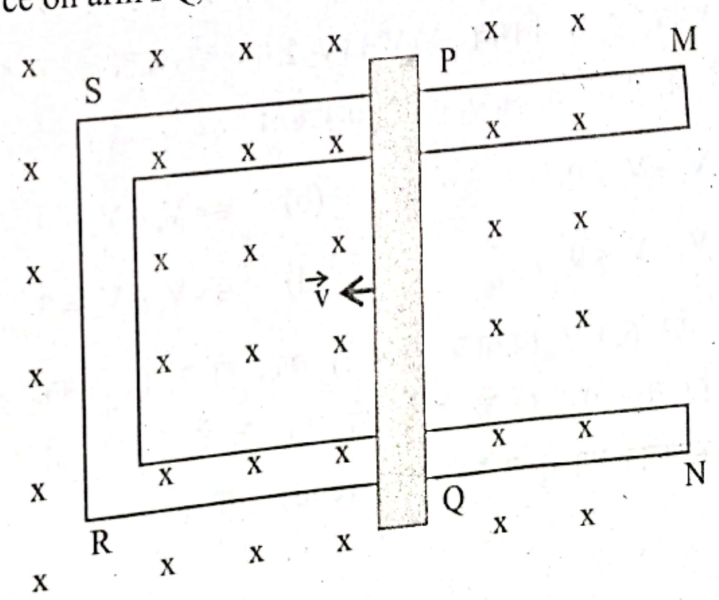
here 'ϵ' is a small positive number.

27. Write two essential conditions for total internal reflection. Obtain an expression for the critical angle for a pair of media. 3

28. (A) Figure shows a straight conductor PQ moving in uniform magnetic field 'B' on a metal frame MSRN. The arm PQ moves with constant velocity $\vec{v}$, towards left. If length of arm PQ is 'ℓ', deduce :

(i) emf induced across the ends of PQ

(ii) force on arm PQ, if resistance of arm PQ is 'R'



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OR

(B) A circular coil of radius 'R' and number of turn 'N' is rotated about its vertical diameter with an angular frequency of 'ω' in a uniform magnetic field 'B' in horizontal plane. Deduce expression for emf induced at any instant 't'. Plot a graph showing variation in induce emf with time. Hence write the average emf induced over one complete rotation. 3

SECTION-D

Question numbers 29 and 30 are case study based questions. Read the following paragraphs and answer the questions that follows.

29. The electrolytic cell is a simple device to maintain a steady current in an electrical circuit. Basically a cell has two electrodes, called the positive and the negative. They are immersed in an electrolytic solution where electrodes exchange charges with the electrolyte. When there is no current the electrolyte has the same potential throughout. When a current flows through the cell, the electrolyte offers a finite resistance known as internal resistance. Cells can be combined together in an electrical circuit (series and parallel combinations). 4x1

(i) The internal resistance of a cell does **NOT** depend on :

(a) Distance between two electrodes

(b) Area of electrodes dipped inside electrolyte

(c) Temperature of electrolytic

(d) EMF of the cell

(ii) The positive electrode of the cell develops a potential V_+ ($V_+ > 0$) and the negative electrode develops a potential $-(V_-)$ ($V_- \geq 0$) relative to electrolyte adjacent to them. If no current is drawn from the cell then, the emf of call is :

(a) $\epsilon = V_+ + V_- > 0$

(b) $\epsilon = V_+ - V_- > 0$

(c) $\epsilon = V_+ - V_- < 0$

(d) $\epsilon = V_+ - V_- = 0$

(iii) (A) Two cells of emf 2.0 V and 6.0 V and internal Resistances 0.1 Ω and 0.4 Ω respectively are connected as shown. The equivalent emf of the combination will be :

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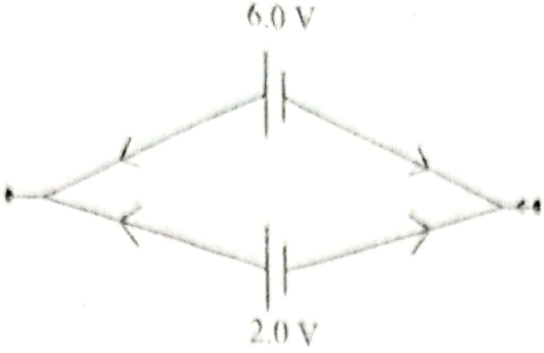


(a) 5.2 V (b) 2.28 V

(c) 2.0 V (d) 6.0 V

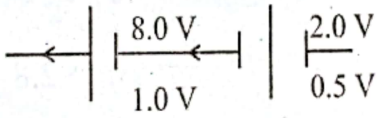
OR

(B) Potential difference across a cell in the open circuit is 6.0 V. It becomes 4.0 V when the cell is connected across an external resistance of 2 Ω. The internal resistance of the cells is :

(a) 5.0 Ω (b) 1.0 Ω

(c) 0.5 Ω (d) 1.5 Ω

(iv) Two cells of emf 8.0 V and 2.0 V and internal resistance 1.0 Ω and 0.5 Ω are connected as shown. The equivalent emf and equivalent internal resistance are given by :



(a) 10V, 1.5Ω (b) 10V, 0.5 Ω

(c) 6.0V, 1.5Ω (d) 6.0V, 0.5 Ω

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(iv) Two cells of emfs 4 V and 6 V and internal resistances 1 Ω and 2 Ω respectively are connected in series combination. The equivalent emf and equivalent internal resistance are given by :

(a) 2V, 1Ω (b) 14/3V, 2/3 Ω

(c) 10V, 3Ω (d) 2/3V, ½ Ω

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30. A number of optical instruments have been designed, utilising reflecting and refracting properties of mirrors, lenses and prisms. Periscope, Kaleidoscope, binoculars, telescopes and microscopes are some examples of optical devices and instruments that are in common practices. Our eye is most important optical device the nature has endowed us with. A simple microscope is a single converging lens whereas a compound microscope and a telescope consist of two lenses named as - objective and eye piece also known as ocular. 4x1

(i) The focal length of objective of a compound microscope is 'f_o' and that for eye piece in 'f_e' which of the following is correct :

(a) Both f_o and f_e should be small such that $f_o < f_e$

(b) Both f_o and f_e should be small such that $f_o > f_e$

(c) Both f_o and f_e should be large such that $f_o < f_e$

(d) Both f_o and f_e should be large such that $f_o > f_e$

(ii) A small telescope has an objective lens of focal length 1.4 m and an eye piece of focal length 5.0 cm. The magnifying power of telescope in normal adjustment is –

(a) 28 (b) 0.28

(c) 2.8 (d) 3.6

(iii) (A) An object of size 1 mm is a being viewed at a distance of 9 cm through a simple microscope of focal length 10.0 cm hold close to eye. The angular magnification produced by the microscope is :

(a) 500 (b) 250

(c) 270 (d) 1.6

OR

(B) If magnification produced by objective is 20 and the focal length of eye piece of a compound microscope is 2.0 cm, the total magnification produced by the microscope in normal adjustment is (take D = 25 cm) :

(a) 500 (b) 250

(c) 270 (d) 1.6

(iv) The aperture and focal length of objective of an optical device is much larger than that of eye piece. The device is :

(a) a microscope (b) a telescope

(c) either microscope or telescope (d) neither microscope nor telescope

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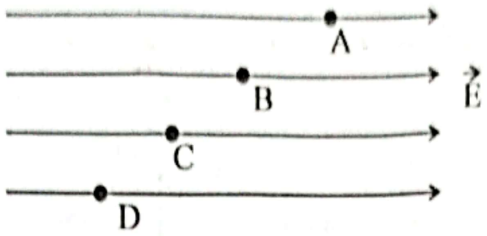
SECTION-E

31.A) (a) Establish a relation between electric field and electric potential. Write two conclusions drawn from this relation.

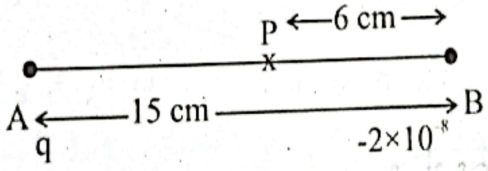
(b) Figure shows a uniform electric field in a region. A, B, C and D are four prints in the region. A charge q_o is taken from point A to points B, C and D in turn. For which point the work done will be maximum? Explain your answer through suitable calculation.



OR

B) (a) Obtain an expression for the electric potential due to a small dipole of dipole moment $\vec{p}$ at a point $\vec{r}$ from its centre, for larger value of $\vec{r}$ compared to size of the dipole.

(b) Two charges 'q' and -2×10^{-8} C are located 15 cm apart. The electric potential at a point P on the line joining two charges is zero as shown in diagram. Find the value of q. 5



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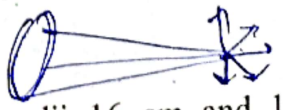
(b) Two charges q_1 and q_2 are located 30 cm apart. The electric potential at a point P on the line joining two charges is zero. If point P is a distance 20 cm from charge 'q_1', calculate the ratio q_1/q_2.

32. (a) Using Biot-Savart law, deduce on expression for magnetic field due to a circular coil, carrying current, at any point on its axis.



(b) X and Y are two concentric and coplanar coils of radii 16 cm and 10 cm respectively. The current flowing in coil X is 4 A in anticlockwise direction. Find the current flowing in Y such that magnetic field at the centre is zero.

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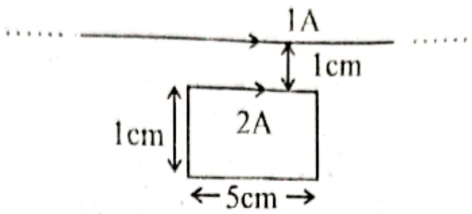
OR

B) (a) A rectangular coil having N turn, carrying current 'I' is placed in a uniform magnetic field 'B'. If plane of coil makes an angle of 'θ' with direction of magnetic field and $A = \ell \times b$ is the area of each turn deduce an expression for torque acting on the coil.

(b) A rectangular loop PQRS carries a current of 1A. A long straight wire carrying a current of 2A in kept near the loop in the same plane as shown in diagram. Calculate torque acting on the loop. 5



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(b) When a current carrying loop is placed in a uniform magnetic field, it does not experience any torque. Write the possible orientation of magnetic field w.r.t. the plane of the loop. Justify your answer.

33.A) (a) An a.c. source of voltage $V = V_o \sin \omega t$ is connected across a pure resistor. Write expression for instantaneous current flowing through the resistor hence obtain expressions for instantaneous and average power in one complete cycle.

(b) Plot a graph showing variation in instantaneous power with time. 5

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(b) If the frequency of a a.c. source connected to a pure resistor is 'ν', write the frequency of instantaneous power associated with it.

OR

B) (a) With the help of a suitable diagram, explain working principle of a transformer.

(b) Establish the relation $\frac{e_s}{e_p} = \frac{N_s}{N_p}$, where symbols have their usual meanings.

(c) Write any two energy losses liking place in a trans former.

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