INTI INTERNATIONAL UNIVERSITY

FOUNDATION IN SCIENCE (CFSI)
PHY1204: GENERAL PHYSICS 2
FINAL EXAMINATION: JANUARY 2016 SESSION

Instruction: 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) If the current in a 180 mH coil drops steadily from 2.5 mA to zero in 3.2 ms, Calculate the induced emf.

(2 marks)

(b) Find the equivalent capacitance of the combination in Figure Q1(b). Given that C_1 = 250 μF, C_2 = 470 μF, C_3 = 450 μF and C_4 = 610 μF.

(3 marks)

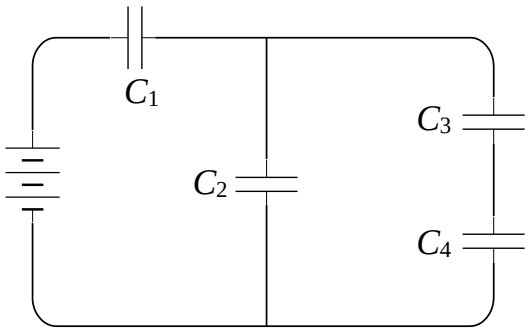

Figure Q1(b)

(c) A parallel-plate air-filled capacitor with a plate area of 24 cm^2 and plate spacing of 2 mm is charged to a potential difference of 12 V. Find

(i) the capacitance of the capacitor,

(2 marks)

(ii) the magnitude of the charge on each plate,

(2 marks)

(iii) the energy stored in the capacitor,

(2 marks)

(iv) the electric field between the plates, and

(2 marks)

(v) the new capacitance of the capacitor if the region between the plates is now filled with material having dielectric of κ = 3.7.

(2 marks)

(d) Calculate

(i) the wavelength of a 27.75×10^{9} Hz radar signal, and

(2 marks)

(ii) the frequency of an X-ray with wavelength 0.10 nm.

(2 marks)

(e) 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. It is measured that the potential difference across the capacitor drops to 7 V in 13 s.

(i) Calculate the time constant of the circuit.

(4 marks)

(ii) Calculate the capacitance of the capacitor.

(2 marks)

Question 2

(a) A thin rod bent into the shape of an arc of a circle of radius 15 cm carries a charge of $-7\ \mu$C. The arc subtends an angle as shown in Figure Q2(a).

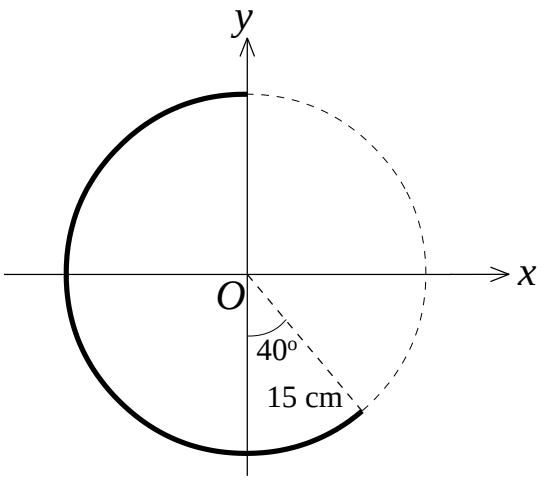

Figure Q2(a)

(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 what direction does the electric field at the origin *O* point to?

(2 marks)

(b) Two spherical charges are given as Q_A = 12 μC and Q_B = −4 μC. These spherical charges are separated by a fixed distance and the force 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 these two spherical charges.

(6 marks)

(c) Two long straight wires are parallel and 8 cm apart. The wires carry 1.5 A current each in opposite direction.

(i) Calculate the magnitude of the force per unit length acting on each wire due to the other wire.

(2 marks)

(ii) Determine whether the force is attractive or repulsive.

(1 mark)

(d) A 600 turns air-core solenoid of length 40 cm carries a current of 13 A.

(i) Determine the magnetic field strength at the center of the solenoid.

(3 marks)

(ii) On a simple diagram, show the direction of the magnetic field together with the direction of the current on the solenoid.

(2 marks)

Question 3

(a) Find the equivalent resistance between the point *P* and *Q* as shown in Figure Q3(a).

(3 marks)

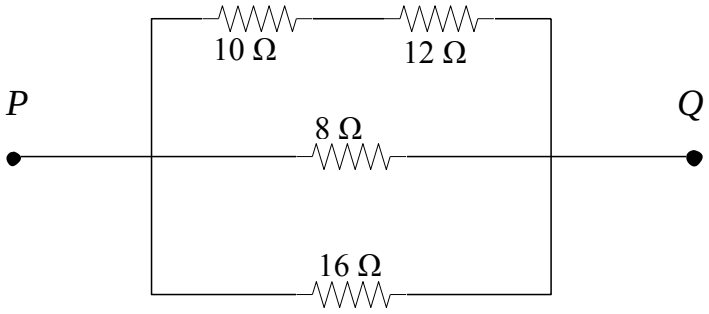

Figure Q3(a)

(b) An electric heater is operated at a potential difference of 230 V. When the device is heating the water, a current of 7.5 A is flowing across the resistor in the device.

(i) Calculate the power produced as thermal energy.

(2 marks)

(ii) Calculate the resistance of the device.

(2 marks)

(c) Calculate the current through each resistor as shown in Figure Q3(c).

(12 marks)

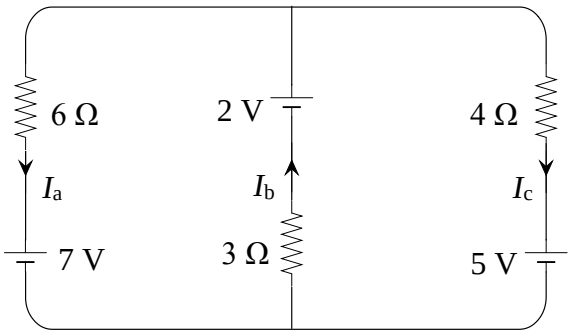

Figure Q3(c)

(d) A monochromatic light of wavelength 441 nm is incident on 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.

(3 marks)

(ii) Find the width of the slit.

(3 marks)

Question 4

(a) In Figure Q4(a), current I = 0.35 A is set up between points *A* and *B*. It is given that the radial length of the larger arc R_1 = 8 cm and the smaller arc R_2 = 5 cm.

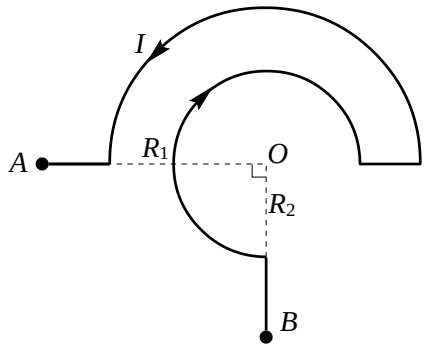

Figure Q4(a)

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

(4 marks)

(ii) Determine whether the direction of the magnetic field is pointing inward or outward.

(1 mark)

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

(i) Calculate the charge enclosed by the surface.

(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)

(c) The prism is 2 m wide, 3 m long, and 2 m high, and is oriented as shown in Figure Q4(c). The prism is placed in a region of uniform electric field, $\vec{E} = (5\hat{i} - 4\hat{j}) \times 10^3$ N/C. Find the electric flux through the

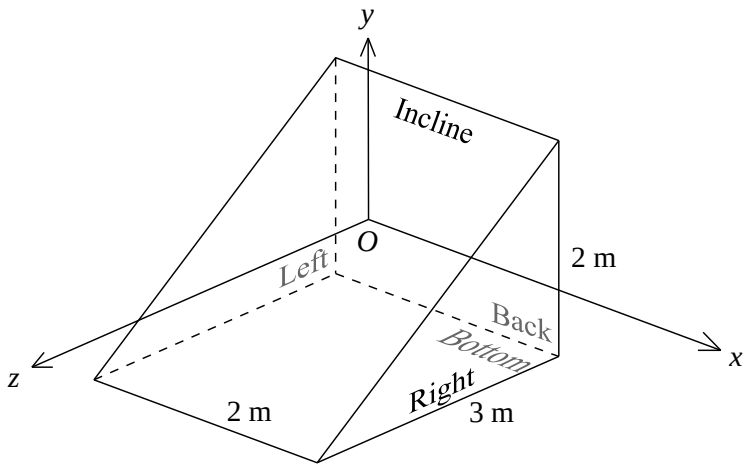

Figure Q4(c)

(i) left surface,

(3 marks)

(ii) incline surface, and

(3 marks)

(iii) bottom surface.

(3 marks)

(d) A direct current is supplied in an *RL* circuit in which R = 50 Ω and L = 6.3 mH. Determine the half-life of the inductor in the circuit.

(3 marks)

(e) Figure Q4(e) shows an electron shot at a speed of 2×10^6 m/s perpendicularly into a magnetic field. The electron revolves in a circle of radius r = 5.7 cm. Calculate the magnitude of the magnetic field.

(3 marks)

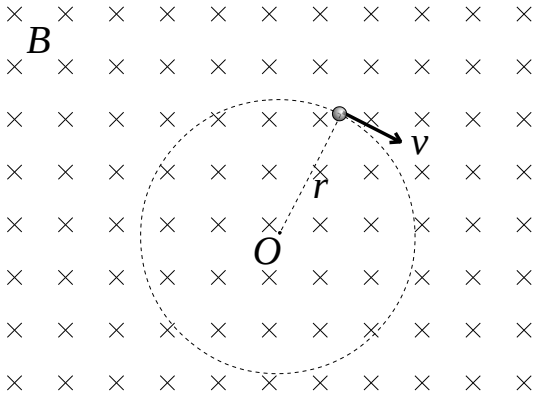

Figure Q4(e)

Question 5

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

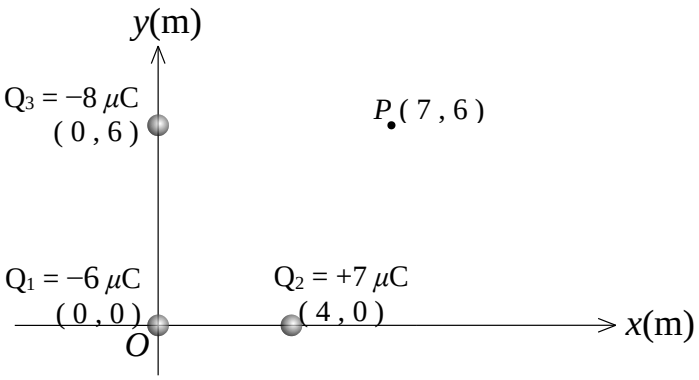

Figure Q5(a)

(i) Draw an electric field diagram for the electric field at point *P* due to the charges Q_1, Q_2 and Q_3 respectively.

(3 marks)

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

(9 marks)

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

(4 marks)

(iv) Determine the direction of the net electric field with respect to the positive *x*-axis.

(3 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	+3	(5 , 0)
B	−8	(13 , 0)

Determine the coordinate at which a third particle of any charge should be placed in order that the net electrostatic force on that particle due to the other two particles is zero.

(6 marks)

-- THE END --

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