INTI INTERNATIONAL UNIVERSITY

FOUNDATION IN SCIENCE (CFSI)
PHY1204: GENERAL PHYSICS 2
FINAL EXAMINATION: MAY 2014 SESSION

This paper consists of **FIVE (5)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

(a) A parallel-plate air-filled capacitor having an area of 17 cm by 2 cm and a plate spacing of 0.15 mm. The capacitor is connected to a 9 V battery.

(i) Calculate the capacitance of the capacitor.

(3 marks)

(ii) Determine the energy stored in the capacitor.

(2 marks)

(iii) The separation of the plates is now filled by a layer of Quartz of dielectric constant $\kappa = 4.3$. What is the new capacitance of the capacitor?

(2 marks)

(b) When a battery whose emf is 24 V is connected to an electrical device of resistance $R = 68\ \Omega$, the current flow across the circuit is measured to be 0.32 A.

(i) Determine the internal resistance of the battery.

(3 marks)

(ii) Calculate the power dissipated due to the internal resistance in the battery.

(2 marks)

(c) A potential difference of 110 V is supplied to an electron gun to accelerate the electrons to a high speed. Determine the speed of an electron just before it left the gun.

(3 marks)

(d) Using Kirchhoff's rules, calculate the current I_1, I_2 and I_3 in the three branches of circuit in Figure Q1(d).

(10 marks)

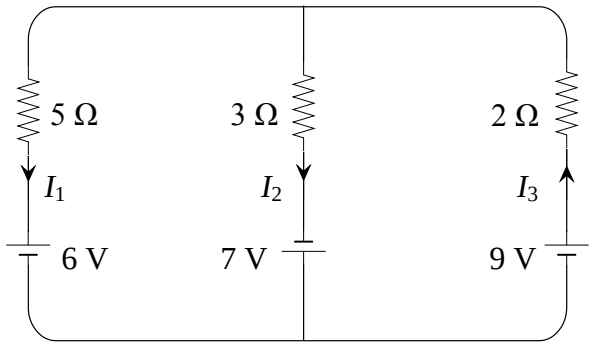

Figure Q1(d)

Question 2

(a) In Figure Q2(a), current I = 0.5 A is set up between point A and B. Given that the radial length of the larger arc R_1 = 5 cm and the smaller arc R_2 = 3 cm.

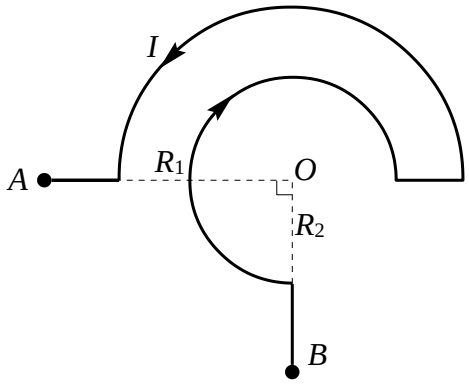

Figure Q2(a)

(i) Calculate the magnitude of the magnetic field at the center of the arcs.

(4 marks)

(ii) At the center of the arc, is the direction of the magnetic field pointing inward or outward?

(1 mark)

(b) An electron is accelerated through an electron gun to a speed of 2×10^{6} m/s. The electron is shot perpendicularly into a region of magnetic field of $B = 2 \times 10^{-4}$ T. It was observed that the electron is traveling in a circular path within the region. Calculate the radius of the path of the electron.

(3 marks)

(c) Figure Q2(c) shows a toroid form by a hollow solenoid that has been curved until its two ends meet. The toroid has a concentric radius of r = 10 cm and total number of 84 turns. When a current of I = 0.8 mA is applied in the toroid windings, calculate the magnetic field generated at the center of the toroid. Mention also the direction of the magnetic field at the center of the toroid.

(2 marks)

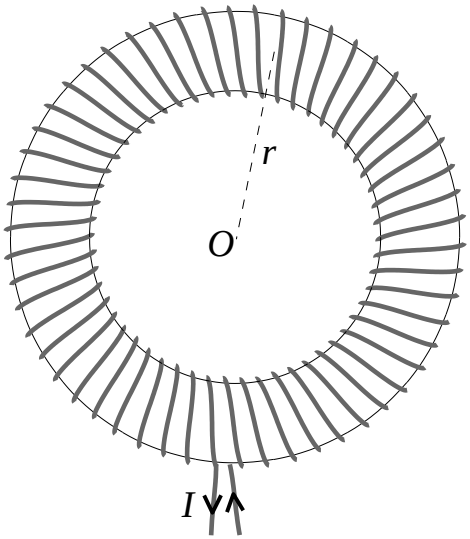

Figure Q2(c)

(d) Calculate

(i) the wavelength of a 27.72×10^{9} Hz radar signal, and

(2 marks)

(ii) the frequency of an X-ray with wavelength 0.13 nm.

(2 marks)

(e) Given that the secondary coil of an ideal transformer has 275 times as many as the primary. It is used in a 230 V circuit. Calculate the voltage across the secondary coil.

(3 marks)

(f) Two 2.0 m long straight wires are parallel and 2.0 mm apart from each other. A current of I_1 = 3.2 mA is carried across one of the wire and another current of I_2 = 7.5 mA is carried across the other wire as shown in Figure Q2(f). Given that the currents flow in the same direction. Find the force exerted on each wire.

(4 marks)

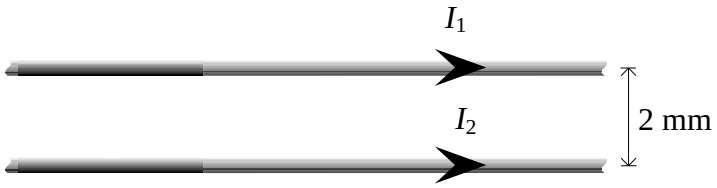

Figure Q2(f)

(g) A 10.0 cm straight wire is placed between a pair of magnet in opposite pole as shown in Figure Q2(g). When a steady current of I = 0.4 A is applied across PQ in the direction shown, calculate the force exerted on the wire and describe the direction of the magnetic force acting on the wire. Given that the magnetic field of the magnet is $B = 2 \times 10^{-4}$ T.

(4 marks)

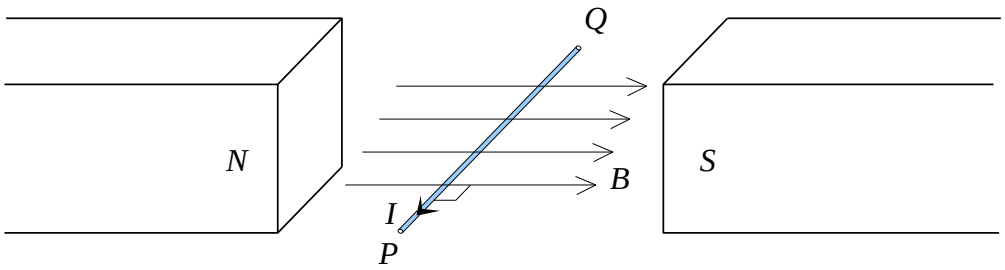

Figure Q2(g)

Question 3

(a) Given that a particle has a charge of +450 μC.

(i) How many electrons would have to be removed from or added to that particle to leave it with such amount of charge?

(2 marks)

(ii) Calculate the total mass of the electrons involved.

(2 marks)

(b) The charges and coordinates of two charged particles held fixed along the *x*-axis are listed as follow:

Particle	**Charge (μC)**	**Coordinates (cm)**
A	−9	(5 , 0)
B	+2	(15 , 0)

At what coordinate should a third particle of any charge be placed such that the net electrostatic force on that third particle due to the other two particles is zero?

(5 marks)

(c) The total electric flux through a cubical Gaussian surface is 5.65×10^5 Nm^2/C. Given that the flux is pointing inward.

(i) Calculate the charge enclosed by the surfaces.

(2 marks)

(ii) Another charge of +7 μC is now placed into the cubical Gaussian surface. Calculate the total electric flux through the cubical Gaussian surface.

(3 marks)

(d) A thin rod bent into the shape of an arc of a circle of radius 12 cm carries a charge of +5 μC. The arc subtends an angle as shown in Figure Q3(d).

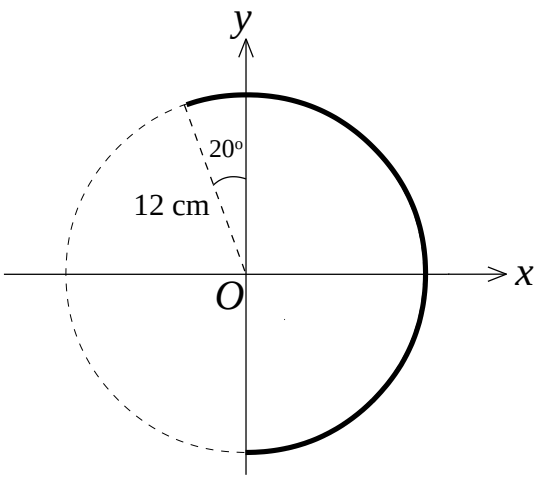

Figure Q3(d)

(i) Calculate the length of the rod.

(3 marks)

(ii) Calculate the linear charge density of the rod.

(2 marks)

(iii) Determine the magnitude of the electric field at the origin *O*.

(4 marks)

(iv) In which direction does the electric field at the origin *O* point to?

(2 marks)

Question 4

(a) Two spherical charges are given as $Q_A = -16\ \mu$C and $Q_B = -3\ \mu$C. These charges are separated by a fixed distance and the force acts on them is measured to be 120 N. A third neutral non-conducting sphere is touched first to Q_A, then to Q_B, and finally removed. Calculate the new force acting on the spherical charges Q_A and Q_B.

(5 marks)

(b) A monochromatic light of wavelength 441 nm is incident through a narrow slit on a screen 2 m away. The distance between the second diffraction minimum and the central maximum is 1.5 cm.

(i) Calculate the angle of diffraction of the second minimum.

(2 marks)

(ii) Find the width of the slit.

(3 marks)

(c) A 15 kΩ resistor and a capacitor are connected in series. A 12 V potential difference is applied across the combination. Given that when the circuit is open, the capacitor discharges through the resistor, and it was measured that the potential difference across the capacitor drops to 5 V in 13 s.

(i) Calculate the time constant of the circuit.

(4 marks)

(ii) Calculate the capacitance of the capacitor.

(3 marks)

(d) A 230 V ac at 60 Hz is applied to a circuit with a 2 kΩ resistor connected in series to a 9 μF capacitor.

(i) Calculate the capacitive reactance.

(2 marks)

(ii) Find the impedance of the combination.

(2 marks)

(iii) Calculate the phase angle in the circuit.

(2 marks)

(iv) Calculate the I_{rms} in the circuit.

(2 marks)

Question 5

(a) Three charged particles lie on the *xy*-axis are shown in Figure Q5(a).

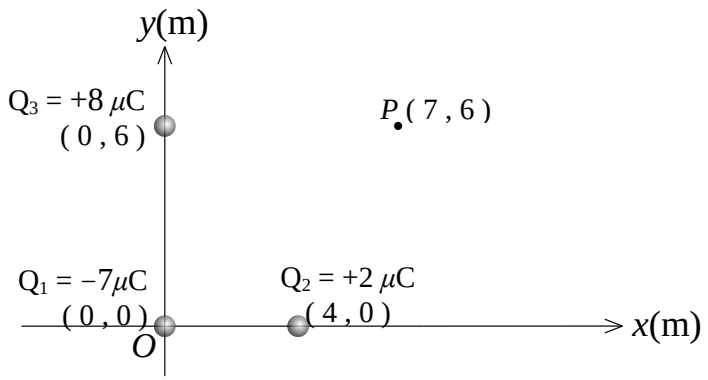

Figure Q5(a)

(i) Draw a diagram on the electric field at point *P* due to the charges.

(2 marks)

(ii) By ignoring the effect between the charges, calculate the electric field at point *P* due to each of the charges.

(7 marks)

(iii) Calculate the magnitude of the net electric field at point *P* due to all the charges.

(4 marks)

(iv) In what direction respect to the positive *x*-axis does the net electric field point to due to all the charges?

(2 marks)

(b) Find the equivalent resistance between the point *P* and *Q* as shown in Figure Q5(b).

(2 marks)

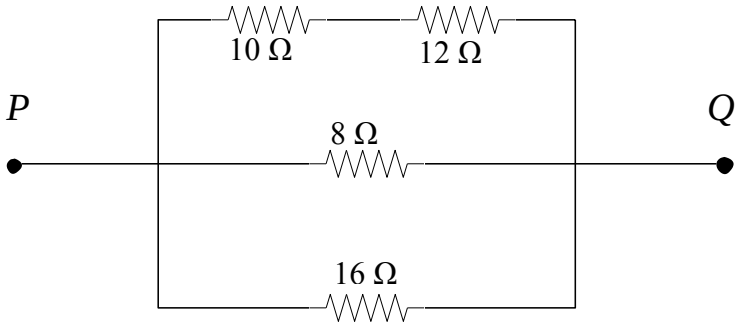

Figure Q5(b)

(c) An object is placed 60 cm in front of a converging lens. Given that the lens has a focal length of 20 cm.

(i) Draw a simple diagram to show the formation of the image.

(3 marks)

(ii) Describe the properties of the image respect to the object.

(3 marks)

(iii) Calculate the magnification of the image.

(2 marks)

-- THE END --

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