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FINAL
Examination Paper

(COVER PAGE)

Session : August 2017

Programme : Foundation in Science (CFSI)

Course : PHY1204: Physics 2

Date of Examination : 13 December 2017 (Wednesday)

Time : 11:00am – 1:00pm Reading Time : Nil

Duration : 2 hours

Special Instructions :

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

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided :

Physics Booklet

Examiner(s) : Dr. Beh Boon Chun

Moderator : Assoc. Prof. Dr. Khoo Bee Ee

This paper consists of 7 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

 FOUNDATION IN SCIENCE (CFSI)
 PHY1204: PHYSICS 2
 FINAL EXAMINATION: AUGUST 2017 SESSION

Instructions: 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 Carnot engine absorbs 40 kJ as heat and exhausts 25 kJ as heat in each cycle.
- Calculate the engine's efficiency and (2 marks)
 - Calculate the work done per cycle in kilojoules. (2 marks)
- (b) Three charged particles are placed at the corners of an equilateral triangle of side 1.20 m as shown in Figure Q1(b). The charges are $+7.0 \mu\text{C}$, $-8.0 \mu\text{C}$ and $-6.0 \mu\text{C}$. Calculate the magnitude and direction of the net force on each due to the other two. (12 marks)

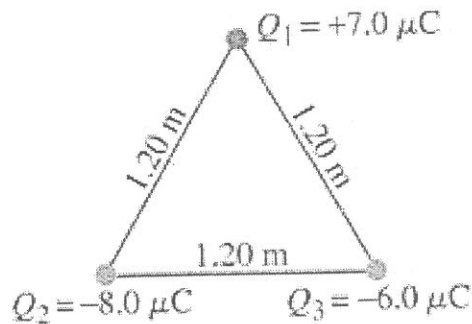


Figure Q1(b)

- (c) Estimate the electric field at a point 1.30 cm perpendicular to the midpoint of a uniformly charged 2.00-m-long thin wire carrying a total charge of $4.75 \mu\text{C}$. (3 marks)
- (d) Three particles are fixed in place as shown in Figure Q1(d) and have charges $q_1 = q_2 = +e$ and $q_3 = +2e$. Distance $a = 6.00 \text{ mm}$. What are the magnitude and direction of the net electric field at point P due to the particles? (3 marks)

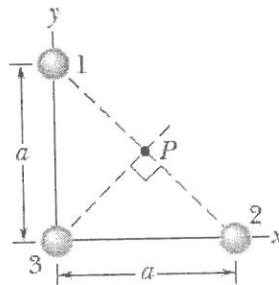


Figure Q1(d)

- (e) You are given two unknown point charges, Q_1 and Q_2 as shown in Figure Q1(e). At a point on the line joining them, one-third of the way from Q_1 to Q_2 , the electric field is zero. What is the ratio Q_1/Q_2 ? (3 marks)

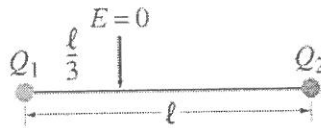


Figure Q1(e)

Question 2

- (a) A uniform electric field of magnitude 4.5×10^2 N/C passes through a circle of radius 12 cm. What is the electric flux through the circle when its face is
- perpendicular to the field lines, (2 marks)
 - at 45° to the field lines, and (2 marks)
 - parallel to the field lines? (2 marks)
- (b) Five closed surfaces that surround various charges in a plane, as indicated in Figure Q2(b). Determine the electric flux through each surface, S_1, S_2, S_3, S_4 , and S_5 . The surfaces are flat “pillbox” surfaces that extend only slightly above and below the plane in which the charges lie. (8 marks)

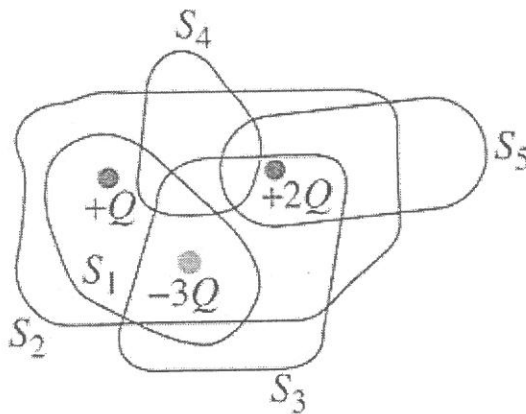


Figure Q2(b)

- (c) A point charge produces an electric flux of 325 N.m²/C through a gaussian sphere of radius 15.0 cm centered on the charge.
- What is the flux through a gaussian sphere with a radius 18.5 cm? (2 marks)
 - What is the magnitude and sign of the charge? (3 marks)

- (d) What is the net electric potential at point P due to the four particles if $V = 0$ at infinity, $q = 5.00 \text{ fC}$, and $d = 4.00 \text{ cm}$ as indicated in Figure Q1(d)? (3 marks)

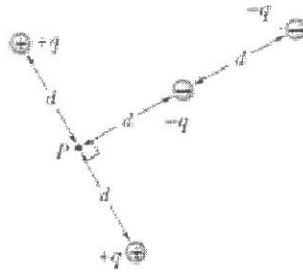


Figure Q2(d)

- (e) Three charged particles held in fixed positions as shown in Figure Q2(e) by forces that are not shown. What is the electric potential energy U of this system of charges? Assume that $d = 12 \text{ cm}$ and that $q_1 = +q$, $q_2 = -4q$, and $q_3 = +2q$, in which $q = 120 \text{ nC}$. (3 marks)

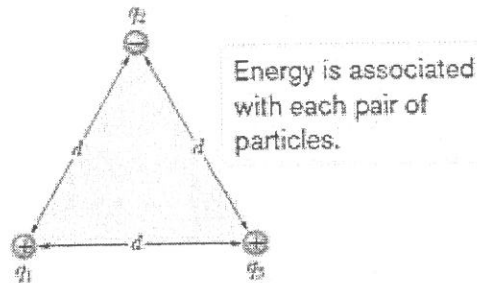


Figure Q2(e)

Question 3

- (a) A $0.50 \mu\text{F}$ and a $0.80 \mu\text{F}$ capacitor are connected in series to a 9.0-V battery.
- Calculate the potential difference across each capacitor and (3 marks)
 - Calculate the charge on each capacitor. (1 mark)
 - Repeat parts (i) and (ii) assuming the two capacitors are in parallel. (4 marks)
- (b) A hair dryer draws 9.0 A when plugged into a 120-V line.
- What is its resistance? (2 marks)
 - How much charge passes through it in 15 min ? (Assume direct current.) (2 marks)
- (c) A certain brand of hot-dog cooker works by applying a potential difference of 120 V across opposite ends of a hot dog and allowing it to cook by means of the thermal energy produced. The current is 10.0 A , and the energy required to cook one hot dog is 60.0 kJ . If the rate at which energy is supplied is unchanged, how long will it take to cook three hot dogs simultaneously? (3 marks)

- (d) In RC series circuit, emf $\mathcal{E} = 12.0$ V, resistance $R = 2.40$ M Ω , and capacitance $C = 1.80$ μ F.
- Calculate the time constant. (2 marks)
 - Find the maximum charge that will appear on the capacitor during charging. (2 marks)
 - How long does it take for the charge to build up to 16.0 μ C? (2 marks)
- (e) How long does it take for the energy stored in a capacitor in a series RC circuit to reach 75% of its maximum value? Express answer in terms of the time constant $t = RC$. (4 marks)

Question 4

- An electron experiences the greatest force as it travels 2.8×10^5 m/s in a magnetic field when it is moving northward. The force is vertically upward and of magnitude 7.5×10^{-13} N. What is the magnitude and direction of the magnetic field? (4 marks)
- A 13.0-cm-diameter circular loop of wire is placed with the plane of the loop parallel to the uniform magnetic field between the pole pieces of a large magnet. When 4.20 A flows in the coil, the torque on it is 0.185 N.m What is the magnetic field strength? (3 marks)
- Two long parallel wires 8.20 cm apart carry 16.5 A currents in the same direction as shown in Figure Q4(c). Determine the magnetic field vector at a point P, 12.0 cm from one wire and 13.0 cm from the other. (4 marks)

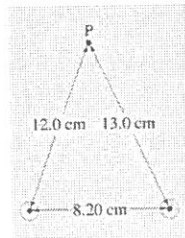


Figure Q4(c)

- A metal rod is forced to move with constant velocity along two parallel metal rails, connected with a strip of metal at one end as indicated in Figure Q4(d). A magnetic field of magnitude $B = 0.40$ T points out of the page.
 - If the rails are separated by $L = 25.0$ cm and the speed of the rod is 55.0 cm/s, what emf is generated? (2 marks)
 - If the rod has a resistance of 15.0 Ω and the rails and connector have negligible resistance, what is the current in the rod? (2 marks)
 - At what rate is energy being transferred to thermal energy? (2 marks)

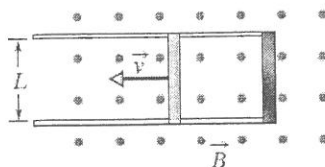


Figure Q4(d)

- (e) Coil 1 has $L_1 = 25$ mH and $N_1 = 100$ turns. Coil 2 has $L_2 = 40$ mH and $N_2 = 200$ turns. The coils are fixed in place; their mutual inductance M is 3.0 mH. A 6.0 mA current in coil 1 is changing at the rate of 4.0 A/s.
- What magnetic flux Φ_{12} links coil 1? (2 marks)
 - What self-induced emf appears in that coil? (2 marks)
 - What magnetic flux Φ_{21} links coil 2? (2 marks)
 - What mutually induced emf appears in that coil? (2 marks)

Question 5

- (a) A coil has an inductance of 0.10 H and a resistance of 12 Ω . It is connected to a 110-V, 60-Hz line. Determine
- the reactance of the coil, (2 marks)
 - the impedance of the coil, (2 marks)
 - the current through the coil, (2 marks)
 - the phase angle between the current and supply voltage (2 marks)
 - the reading of a wattmeter connected in the circuit. (2 marks)
- (b) When the rectangular metal tank is filled to the top with an unknown liquid as shown in Figure Q5(b), observer O, with eyes level with the top of the tank, can just see corner E. A ray that refracts toward O at the top surface of the liquid is shown. If $D = 85.0$ cm and $L = 1.10$ m, what is the index of refraction of the liquid? (5 marks)

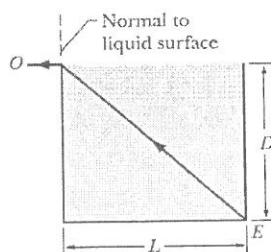


Figure Q5(b)

- (c) A 3.5 cm tall object is placed 25 cm in front of a spherical mirror. It is desired to produce a virtual image that is upright and 2.5 cm tall.
- (i) What type of mirror should be used? (1 mark)
 - (ii) Where is the image located? (2 marks)
 - (iii) What is the focal length of the mirror? (2 marks)
 - (iv) What is the radius of curvature of the mirror? (2 marks)
- (d) Sunlight is observed to focus at a point 15.5 cm behind a lens.
- (i) What kind of lens is it? (1 mark)
 - (ii) What is its power in diopters? (2 marks)

-- THE END --
PHY1204(F)AUG2017

