INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session : August 2018

Programme : Foundation In Science (CFSI)

Course : **PHY1206 : PHYSICS 2**

Date of Examination : 14 December 2018 (Friday)

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.

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FOUNDATION IN SCIENCE (CFSI)
PHY1206: PHYSICS 2
FINAL EXAMINATION: AUGUST 2018 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 steam engine has a boiler that operates at 5.00×10^2 K. The energy from the boiler changes water to steam, which drives the piston. The temperature of the exhaust is that of the outside air, 3.00×10^2 K.

(i) What is the engine's efficiency if it's an ideal engine? (2 marks)

(ii) If the 3.50×10^3 J of energy is supplied from the boiler, find the energy transferred to the cold reservoir and the work done by the engine on its environment. (4 marks)

(b) Four point charges are at the corners of a square of side a as shown in Figure Q1(b). Determine the magnitude and direction of the resultant electric force on q, with k_e , q, and a left in symbolic form. (5 marks)

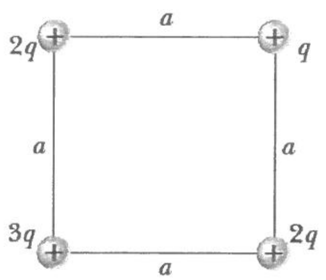

Figure Q1(b)

(c) Three point charges are located on a circular arc as shown in Figure Q1(c). What is the magnitude of the total electric field at P, the center of the arc? (5 marks)

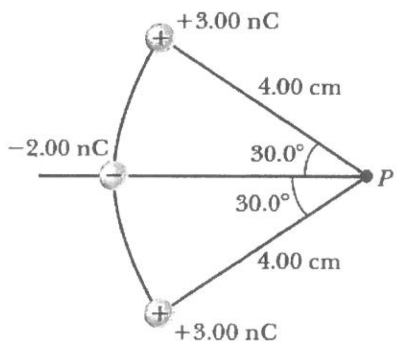

Figure Q1(c)

(d) Four closed surfaces, S_1 through S_4, together with the charges -2Q, Q, and -Q, are sketched in Figure Q1(d). Find the electric flux through each surface. (4 marks)

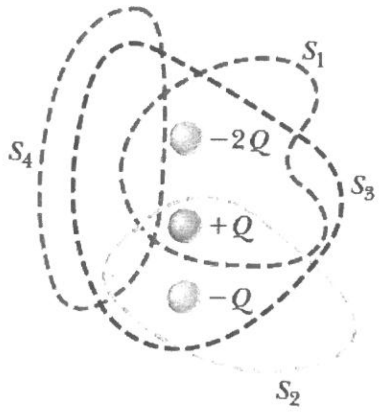

Figure Q1(d)

(e) A 5.00 μC point charge is at the origin, and a point charge q_2 = -2.00 μC is on the x-axis at (3.00, 0) m, as in Figure Q1(e).

(i) If the electric potential is taken to be zero at infinity, find the electric potential due to these charges at point *P* with coordinates (0, 4.00) m. (3 marks)

(ii) How much work is required to bring a third point charge of 4.00 μC from infinity to *P*? (2 marks)

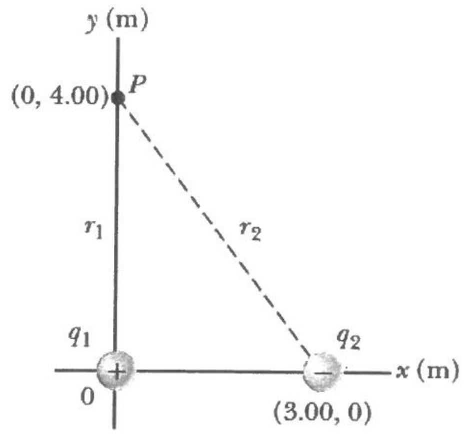

Figure Q1(e)

Question 2

(a) In Figure Q2(a), V = 12 V, $C_1 = C_5 = C_6 = 6.0\ \mu F$, and $C_2 = C_3 = C_4 = 4.0\ \mu F$. Determine the

(i) the net charge stored on the capacitors and (2 marks)

(ii) the charge on capacitor 4, (3 marks)

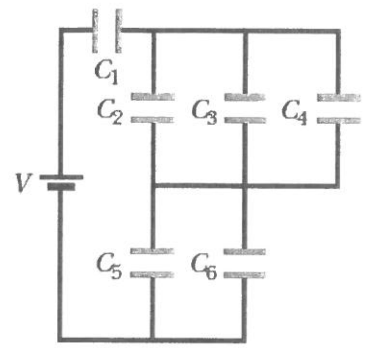

Figure Q2(a)

(b) An aluminum rod with a square cross section is 1.3 m long and 5.2 mm on edge.

(i) What is the resistance between its ends? (2 marks)

(ii) What must be the diameter of a cylindrical copper rod of length 1.3 m if its resistance is to be the same as that of the aluminum rod? (3 marks)

(c) Switch S in Figure Q2(c) is closed at time $t = 0$, to begin charging an initially uncharged capacitor of capacitance $C = 15.0\ \mu F$ through a resistor of resistance $R = 20.0\ \Omega$. At what time is the potential across the capacitor equal to that across the resistor? (5 marks)

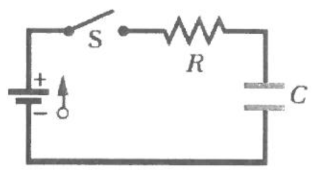

Figure Q2(c)

(d) An electron of kinetic energy 1.20 keV circles in a plane perpendicular to a uniform magnetic field. The orbit radius is 25.0 cm. Find

(i) the electron's speed, (2 marks)

(ii) the magnitude of magnetic field, (2 marks)

(e) Two long straight wires are parallel and 8.0 cm apart. They are to carry equal currents such that the magnetic field at a point halfway between them has magnitude 300 μT.

(i) Should the currents be in the same or opposite direction? Explain your answer. (3 marks)

(ii) How much current is needed? (3 marks)

Question 3

(a) A conducting circular loop of radius 0.250 m is placed in the xy-plane in a uniform magnetic field of 0.360 T that points in the positive z-direction, the same direction as the normal to the plane.

(i) Calculate the magnetic flux through the loop. (2 marks)

(ii) Suppose the loop is rotated clockwise around the x-axis, so the normal direction now points at a 45.0° angle with respect to the z-axis. Recalculate the magnetic flux through the loop. (2 marks)

(b) Calculate the inductance of a solenoid containing 300 turns if the length of the solenoid is 25.0 cm and its cross-sectional area is $4.00 \times 10^{-4}\ m^2$ and the self-induced emf in the solenoid if the current in the solenoid decreases at the rate of 50.0 A/s. (4 marks)

(c) A 12.6 V battery is in a circuit with a 30.0 mH inductor and a 0.150 V resistor, as shown in Figure Q3(c). The switch is closed at t = 0.

(i) Find the time constant of the circuit. (2 marks)

(ii) Find the current after one time constant has elapsed. (3 marks)

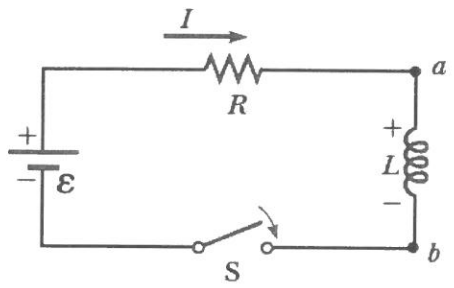

Figure Q3(c)

(d) Consider a series RLC circuit with R = 25 Ω, L = 6.0 mH, and C = 25 μF. The circuit is connected to a 10-V (rms), 600-Hz AC source.

(i) Is the sum of the voltage drops across R, L, and C equal to 10 V (rms)? (6 marks)

(ii) Find the average power delivered to the circuit. (2 marks)

(e) A step-down transformer is used for recharging the batteries of portable devices. The turns ratio N_2/N_1 for a particular transformer used in a CD player is 1:13. When used with 120 V (rms) household service, the transformer draws an rms current of 250 mA. Find the

(i) rms output voltage of the transformer and (2 marks)

(ii) power delivered to the CD player. (Assume that the transformer is an ideal transformer). (2 marks)

Question 4

(a) Consider a bright star in our night sky. Assume its distance from the Earth is 20.0 light-years (ly) and its power output is 4.00 x 10^{28} W, about 100 times that of the Sun. Find the intensity of the starlight at the Earth. One light-year is the distance traveled by light through a vacuum in one year. (4 marks)

(b) An airplane flying at a distance of 10 km from a radio transmitter receives a signal of intensity 10 mW/m^2. What is the amplitude of the electric and magnetic component of the signal at the airplane? (4 marks)

(c) A beam of light is incident from air on the surface of a liquid. If the angle of incidence is 30.0° and the angle of refraction is 22.0°, find the critical angle for the liquid when surrounded by air. (4 marks)

(d) You are standing 3.0 m from a convex security mirror in a store. You estimate the height of your image to be half of your actual height. Estimate the radius of curvature of the mirror. (6 marks)

(e) A stamp collector uses a converging lens with focal length 28 cm to view a stamp 18 cm in front of the lens.

(i) Where is the image located? (3 marks)

(ii) What is the magnification? (3 marks)

(iii) What is the characteristics of the image formed? (1 mark)

Question 5

(a) When a red laser with 632.8 nm light falls on two closely spaced slits, an interference pattern formed on a wall several meters away has bright fringes spaced 5.00 mm apart near the center of the pattern. When the laser is replaced by a small laser pointer, the fringes are 5.14 mm apart. What is the wavelength of light produced by the pointer? (4 marks)

(b) A blue light of wavelength 480 nm gives a second-order maximum at a certain location on the screen in a double-slit experiment. What wavelength of visible light would have a minimum at the same location? (5 marks)

(c) Light of wavelength 5.0 x 10^{-7} m passes through two parallel slits and falls on a screen 4.0 m away. Adjacent bright bands of the interference pattern are 2.0 cm apart.

(i) Find the distance between the slits. (2 marks)

(ii) The same two slits are next illuminated by light of a different wavelength, and the fifth-order minimum for this light occurs at the same point on the screen as the fourth-order minimum for the previous light. What is the wavelength of the second source of light? (2 marks)

(d) Light of wavelength 580 nm falls on a slit that is 3.80 x 10^{-3} mm wide. Estimate how far the first brightest diffraction fringe is from the strong central maximum if the screen is 10.0 m away. (6 marks)

(e) Light of wavelength 600 nm falls on a 0.40 mm wide slit and forms a diffraction pattern on a screen 1.5 m away.

(i) Find the position of the first dark band on each side of the central maximum. (3 marks)

(ii) Find the width of the central maximum. (3 marks)

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