



INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session : August 2019

Programme : Foundation In Science (CFSI)

Course : **PHY1206 : PHYSICS 2**

Date of Examination : 12 December 2019 (Thursday)

Time : 8:00AM – 10:00AM 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.

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 consist of 7 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

FOUNDATION IN SCIENCE (CFSI)
PHY1206: PHYSICS 2
FINAL EXAMINATIONS: AUGUST 2019 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) The density of a gas at temperature 273 K and pressure 1.00×10^{-2} atm is 1.24×10^{-5} g/cm³. Calculate the rms speed and molar mass of the gas. (6 marks)
- (b) A gas sample undergoes a reversible isothermal expansion. Figure Q1(b) gives the change ΔS in entropy of the gas versus the final volume V_f of the gas. The scale of the vertical axis is set by $\Delta S_s = 64$ J/K. Calculate how many moles are in the sample? (3 marks)

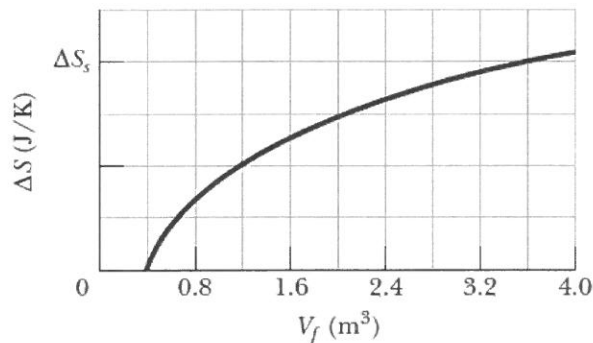


Figure Q1(b)

- (c) Three charged particles ($Q_1 = +7.0 \mu\text{C}$, $Q_2 = -8.0 \mu\text{C}$ and $Q_3 = -6.0 \mu\text{C}$) are placed at the corners of an equilateral triangle of side 1.20 m as shown in Figure Q1(c). Calculate the magnitude and direction of the net force on Q_2 due to the other charges. (8 marks)

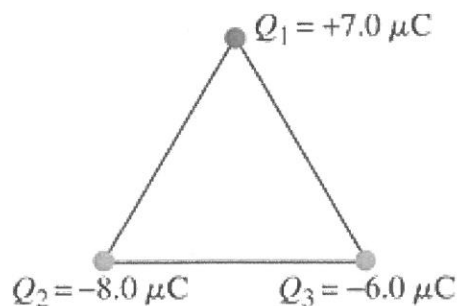


Figure Q1(c)

- (d) Two small nonconducting spheres have a total charge of $90.0 \mu\text{C}$. When placed 1.16 m apart, the force each exerts on the other is 12.0 N and the force is repulsive. Calculate the charge on each sphere? (3 marks)
- (e) Two point charges, $Q_1 = -25 \mu\text{C}$ and $Q_2 = +45 \mu\text{C}$ are separated by a distance of 10 cm as shown in Figure Q1(e). The electric field at point P is zero. Calculate the distance x ? (5 marks)

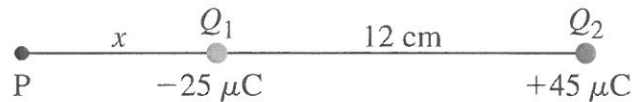


Figure Q1(e)

Question 2

- (a) An electron on the axis of an electric dipole is 25 nm from the center of the dipole. Calculate the magnitude of the electrostatic force on the electron if the dipole moment is $3.6 \times 10^{-29} \text{ C}\cdot\text{m}$. Assume that 25 nm is much larger than the separation of the charged particles that form the dipole. (4 marks)
- (b) Two objects, O_1 and O_2 have charges $+1.0 \mu\text{C}$ and $-2.0 \mu\text{C}$ respectively as indicated in Figure Q2(b), and a third object, O_3 is electrically neutral.

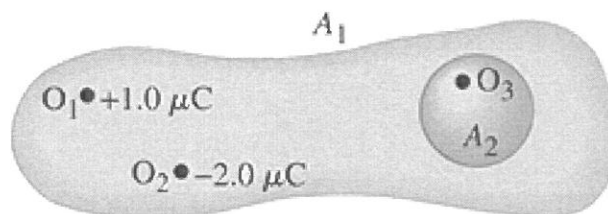


Figure Q2(b)

- (i) Calculate the electric flux through the surface A_1 that encloses all the three objects? (2 marks)
- (ii) Calculate the electric flux through the surface A_2 that encloses the third object only? (2 marks)
- (c) A long thin wire, hundreds of meters long, carries a uniformly distributed charge of $-7.2 \mu\text{C}$ per meter of length. Calculate the magnitude and direction of the electric field at points
- (i) 5.0 m perpendicular from the center of the wire and (3 marks)
- (ii) 2.5 m perpendicular from the center of the wire. (3 marks)

- (d) The electric potential at points in xy plane is given by $V = (2.0 \text{ V/m}^2) x^2 - (3.0 \text{ V/m}^2) y^2$. In unit-vector notation, what is the electric field at the point $(4.5 \text{ m}, 3.0 \text{ m})$? (7 marks)
- (e) Calculate the work required to bring a particle, of charge $Q = +16e$ and initially at rest, along the dashed line from infinity to the indicated point near two fixed particles of charges $q_1 = +4e$ and $q_2 = -q_1/2$ as shown in Figure Q2(e)? Distance $d = 1.40 \text{ cm}$, $\theta_1 = 43^\circ$, and $\theta_2 = 60^\circ$. (4 marks)

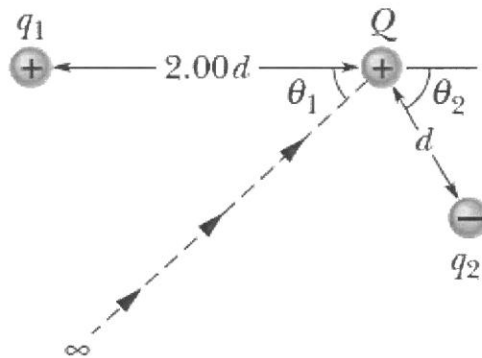


Figure Q2(e)

Question 3

- (a) Two identical capacitors are connected in parallel and each acquires a charge Q_0 when connected to a source of voltage V_0 . The voltage source is disconnected and then a dielectric ($\kappa = 2.8$) is inserted to fill the space between the plates of one of the capacitors. Calculate
- the new charge on each capacitor in terms of Q_0 . (4 marks)
 - the new voltage across each capacitor in terms of V_0 . (4 marks)
- (b) Suppose a kite string of radius 2.00 mm extends directly upward by 0.8 km and is coated with a 0.500 mm layer of water having resistivity $150 \Omega\text{m}$. If the potential difference between the two ends of the string is 300 MV , calculate the current through the water layer. (6 marks)
- (c) A 150 W lightbulb is plugged into a standard 120 V outlet. How much does it cost per month (29 days) to leave the light turned on continuously? Assume electrical energy costs $\text{RM } 0.05/\text{kWh}$. (3 marks)
- (d) Calculate the current flow through the resistor of 15Ω , 25Ω and 30Ω as shown in Figure Q3(d) using Kirchhoff's Rules. (Hint: you may arbitrarily assign the current direction at a junction before applying Kirchhoff's Rules). (8 marks)

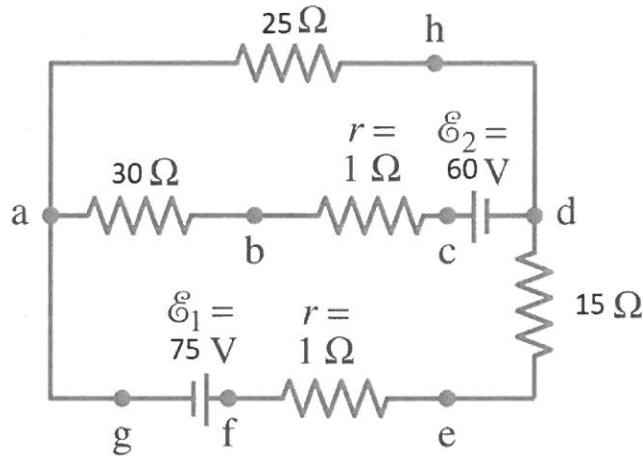


Figure Q3(d)

Question 4

- (a) A 1.5 m length of wire carrying 4.5 A of current toward the south is oriented horizontally. At that point on the Earth's surface, the dip angle of the Earth's magnetic field makes an angle of 30° to the wire. Calculate the magnitude of the magnetic force on the wire due to the Earth's magnetic field of $4.5 \mu\text{T}$ at this point. (3 marks)
- (b) Alpha particles of charge $q = -2e$ and mass $m = 6.6 \times 10^{-27} \text{ kg}$ are emitted from a radioactive source at a speed of $1.6 \times 10^7 \text{ m/s}$.
- Calculate the magnetic field strength that would be required to bend them into a circular path of radius $r = 0.18 \text{ m}$. (3 marks)
 - Calculate the maximum acceleration needed for the alpha particle to move in circular path. (3 marks)
- (c) Four long straight wires are perpendicular to the page, and their cross sections form a square of edge length $a = 13.5 \text{ cm}$ as shown in Figure Q4 (c). Each wire carries 7.50 A, the currents are out of the page in wires 1 and 4 and into the page in wires 2 and 3. Calculate the magnitude and direction of net magnetic force on wire 4. (8 marks)

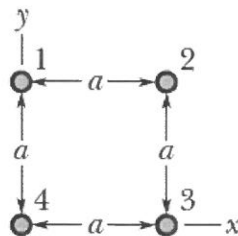


Figure Q4(c)

- (d) A coil is connected in series with a $10.0 \text{ k}\Omega$ resistor. An ideal 50.0 V battery is applied across the two devices, and the current reaches a value of 2.00 mA after 5.00 ms .
- (i) Calculate the inductance of the coil. (5 marks)
- (ii) Calculate the energy stored in the coil at this same moment. (3 marks)

Question 5

- (a) An ac generator operating at frequency 500 Hz and have emf amplitude $\mathcal{E}_m = 240 \text{ V}$ causes oscillations in a series RLC circuit having $R = 300 \ \Omega$, $L = 150 \text{ mH}$, and $C = 40.0 \ \mu\text{F}$. Calculate
- (i) the inductive reactance X_L , (2 marks)
- (ii) the capacitive reactance X_C , (2 marks)
- (iii) the impedance Z , and (2 marks)
- (iv) the phase angle ϕ . (2 marks)
- (b) In an EM wave traveling west, the B field oscillates vertically and has a frequency of 80.0 kHz and an rms strength of $9.75 \times 10^{-9} \text{ T}$.
- (i) Calculate the frequency and rms strength of the electric field. (4 marks)
- (ii) What is the direction of the electric field? (1 mark)
- (c) A light ray in an underlying material is incident at angle θ_1 on a boundary with water, and some of the light refracts into the water. There are two choices of underlying material which are material 1 and material 2. For each material, the angle of refraction θ_2 versus the incident angle θ_1 is given in Figure Q5(c). The dotted line is for material 1 and solid line is for material 2. The horizontal axis scale is set by $\theta_{1s} = 90^\circ$.

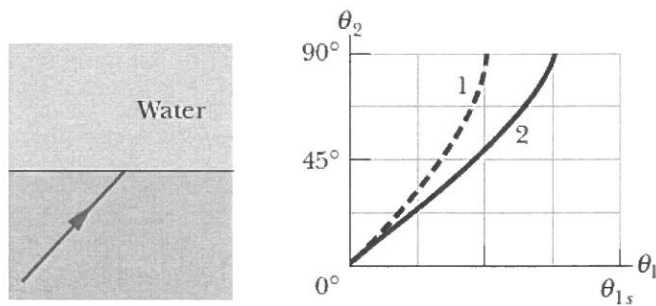


Figure Q5(c)

- (i) Without calculation, determine whether the index of refraction of material 1 is greater or less than the index of water ($n = 1.33$). Explain your answer. (2 marks)
- (ii) Calculate the index of refraction of material 1. (2 marks)
- (d) The distance between the first and fifth minima of a single slit diffraction pattern is 0.35 mm with the screen 40 cm away from the slit, when light of wavelength 550 nm is used.
- (i) Calculate the slit width. (3 marks)
- (ii) Calculate the angle θ (in radian) of the first diffraction minimum. (2 marks)
- (e) Suppose that Young's experiment is performed with green light of wavelength 550 nm. The slits are 1.50 mm apart, and the viewing screen is 5.40 m from the slits. How far apart are the bright fringes near the center of the interference pattern? (3 marks)

~ The End ~
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