



UNIVERSITI SAINS MALAYSIA

Final Examination
2016/2017 Academic Session

May/June 2017

JIF 217 – Electricity and Magnetism
[Keelektrikan dan Kemagnetan]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **NINE** 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.

In the event of any discrepancies in the exam questions, the English version shall be used.

*Sila pastikan kertas peperiksaan ini mengandungi **SEMBILAN** 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.

Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.

Constants:

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

1 Pa = 1 N m⁻²

1 atm = 1.013 × 10⁵ Pa

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

Permeability constant $\mu_0 = 4\pi \times 10^{-7} \text{ wb A}^{-1} \text{ m}^{-1}$ (or H m⁻¹)

Permittivity constant $\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$

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

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

1 eV = 1.60 × 10⁻¹⁹ J

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

Mass of proton = 1.007276 amu

Mass of neutron = 1.008665 amu

Avogadro's number = 6.022 × 10²³ mol⁻¹

1 amu = 1.66 × 10⁻²⁷ kg = 931 MeV

1. (a) In a vector form, write down the equation of the Coulomb's force acting on one of two point charges, q_1 and q_2 . Interpret the meaning of the subscripts of the vectors and the unit vectors.

(8 marks)

- (b) Figure 1 shows two point charges at the corners of a square. Given that $q = 1.0 \times 10^{-8}$ C and $a = 5.0$ cm.

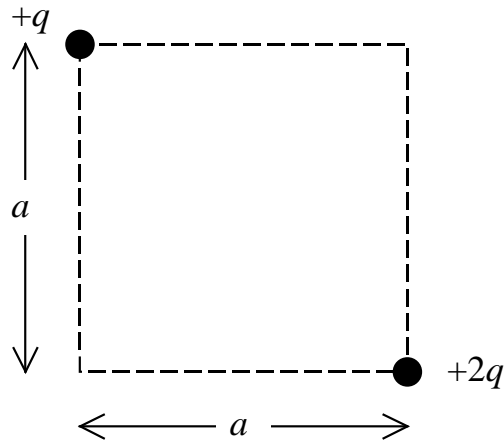


Figure 1

Find the magnitude and the direction of the

- (i) force acting on the point charge $+q$,
- (ii) electric field at the center of the square.

(12 marks)

2. (a) Explain the Gauss's law in words, equation and suitable diagrams. (8 marks)

(b) A thin metallic sphere has a radius a and is carrying charge q_a . An identical concentric sphere has a radius b ($b > a$) and is carrying charge q_b . Use Gauss's Law to determine the electric field E at the radial points r where

(i) $r < a$,

(ii) $a < r < b$.

(12 marks)

3. (a) Define Kirchoff's Laws. (6 marks)

(b) Determine the current passing through the resistor $2R$ in terms of ε and R as shown in Figure 2. Assume the ammeter A has no internal resistance.

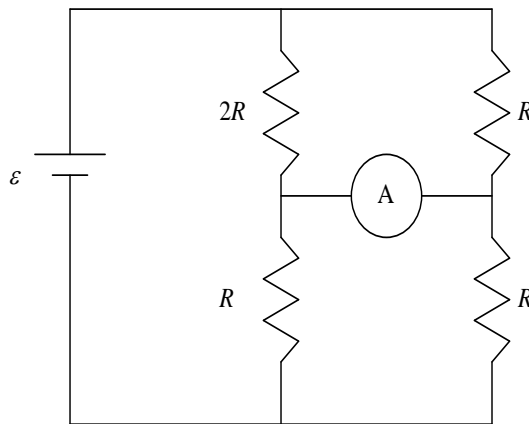


Figure 2

(14 marks)

4. (a) Explain Ampere's Law. Write down the Ampere's Law equation for an infinite long conductor wire and explain the meaning of the symbols used.

(6 marks)

- (b) Prove that for unit vectors.

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

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

(14 marks)

5. (a) Lenz's law is stated as: "The direction of an induced current is such as to oppose the cause producing it." Using proper diagrams, clarify what it means.

(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 be half of this equilibrium energy be stored in the magnetic field?

(12 marks)

Pemalar-pemalar:

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

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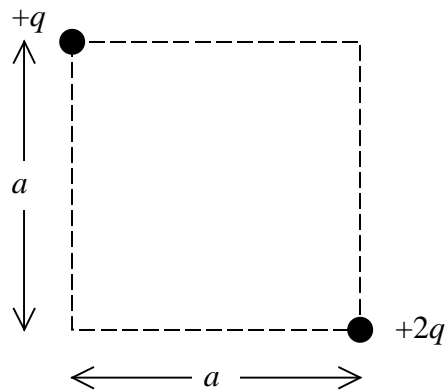
Avogadro's number = 6.022 × 10²³ mol⁻¹

1 amu = 1.66 × 10⁻²⁷ kg = 931 MeV

1. (a) Dalam bentuk vektor, tuliskan persamaan daya Coulomb yang bertindak pada salah satu daripada dua cas titik, q_1 dan q_2 . Jelaskan maksud subskrip vektor dan subskrip vektor unit.

(8 markah)

- (b) Rajah 1 menunjukkan dua cas titik pada penjuru suatu segi empat sama. Diberikan $q = 1.0 \times 10^{-8} \text{ C}$ dan $a = 5.0 \text{ cm}$.



Rajah 1

Tentukan magnitud dan arah daya

- (i) yang bertindak pada cas titik $+q$,
(ii) medan elektrik di pusat segiempat tersebut.

(12 markah)

2. (a) *Jelaskan hukum Gauss dengan perkataan, persamaan dan rajah yang sesuai.*
(8 markah)

(b) *Suatu sfera logam nipis mempunyai jejari a dan membawa cas q_a . Suatu sfera sepusat seiras mempunyai jejari b ($b > a$) dan membawa cas q_b . Gunakan hukum Gauss untuk menentukan medan elektrik E pada titik-titik jejarian r berikut*

(i) $r < a$,

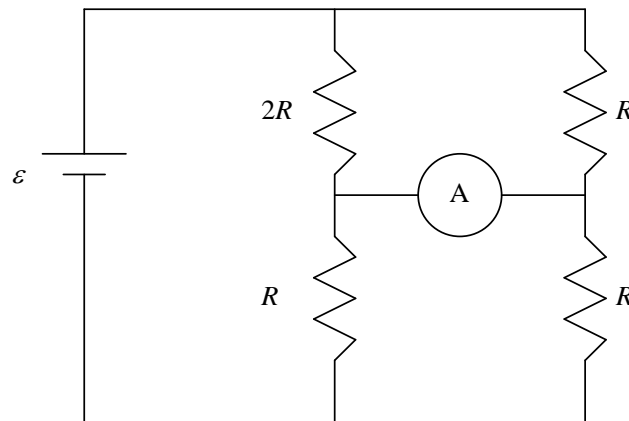
(ii) $a < r < b$.

(12 markah)

3. (a) *Takrifkan hukum Kirchoff.*

(6 markah)

(b) *Tentukan arus yang melalui perintang $2R$ dalam sebutan ε dan R seperti pada Rajah 2. Andaikan ammeter A tidak mempunyai rintangan dalaman.*



Rajah 2

(14 markah)

4. (a) *Jelaskan hukum Ampere. Tuliskan persamaan hukum Ampere bagi suatu dawai konduktor panjang tak terhingga dan jelaskan maksud simbol-simbol yang digunakan.*

(6 markah)

- (b) *Buktikan bahawa bagi vektor unit.*

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

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

(14 markah)

5. (a) *Hukum Lenz dinyatakan sebagai: "Arah arus teraruh adalah sedemikian ia menentang asbab yang menghasilkannya." Dengan menggunakan gambar rajah bersesuaian, jelaskan maksud pernyataan ini.*

(8 markah)

- (b) *Satu gelung mempunyai induktans 53 mH dan rintangan 0.35 Ω .*

(i) *Tentukan pemalar masa induktif bagi gelung?*

(ii) *Jika 12 V emf disambungkan merentasi gelung, berapa tenaga disimpan di dalam medan magnet selepas arus dibina sehingga mencapai nilai keseimbangan?*

(iii) *Selepas berapa pemalar masa, tenaga keseimbangan disimpan dalam medan magnet menjadi separuh?*

(12 markah)