THE OPEN UNIVERSITY OF SRI LANKA

CREDIT CERTIFICATES FOR FOUNDATION COURSES IN SCIENCE

TAF2502 – PHYSICS -3

FINAL EXAMINATION

DURATION – THREE HOURS

Date: 29th December 2019 Time: 0930-1230 Hours

Part -A

- **The Question paper consists of 25 multiple choice questions**
- **Answer all the questions**
- **Answers for the Multiple Choice Questions, should be provided by placing X in the relevant cage indicating the most appropriate answer in the MCQ answer sheet provided**
- **At the end of the examination you should submit the question paper with answer sheet.**
- **Maximum marks for this part is 40%.**

(1).Two point charges **15μC** and **5μC** are **4 cm** apart. What would be the force between them?

(1) 250 N (2) 7.5×10^{-6}N (3) 500 N (4) 7.5×10^{-6}N (5) 750 N

(2). The electric field intensity at a point, distance '**r**' from a point charge **q** is

(1) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ (3) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r}$ (4) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$ (5) 0

(3). A charged particle of mass '**m**' and charge '**q**' is released from rest in a uniform electric field '**E**'. The kinetic energy of the particle after time **t** is

(1) $\frac{2E^2r^2}{mq}$ (2) $\frac{Eq^2m}{2r^3}$ (3) $\frac{E^2q^2t^2}{2m}$ (4) $\frac{Eqm}{2t}$ (5) $\frac{Eq}{m}$

(4). There is a charged spherical conductor of radius '**a**' having charge '**q**'. what would be the electric field intensity '**E**' at a point distance '**r**' from its centre. **(r>a)**

(1) 0 (2) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ (3) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ (4) $\frac{1}{4\pi\varepsilon_0}\frac{q}{(r-a)^2}$ (5) $\frac{1}{4\pi\varepsilon_0}\frac{q}{(r-a)}$

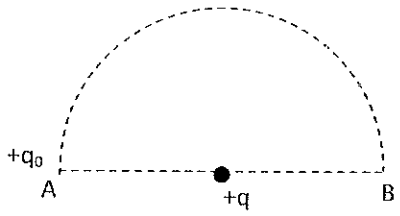
(5). The magnitude of the electric field required to just balance in air a liquid drop of mass $2 \times 10^{-4} kg$, Carries a charge of $10 \times 10^{-2} \mu C$ is,

(1) $10^4\ NC^{-1}$ (2) $2 \times 10^4\ NC^{-1}$ (3) $4 \times 10^4\ NC^{-1}$ (4) $5 \times 10^4\ NC^{-1}$ (5) $10 \times 10^4\ NC^{-1}$

(6). Two charged conducting spheres of radii R_1 and R_2Separated by a large distance are connected a long wire. The ratio of the charge on first and second sphere is,

(1) $\frac{R_1}{R_2}$ (2) $\frac{R_2}{R_1}$ (3) $\frac{R_1^2}{R_2^2}$ (4) $\frac{R_2^2}{R_1^2}$ (5) I

(7) A particle of charge q_0 is moved around a charge **+q** along the semicircular path of radius **r** from **A** to **B**. The work done in this is,



(1) $\frac{1}{4\pi\varepsilon_0}\frac{qq_0}{r}$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{2qq_0}{r}$ (3) $\frac{1}{4\pi\varepsilon_0}\frac{qq_0}{r^2}\pi h$

(4) $\frac{1}{4\pi\varepsilon_0}\frac{qq_0}{r^2}2\pi h$ (5) 0

(8). A positively charged particle of mass **'m' (kg)** and charge **'q'(C)** travels from rest througha potential difference **V** (V)'. Its kinetic energy is,

(1) qV (2) mqV (3) $\frac{mq}{V}$ (4) $\frac{m}{qV}$ (5) $\frac{1}{2}\mathrm{m}V^2$

(9). Three capacitors each of **1μF**, are connected in parallel. To this combination,a fourth capacitor of **1μF** is connected in series. The equivalent capacitance of this system is,

(1) $\frac{3}{4}\mu F$ (2) $\frac{4}{3}\mu F$ (3) $2\ \mu F$ (4) $4\ \mu F$ (5) $1\ \mu F$

(10). A charge is distributed uniformly with charge density σ over the surface of an isolated conducting sphere of radius **'a'**. The electric potential at the centre of the sphere is

(1) $\frac{a\sigma}{\varepsilon_0}$ (2) $\frac{a^2\sigma}{\varepsilon_0}$ (3) $\frac{a^2\sigma^2}{\varepsilon_0}$ (4) $\frac{\sigma}{2\varepsilon_0}$ (5) 0

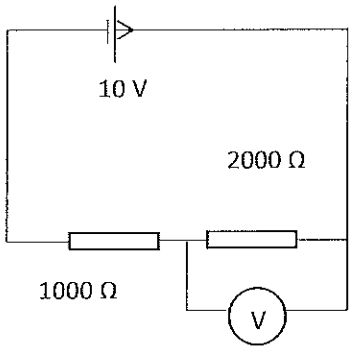
(11). A wire of resistance R is stretched till its length is increased to **n** times its original length. What is its new resistance?

(1) R (2) nR (3) nR^2 (4) $\frac{R}{n}$ (5) $\frac{R}{n^2}$

(12). A current of **5 A** is pressing through a metallic wire of cross-sectional area $4 \times 10^{-6} m^2$. If the density of the charge carries in the wire is $5 \times 10^{26} m^{-3}$, the drift velocity of the electron is,

(1) $\frac{1}{16}\ m$ (2) $\frac{1}{32}\ m\ s^{-1}$ (3) $\frac{1}{64}\ m\ s^{-1}$ (4) $\frac{1}{128}\ m\ s^{-1}$ (5) $\frac{1}{5}\ m\ s^{-1}$

(13). In the given circuit e.m.f of the cell is **10 V** and internal resistance is negligible. The internal resistance of the voltmeter is **2000 Ω**. what would be the voltmeter reading?



(1) 0 V

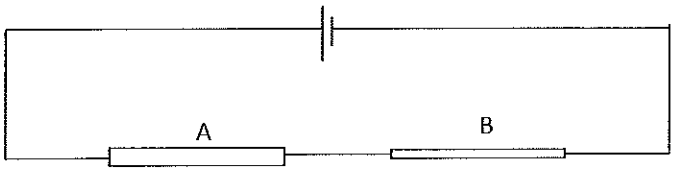
(2) 5 V

(3) 6 V

(4) 3 V

(5) 10 V

(14). A thick wire **A** and thin wire **B** made of the same material are connected to a battery as shown in the figure. The lengths of the two wires are same. What is the true statement?



(1) Both A and B have same resistance

(2) Free electron density of A is greater than that of B.

(3) Drift velocity of electrons in A is smaller than that in B.

(4) Current in A is greater than in B

(5) Drift velocity of the electrons at A is same as in B.

(15). A cell of e.m.f**9 V** and internal resistance **0.5 Ω** connected across a resistor and an ammeter in series. The reading of the ammeter is found to be **1 A**. The rate of dissipation of energy in the resistor is,

(1) 0.5 W (2) 2 W (3) 2.5 W (4) 8.5 W (5) 9W

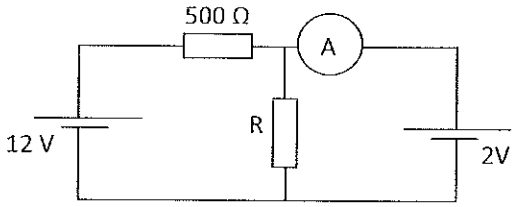
(16). A cell of e.m.fE is connected across a resistor **'r'**. The potential difference between the terminals of the cell is found to be **V**. The internal resistance of the cell must be,

(1) $\frac{2(E-V)V}{r}$ (2) $\frac{2(E-V)r}{E}$ (3) $\frac{(E-V)r}{V}$ (4) (E-V) r (5) $\frac{E}{r}$

(17). Five cells each of e.m.f **E** and internal resistance **r** are connected in series. If, by mistake, one of the cells is connected wrongly. (Opposite polarities) the equivalent e.m.f and internal resistance of the combination are,

(1) 5E, 5r (2) 5E, 4r (3) 4E, 5r (4) 4E, 4r (5) 3E, 4r

(18). In the given circuit the ammeter reading is zero. what would be the value of resistance R?



(1) 10 Ω (2) 50 Ω (3) 100 Ω (4) 200 Ω (5) 500 Ω

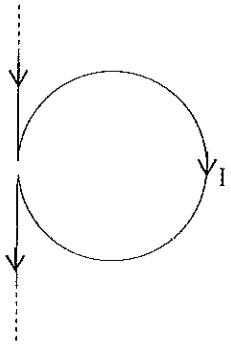
(19). A voltmeter has a resistance **R** and range **V**. The series resistance required to convert it into a voltmeter of **nV(n>1)** is,

(1) nR (2) (n-1)R (3) $\frac{R}{n}$ (4) $\frac{R}{n-1}$ (5) R

(20). In a potentiometer circuit the balanced length of a cell of e.m.f **E= 1.2 V** is found to be **60 cm**. When another cell of unknown e.m.f was substituted for **E**. the balance length was found to be **40 cm**. What would be the e.m.f of the second cell?

(1) 0.8 V (2) 1 V (3) 1.2 V (4) 1.5 V (5) 0.67 V

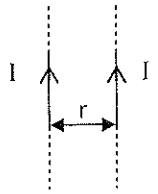
(21) A long straight conductor carrying a current **I**, is bent into the shape shown in the figure. The radius of the circular loop is **'r'**. The magnetic field at the centre of the loop is,



(1) $\frac{\mu_0 I}{2r}(1+\frac{1}{\pi})\otimes$ (2) $\frac{\mu_0 I}{2r}\left(1-\frac{1}{\pi}\right)\odot$ (3) $\frac{\mu_0 I}{2r}(1-\frac{1}{\pi})\otimes$

(4) $\frac{\mu_0 I}{2r}(1+\frac{1}{\pi})\odot$ (5) $\frac{\mu_0 I}{2r}(1+\pi)\otimes$

(22). Two long straight wires, each carrying a current I, are separated by a distance **'r'**. If the currents are in opposite directions then the magnetic field at a point midway between the two wires is,



(1) $\frac{\mu_0 I}{\pi h}$ (2) $\frac{2\mu_0 I}{\pi r}$ (3) $\frac{\mu_0}{2\pi r}$ (4) $\frac{4\mu_0 I}{\pi r}$ (5) 0

(23). A charge **q (C)** is circulating in an orbit of radius **r (m)** making **'n'**revolutions per second. The magnetic field produced at the centre of the circle is,

(1) $\frac{2\pi q}{nr}10^{-7}$ (2) $\frac{2\pi q}{r}10^{-7}$ (3) $\frac{2\pi nq}{r}10^{-7}$ (4) $\frac{2\pi n}{r}10^{-7}$ (5) 0

(24). A horizontal wire of length **10 cm** and mass **0.3 g** carries a current of **5A**. The magnitude of the magnetic field which support the weight of the wire is,

(1) $3 \times 10^{-3}T$ (2) $6 \times 10^{-3}T$ (3) $3 \times 10^{-4}T$ (4) $6 \times 10^{-4}T$ (5) $8 \times 10^{-4}T$

(25). A long straight wire carries a current of 10 A. An electron travels with a velocity of $5x10^6$ ms^{-1} parallel to the wire 0.1 m away from it. The force exerted by the magnetic field of the current on the electron is,

(1) $1.6x10^{-17}$ N (2) 3.2×10^{-17} N (3) 1.6×10^{-18} N (4) $3.2x\ 10^{-10}$ N (5) $4.8x\ 10^{18}$ N

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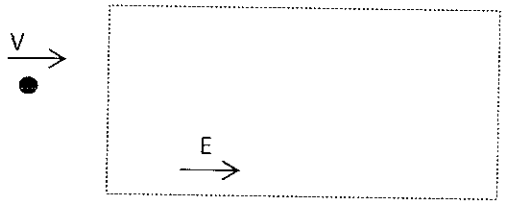
Part - B

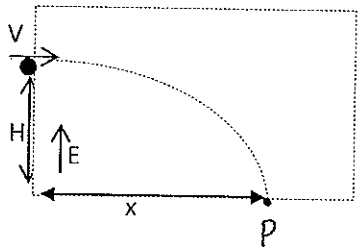
- **Answer any four (04) questions only.**
- **If more than (04) question are answered only the first four will be marked.**
- **Each question earn fifteen(15) marks, amounting to total of 60% marks.**
- **You have to show the steps involved in solving problems. No marks are awarded for the mere final answer without proper steps.**

(1) (a) Define the electric field intensity of a point in an electric field. **(02 Marks)**

(b) An electron of charge '**-q**' and mass '**m**' is moving along the positive **x** direction in a vacuum. This particle then enters at x=0, a uniform electric field of intensity **E**, extended over a large region with velocity **V** as shown in the figure. The electric field is directed along the positive **x** direction. Describe the motion of the particle qualitatively after entering to the electric field. **(05 Marks)**



(c) An electron of charge '-q' and mass 'm' is projected horizontally with the initial velocity V_0 into uniform electric field between two charged plates as shown in the figure. Assume that the effect due to gravity is negligible and the electric field is directed vertically upward with intensity E.



(i) What would be the force acting on the electron by the electric field. **(02 Marks)**

(ii) What would be the acceleration of the electron. **(02 Marks)**

(iii) If the electron strikes the lower plate at point P, Find the distance x. **(04 Marks)**

(2) (a) What is capacitance of a capacitor? **(02 Marks)**

(b) Derive an expression for a parallel plate capacitor of the plate area 'A', distance between plates 'd' and filled with the medium of relative permittivity ε_L. **(03 Marks)**

(c) A parallel plate capacitor with air as medium has plates of area $4 \times 10^{-2}\, m^2$ which are 2 mm apart. It is charged by connected to a 100 V battery. It is then disconnected from the battery and connected in parallel with a similar uncharged capacitor with plates of half the area which are twice the distance apart. (Take $\varepsilon_0 = 8 \times 10^{-12}\, \mathrm{N^{-1}C^2m^{-2}}$)

(i) what would be the capacitance of the 1st capacitor? **(03 Marks)**
(ii) Calculate the charge of the 1st Capacitor. **(03 Marks)**
(iii) Calculate the final charge of each capacitor after they are connected. **(04 Marks)**

(03)(a) Define the electric current. **(02 Marks)**

(b) What do you understand by the "drift velocity" of a electrons in a flow of electric current. **(02 Marks)**

(c) State Kirchhoff's laws **(02 Marks)**

(d) Describe what you mean by electromotive force (e.m.f) and internal resistance of a cell. **(02 Marks)**

(e) A moving coil galvanometer has resistance of 5 Ω and full scale deflection is produced by a current of 1 mA. How do you convert the galvanometer be adapted to

(i) Ammeter of range 0-2 A **(03 Marks)**

(ii) Voltmeter of Range 0-10 V **(04 Marks)**

(You should describe with clear diagram)

(4) (a) Describe how would you use the potentiometer to determine the e.m.f of a cell. Give experimental details of the procedure and label the circuit diagram. **(07 Marks)**

(b) A series circuit consisting of a battery with considerable internal resistance and two resistors of resistance 10 Ω and 990 Ω respectively. The potential difference across the 10 Ω resistor is balanced by 715 mm length of a potentiometer. When the resistors in the circuit is replace by two other resistors of 1 Ω and 99 Ω respectively. The balance length of the same potentiometer wire across the 1Ω resistor is 500 mm. Calculate the internal resistance of the battery. **(08 Marks)**

(5) (a) State the 'Biot-Savat' law in electromagnetism. **(01 Marks)**

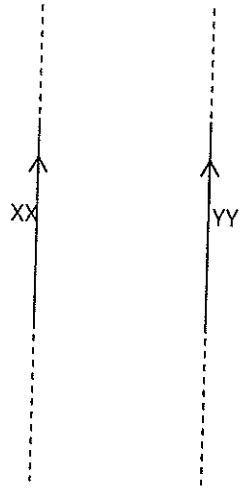
(b) Current 'I' is flowing through a conductor coil of radius 'a'. This loop has 'n' turns. Derive an expression for the magnetic field at the centre of the coil. **(03 Marks)**

(c) Write down the magnetic field B at a distance 'r' from a long straight wire carry current **I**.

(01 Marks)

(d) There are two **X** and **Y** long, straight, parallel conductors carrying currents I_1 and I_2 and separated by a distance **r** as shown in the figure.

(i) Find out the magnitude and the direction of the magnetic force per unit length acting on them. **(04 Marks)**

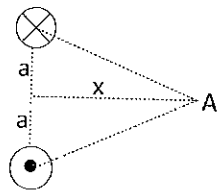


(ii) What changes may occur if the direction of the current is changes in conductor **Y**?

(01 Marks)

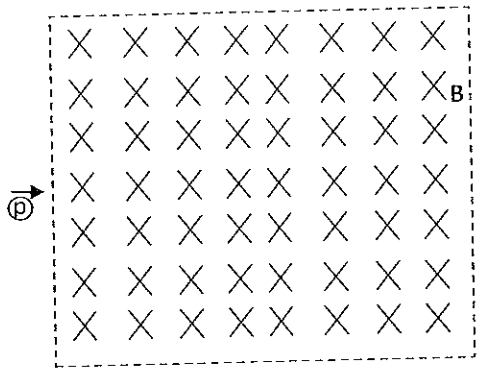
(e) Two infinitely long wires carrying equal current **I** in the opposite directions are placed perpendicular to the plane. Find the magnitude and direction of the magnetic field **B** at the point **A**.

(05 Marks)



(6). An proton enters perpendicular to a uniform magnetic field of **0.03** T with velocity $\mathbf{10 \times 10^5\ m\ s^{-1}}$ as shown in the diagram, where the magnetic field is directed into the paper. The charge and mass of the proton is $\mathbf{1.6 \times 10^{-19}C}$ and $1.6 \times \mathbf{10^{-27}\ kg}$.

(i) Draw a rough sketch of the path of the electron. **(04 Marks)**



(ii) Describe the path you drawn in the question **(i)** **(03 Marks)**

(iii) Calculate the radius of circular path. **(04 Marks)**

(iv) If instead, a electron enters with the same velocity in a similar manner how does its path differ from the path of the electron. **(02 Marks)**

(v)If a neutron is entered with same velocity describe the path. Give reasons **(02 Marks)**

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