INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session	:	April 2019
Programme	:	Foundation In Science (CFSI)
Course	:	**PHY1206 : PHYSICS 2**
Date of Examination	:	28 July 2019 (Sunday)
Time	:	2:00PM – 4:00PM 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.

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 **8** printed pages, including the cover page.*

INTI INTERNATIONAL COLLEGE PENANG

FOUNDATION IN SCIENCE (CFSI)
PHY1206: PHYSICS 2
FINAL EXAMINATIONS: APRIL 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) An automobile tire has a volume of 1.64×10^{-2} m^3 and contains air at a gauge pressure (pressure above atmospheric pressure) of 165 kPa when the temperature is 0.00°C. What is the gauge pressure of the air in the tires when its temperature rises to 27.0°C and its volume increases to 1.67×10^{-2} m^3?
Assume atmospheric pressure is 1.01×10^5 Pa. (4 marks)

(b) A 2.00 mol sample of an ideal gas expands reversibly and isothermally at 350 K until its volume is tripled.
What is the increase in entropy of the gas? (3 marks)

(c) The charges and coordinates of two charged particles held fixed in an xy plane are $q_1 = +3.0$ μC, $x_1 = 3.5$ cm, $y_1 = 0.50$ cm, and $q_2 = -4.0$ μC, $x_2 = -2.0$ cm, $y_2 = 1.5$ cm. Compute the magnitude and direction of the electrostatic force on particle 2 due to particle 1. (5 marks)

(d) An arrangement of four charged particles was shown in Figure Q1(d), with angle $\theta = 30.0°$ and distance $d = 2.00$ cm. Particle 2 has charge $q_2 = +8.00 \times 10^{-19}$ C; particles 3 and 4 have charges $q_3 = q_4 = -1.60 \times 10^{-19}$ C.

(i) What is distance D between the origin and particle 2 if the net electrostatic force on particle 1 due to the other particles is zero? (4 marks)

(ii) If particles 3 and 4 were moved closer to the x axis but maintained their symmetry about that axis, would the required value of D be greater than, less than, or the same as in part (i)? Explain your answer. (3 marks)

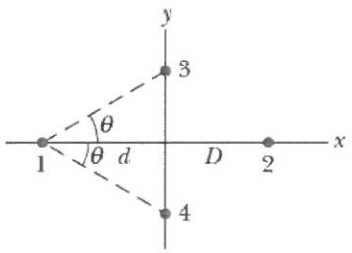

Figure Q1(d)

(e) Four particles are fixed in place as shown in Figure Q1(e) and all of them have charges $q_1 = q_2 = +5e$, $q_3 = +3e$, and $q_4 = -12e$. Distance d is given as 6.0 mm.

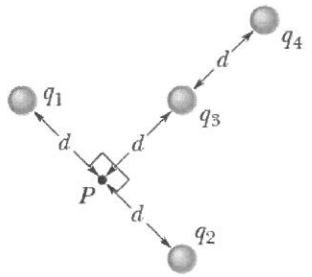

Figure Q1(e)

(i) What is the magnitude of net electric field at point P due to the particles? (4 marks)

(ii) What will happen to the net electric field at point P when $q_1 = +5e$ and $q_2 = -5e$? (2 marks)

Question 2

(a) An electric dipole consists of charges $+3e$ and $-3e$ separated by 0.78 nm. It is in an electric field of strength 3.2×10^5 N/C.
Calculate the magnitude of the torque on the dipole when the dipole moment is

(i) parallel to the electric field, (2 marks)

(ii) perpendicular to the electric field. (2 marks)

(b) A proton is a distance d/2 directly above the center of a square of side d as shown in Figure Q2(b).

(i) What is the magnitude of the electric flux through the square?
(Hint: Think of the square as one face of a cube with edge d). (3 marks)

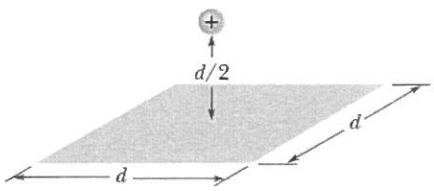

Figure Q2(b)

(ii) A point charge of 2.8 μC is at the center of a Gaussian cube with d = 40 cm. What is the net electric flux through the cube surface? (2 marks)

(c) Space vehicles traveling through Earth's radiation belts can intercept a significant number of electrons. The resulting charge buildup can damage electronic components and disrupt operations.
Suppose a spherical metal satellite 1.5 m in diameter accumulates 3.0 μC of charge in one orbital revolution.

(i) Compute the resulting surface charge density. (3 marks)

(ii) Calculate the magnitude of the electric field just outside the surface of the satellite, due to the surface charge. (3 marks)

(d) Two charges are separated by 52 cm as shown in Figure Q2(d).
Calculate the electric potential

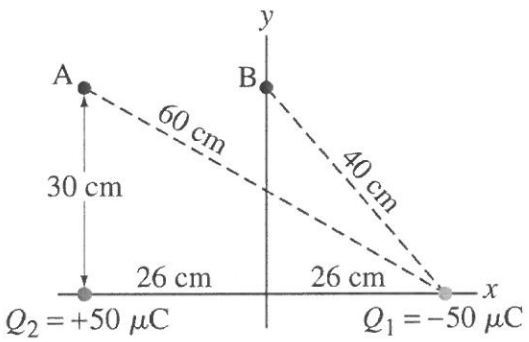

Figure Q2(d)

(i) at point A, and (3 marks)

(ii) at point B. (2 marks)

(e) A +25 μC point charge is placed 6.0 cm from an identical +25 μC point charge. How much work would be required by an external force to move a +0.18 μC test charge from a point midway between them to a point 1.0 cm closer to either of the charges? (5 marks)

Question 3

(a) A parallel-plate air-filled capacitor having area 30 cm^2 and plate spacing 1.5 mm is charged to a potential difference of 500 V.
Compute

(i) the capacitance, (2 marks)

(ii) the magnitude of the charge on each plate, (2 marks)

(iii) the stored energy, (2 marks)

(iv) the electric field between the plates, and (2 marks)

(v) the energy density between the plates. (2 marks)

(b) How many kWh of energy does a 550 W toaster use in the morning if it is in operation for a total of 6.0 min? At a cost of 7.0 cents/kWh, estimate how much this would add to your monthly electric energy bill if you made toast four mornings per week. (3 marks)

(c) A small but measurable current of 0.12 nA exists in a copper wire whose diameter is 2.5 mm. The number of charge carriers per unit volume is 8.49×10^{28} m^{-3}. Assuming the current is uniform, calculate the

(i) current density and (2 marks)

(ii) electron drift speed. (2 marks)

(d) A 2.0 μF capacitor with an initial stored energy of 1.50 J is discharged through a 1.0 MΩ resistor.

(i) What is the initial charge on the capacitor? (2 marks)

(ii) What is the current through the resistor when the discharge starts? (3 marks)

(iii) Find an expression that gives the potential difference V_C across the capacitor as a function of time t. (3 marks)

Question 4

(a) A uniform magnetic field B, with magnitude 1.2 mT, is directed vertically upward throughout the volume of a laboratory chamber. A proton with kinetic energy 5.3 MeV enters the chamber, moving horizontally from south to north.
What is the magnetic force that acts on the proton as it enters the chamber and what is the proton's acceleration due to the magnetic force? The proton mass is 1.67×10^{-27} kg. (Neglect Earth's magnetic field). (5 marks)

(b) An electron is projected vertically upward with a speed of 1.7×10^{6} m/s into a uniform magnetic field of 0.480 T that is directed horizontally away from the observer. Describe the electron's path in this field. (3 marks)

(c) Determine the magnetic field midway between two long straight wires 2.0 cm apart if one wire carries current of 30 A and another wire carries 25 A.
Assume these currents are

(i) in the same direction, and (3 marks)

(ii) in opposite directions. (3 marks)

(d) At t = 0, a 12.0 V battery is connected in series with a 220 mH inductor and a total of 30 Ω resistance, as shown in Figure Q4(d).

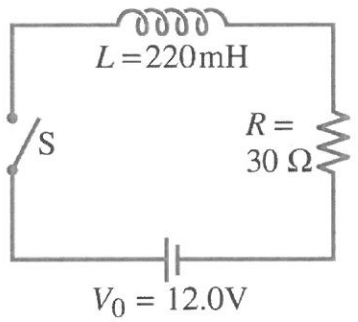

Figure Q4(d)

(i) What is the current at t = 0? (1 mark)

(ii) What is the time constant? (2 marks)

(iii) What is the maximum current? (2 marks)

(iv) How long will it take the current to reach half its maximum possible value? (2 marks)

(e) In order to make the rod move to the right at speed v as shown in Figure Q4(e), an external force needs to be applied on the rod.
Determine the magnitude of the required force in terms of B, l, v and R where R is the resistance of conductor. (4 marks)

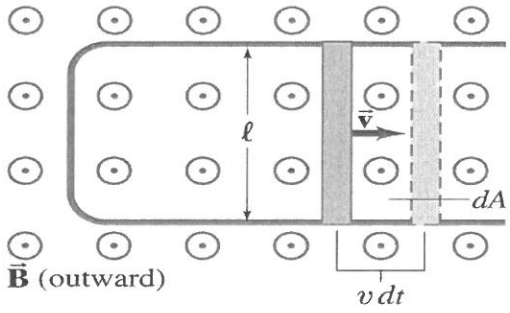

Figure Q4(e)

Question 5

(a) In a RLC circuit, $R = 25.0\ \Omega$, $L = 30.0$ mH, and $C = 12.0\ \mu$F.
The capacitor, inductor and resistor are connected in series to an ac generator with 90 V (rms) and operating at a frequency of 500 Hz.
Calculate

(i) the current in the circuit, (4 marks)

(ii) the voltmeter readings (rms) across R, L and C, (3 marks)

(iii) the phase angle ϕ. (2 marks)

(b) An electromagnetic wave has an electric field given by the expression

$$\hat{E} = \left(225\,\frac{V}{m}\right)\sin[(0.77\text{m}^{-1})\text{z} - (2.3 \times 10^7\ \text{rad/s})\text{t}]\,\hat{\imath}$$

(i) What are the wavelength and frequency of the wave? (2 marks)

(ii) Write down an expression for the magnetic field. (2 marks)

(c) A ray of light is incident perpendicular to the surface ab of a glass prism (n = 1.52) as shown in Figure Q5(c).

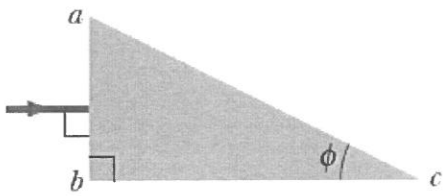

Figure Q5(c)

Compute the largest value for the angle Φ so that the ray is totally reflected at surface ac if the prism is immersed

(i) in air and (2 marks)

(ii) in water (2 marks)

(d) A physics lecturer want to perform a lecture demonstration of Young's double-slit experiment for her class using the 600 nm light from a He–Ne laser. Because the lecture hall is very large, the interference pattern will be projected on a wall that is 5.5 m from the slits. For easy viewing by all students in the class, the lecturer want the distance between the m = 0 and m =1 maxima to be 25 cm.
What slit separation is required in order to produce the desired interference pattern?
(4 marks)

(e) Monochromatic light of wavelength 550 nm is incident on a narrow slit. On a screen 2.00 m away, the distance between the second diffraction minimum and the central maximum is 1.50 cm.

(i) Calculate the angle of diffraction θ of the second minimum. (2 marks)

(ii) Compute the width of the slit. (2 marks)

~ The End ~