UNIVERSITI SAINS MALAYSIA

Peperiksaan Kursus Semasa Cuti Panjang
Academic Session 2008/2009

Jun 2009

JIF 217 – Electricity and Magnetism
[JIF 217 – Keelektrikan dan Kemagnetan]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **THIRTEEN** printed pages before you begin the examination.

Answer **ALL** questions. You may answer **either** in Bahasa Malaysia or in English.

Read the instructions carefully before answering.

Each question carries 20 marks.

*Sila pastikan kertas peperiksaan ini mengandungi **TIGA BELAS** muka surat yang bercetak sebelum anda menjawab sebarang soalan.*

*Jawab **SEMUA** soalan. Anda dibenarkan menjawab soalan **sama ada** dalam Bahasa Malaysia atau Bahasa Inggeris.*

Baca setiap arahan dengan teliti sebelum menjawab.

Setiap soalan diperuntukkan 20 markah.

...2/-

Constants:

Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

1 Pa = 1 N m^{-2}

1 atm = 1.013×10^5 Pa

Molar gas constant $R = 8.31$ J mol^{-1} K^{-1}

Permeability constant $\mu_o = 4\pi \times 10^{-7}$ wb A^{-1} m^{-1} (or H m^{-1})

Permittivity constant $\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}

Planck's constant $h = 6.6 \times 10^{-34}$ J s

$c = 3 \times 10^8$ m s^{-1}

1 eV = 1.60×10^{-19} J

Electron rest-mass $m_e = 9.11 \times 10^{-31}$ kg

Mass of proton = 1.007276 amu

Mass of neutron = 1.008665 amu

Avogadro's number = 6.022×10^{23} mol^{-1}

1 amu = 1.66×10^{-27} kg = 931 MeV

...3/-

1. (a) Prove that for unit vectors.

(i) $\hat{i} \cdot \hat{i} = \hat{j} \cdot \hat{j} = \hat{k} \cdot \hat{k} = 1$.

(ii) $\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0$.

(8 marks)

(b)

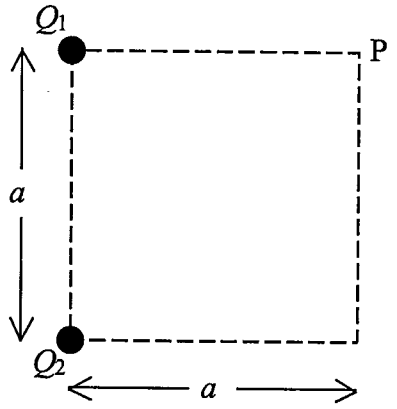

Figure 1

Figure 1 shows two point charges at the corners of a square. Given that $Q_1 = 1.0 \times 10^{-8}$ C, $Q_2 = -2.0 \times 10^{-8}$ C and $a = 2.0$ cm. Determine

(i) the magnitude and the direction of the electric field at point P due to charge Q_2,

(ii) the magnitude and the direction of the electrostatic force acting on charge Q_1.

(12 marks)

2. (a) Describe the Gaussian surface. Why it is not needed in Coulomb's equation? Your description must include its shape, function and relevant equation.

(8 marks)

(b)

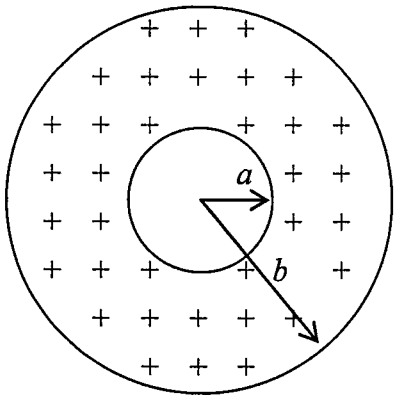

Figure 2

Figure 2 shows a spherical shell with a uniform volume charge density $\rho = 2.0$ nC m^{-3}, inner radius a = 10.0 cm, and outer radius b = 20.0 cm. What is the magnitude of the electric field at radial distances

(i) $r = a$;

(ii) $r = 1.5a$;

(iii) $r = b$.

(12 marks)

3. (a) Explain, with the help of an equation, how the direction of the magnetic force acting on a charged particle moving in a magnetic field is determined.

(6 marks)

(b)

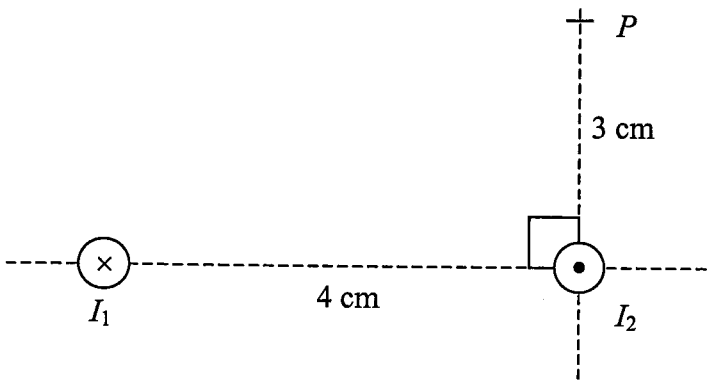

Figure 3

Given two infinitely long parallel wires as shown in Figure 3 each carrying a current $I_1 = 10$ A and $I_2 = 5$ A. Determine

(i) the magnetic field at point P due to I_2,

(ii) the magnetic force acting on I_1.

(14 marks)

...6/-

4. (a) Explain how would you determine the direction of the induced current in a conductor moving across a magnetic field.

(6 marks)

(b)

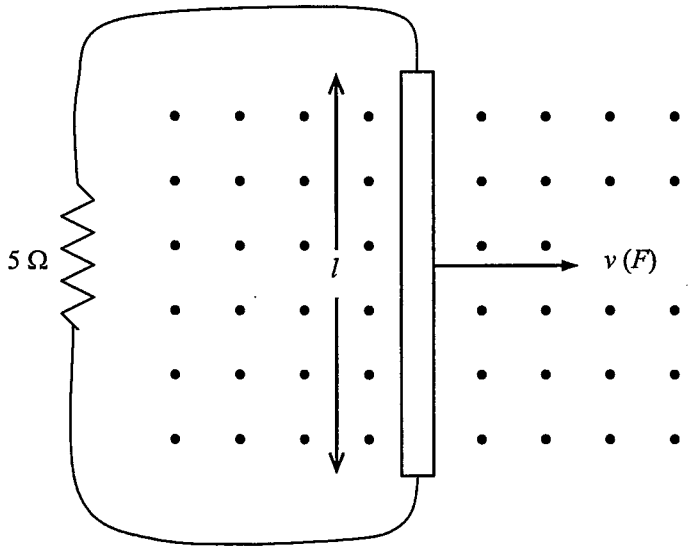

Figure 4

Consider a long conducting rod of length $l = 0.5$ m is moved to the right with a speed $v = 2$ m s^{-1} in a magnetic field $B = 3$ T directed outward from the plane of the paper as shown in Figure 4.

(i) Calculate the induced electromotive force (emf).

(ii) Determine the direction of the induced current flowing in the rod.

(iii) Calculate the magnitude of the induced current in the circuit if both ends of the conductor is connected using a wire of resistance 5 Ω.

(14 marks)

...7/-

5. (a) Define the inductive time constant of a coil.

(8 marks)

(b) A coil has an inductance of 53 mH and a resistance of 0.35 Ω.

(i) What is the inductive time constant of the coil?

(ii) If a 12 V emf is applied across the coil, how much energy is stored in the magnetic field after the current has built up to its equilibrium value?

(iii) After how many time constants will half this equilibrium energy be stored in the magnetic field?

(12 marks)

...8/-

Pemalar-pemalar:

Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

1 Pa = 1 N m^{-2}

1 atm = 1.013×10^5 Pa

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Mass of neutron = 1.008665 amu

Avogadro's number = 6.022×10^{23} mol^{-1}

1 amu = 1.66×10^{-27} kg = 931 MeV

...9/-

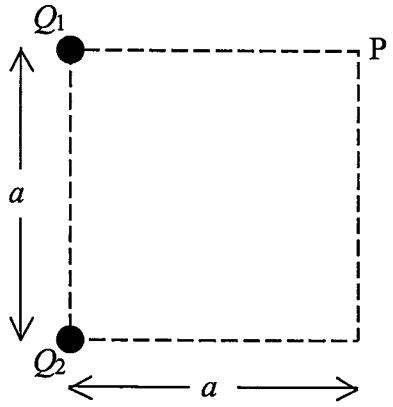
1. (a) *Buktikan bahawa bagi vektor unit.*

(i) $\hat{i}\cdot\hat{i}=\hat{j}\cdot\hat{j}=\hat{k}\cdot\hat{k}=1.$

(ii) $\hat{i}\times\hat{i}=\hat{j}\times\hat{j}=\hat{k}\times\hat{k}=0.$

(8 markah)

(b)



Rajah 1

Rajah 1 menunjukkan dua cas titik di penjuru suatu segiempat sama. Diberikan $Q_1 = 1.0 \times 10^{-8}$ *C,* $Q_2 = -2.0 \times 10^{-8}$ *C dan a = 2.0 cm. Tentukan*

(i) magnitud dan arah medan elektrik pada titik P disebabkan oleh cas Q_2,

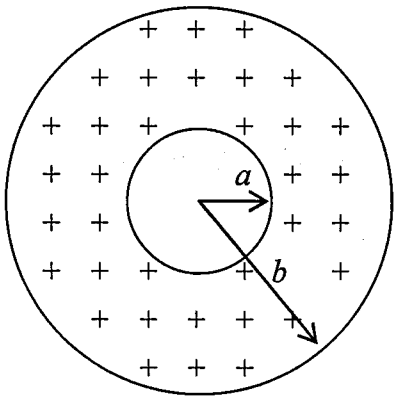
(ii) magnitud dan arah daya elektrostatik yang bertindak pada cas Q_1.

(12 markah)

2. (a) *Perihalkan permukaan Gauss. Mengapa ia tidak diperlukan dalam persamaan Coulomb? Pemerihalan anda haruslah mencakupi bentuknya, fungsinya dan persamaan yang berkaitan.*

(8 markah)

(b)



Rajah 2

Rajah 2 menunjukkan suatu petala sferaan yang mengandungi suatu ketumpatan cas isipadu seragam $\rho = 2.0\ nC\ m^{-3}$, *jejari dalaman* $a = 10.0\ cm$, *dan jejari luaran* $b = 20.0\ cm$. *Berapakah magnitud medan elektrik pada jarak jejarian*

(i) $r = a$;

(ii) $r = 1.5a$;

(iii) $r = b$.

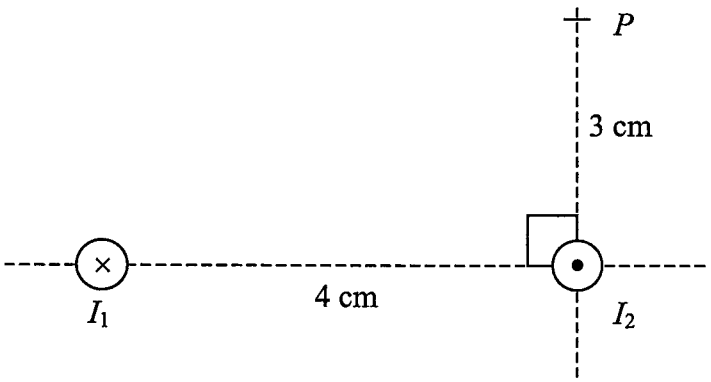
(12 markah)

...11/-

3. (a) *Jelaskan, dengan bantuan suatu persamaan, bagaimana anda menentukan arah daya magnet yang bertindak pada suatu zarah bercas yang bergerak dalam suatu medan magnet.*

(6 markah)

(b)



Rajah 3

Diberikan dua dawai selari panjang tak terhingga seperti yang ditunjukkan dalam Rajah 3 setiapnya membawa arus $I_1 = 10$ A dan $I_2 = 5$ A. Tentukan

(i) medan magnet pada titik P disebabkan oleh I_2,

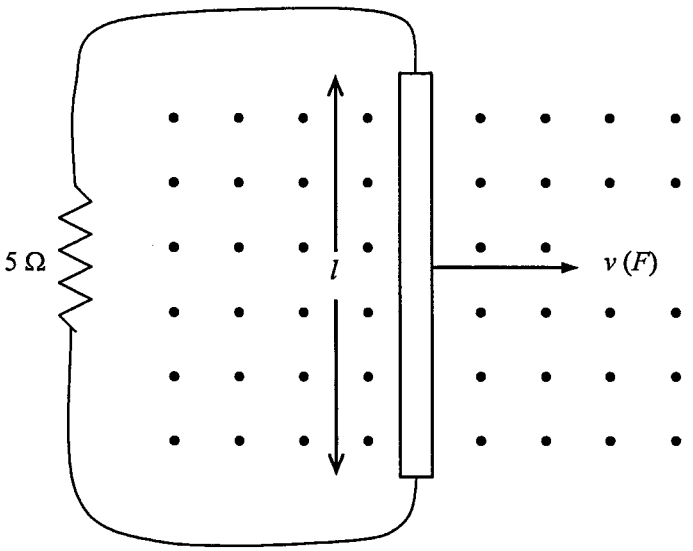
(ii) daya magnet yang bertindak pada I_1.

(14 markah)

4. (a) *Jelaskan bagaimana anda menentukan arah arus teraruh dalam suatu konduktor yang bergerak merentasi suatu medan magnet.*

(6 markah)

(b)



Rajah 4

Pertimbangkan sebatang konduktor panjang l = 0.5 m digerakkan ke kanan dengan kelajuan v = 2 m s^{-1} dalam suatu medan magnet B = 3 T yang menghala keluar satah kertas seperti yang ditunjukkan dalam Rajah 4.

(i) Hitung daya gerak elektrik (dge) teraruh.

(ii) Tentukan arah arus teraruh yang mengalir dalam batang.

(iii) Hitung magnitud arus teraruh dalam litar jika kedua-dua hujung konduktor itu disambungkan dengan suatu dawai berkerintangan 5 Ω.

(14 markah)

...13/-

5. (a) *Takrifkan pemalar masa induktif bagi suatu gegelung.*

(8 markah)

(b) *Suatu gegelung mempunyai induktans 53 mH dan rintangan 0.35 Ω.*

(i) *Berapakah pemalar masa induktif gegelung tersebut?*

(ii) *Jika suatu dge 12 V dibekalkan merentasi gegelung, berapa banyakkah tenaga yang disimpan dalam medan magnet selepas arus meningkat ke nilai keseimbangannya?*

(iii) *Selepas berapa pemalar masakah setengah tenaga keseimbangan ini disimpan dalam medan magnet?*

(12 markah)

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