

---

UNIVERSITI SAINS MALAYSIA

Final Examination  
2015/2016 Academic Session

May/June 2016

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

Duration : 3 hours  
*[Masa : 3 jam]*

---

Please ensure that this examination paper contains **ELEVEN** 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 100 marks.

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

*Sila pastikan kertas peperiksaan ini mengandungi **SEBELAS** 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 100 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<sup>-2</sup>

1 atm = 1.013 × 10<sup>5</sup> 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<sup>-1</sup>)

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<sup>-19</sup> 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 × 10<sup>23</sup> mol<sup>-1</sup>

1 amu = 1.66 × 10<sup>-27</sup> kg = 931 MeV

1.

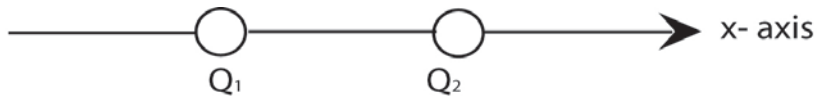


Figure 1

(a) Figure 1 shows two positively charged particles. The charges are  $Q_1 = 5.20 \times 10^{-19} \text{ C}$  and  $Q_2 = 3.00 \times 10^{-19} \text{ C}$  separated by a distance of 2.5 m.

(i) What is the magnitude and direction of the electrostatic force,  $F_{12}$  on particle 1 due to particle 2?

(30 marks)

(ii) Calculate the electric field at the centre of the two charged particles.

(30 marks)

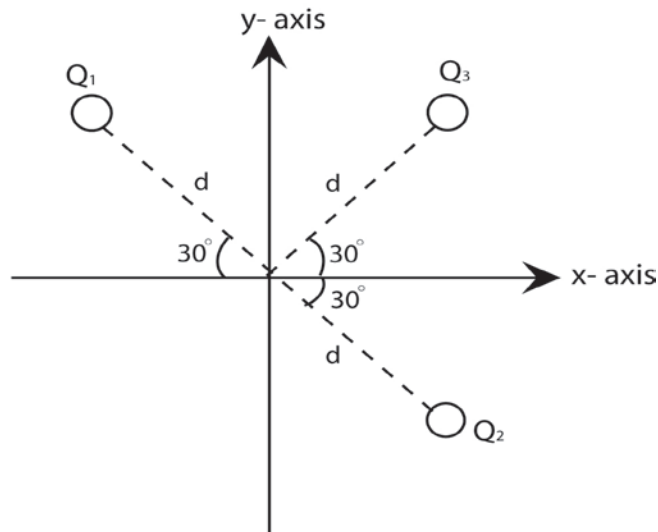


Figure 2

(b) Figure 2 shows three particles  $Q_1 = +2Q$ ,  $Q_2 = -2Q$  and  $Q_3 = -4Q$ , each a distance,  $d$  from the origin. What is the net electric field  $E$  at the origin in terms of  $d$ ?

(40 marks)

...4/-

2. (a) Define Gauss's law with the help of equations and suitable diagrams. (20 marks)

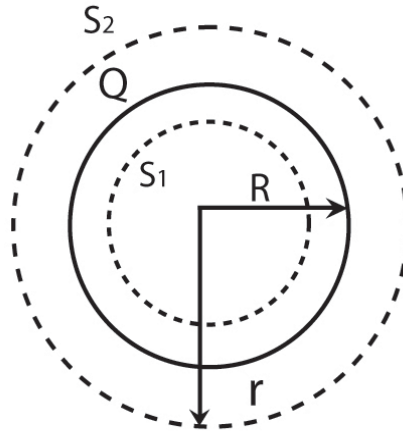


Figure 3

- (b) Figure 3 shows a charged spherical shell with charge  $Q = 5.0 \times 10^{-19} C$ , radius  $R = 4 \text{ cm}$  and two concentric spherical Gaussian surfaces,  $S_1$  and  $S_2$ . Find the electric field for
- (i)  $r \geq R$
  - (ii)  $r < R$
- (40 marks)

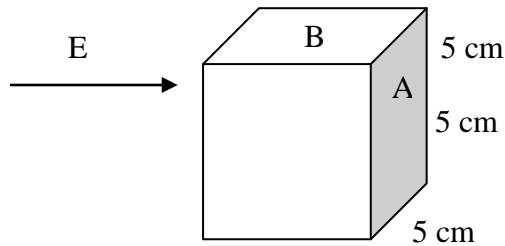


Figure 4

- (c) Consider a cube resting within a horizontal electric field of magnitude  $E = 8.0 \times 10^4 \text{ N/C}$  as shown in Figure 4. Calculate the
- (i) electric flux through the surface  $A$  and  $B$  of the cube with side  $5 \text{ cm}$ .

(ii) electric flux for the entire cube.

(40 marks)

3. (a) Three capacitors,  $C_1 = 10 \text{ F}$ ,  $C_2 = 15 \text{ F}$  and  $C_3 = 12 \text{ F}$  are connected in parallel. They are connected to a power supply of  $50 \text{ V}$ . Draw a circuit diagram and calculate the

(i) equivalent capacitance.

(ii) total charge for the circuit.

(iii) total energy stored in capacitor  $C_2$ .

(50 marks)

(b) If the three capacitors are connected in series. Calculate the

(i) equivalent capacitance.

(ii) total charge for the circuit.

(iii) total energy stored in capacitor  $C_2$ .

(50 marks)

4. (a) Define Kirchoff's Laws.

(20 marks)

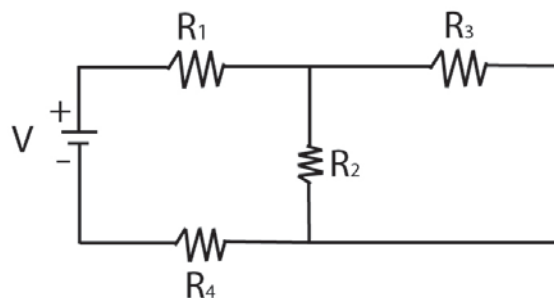


Figure 5

(b) Figure 5 shows a circuit containing a  $12 \text{ V}$  battery and four resistors:

[Given  $R_1 = 20 \Omega$ ,  $R_2 = 20 \Omega$ ,  $R_3 = 30 \Omega$ , and  $R_4 = 8 \Omega$ ]

...6/-

- (i) What is the equivalent resistance for the circuit?
- (ii) What is the current through the circuit?
- (iii) What is the current through  $R_2$ ?

(80 marks)

5.



Figure 6

- (a) Sketch magnetic field due to the current in the wires as shown in Figure 6.
- (b) Find the value of magnetic field produced by a long straight wire at a distance,  $R = 0.200\text{ m}$  where the current flow is  $I = 3.5\text{ mA}$ .

(30 marks)

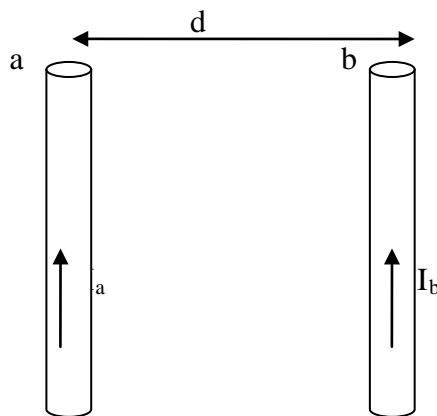
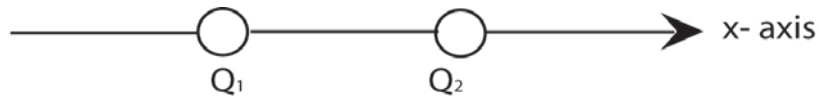


Figure 7

- (c) Figure 7 shows two parallel wires carrying currents in the same direction attract each other. Given the value for  $I_a = 2.5\text{ mA}$ ,  $I_b = 3.0\text{ mA}$ , wire length  $L = 1.5\text{ m}$  and  $d = 1.5\text{ cm}$ . Calculate the magnitude of  $F_{ba}$ .

(50 marks)

1.



Rajah 1

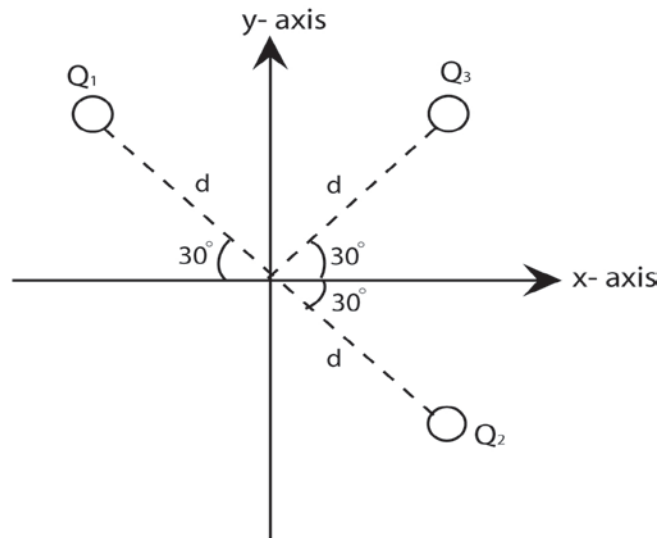
(a) *Rajah 1 menunjukkan dua zarah bercas positif  $Q_1 = 5.20 \times 10^{-19} \text{ C}$  dan  $Q_2 = 3.00 \times 10^{-19} \text{ C}$ , terpisah sejauh 2.5 m.*

(i) *Apakah magnitud dan arah daya elektrostatik  $F_{12}$  pada zarah 1 dari zarah 2?*

(30 markah)

(ii) *Hitung medan elektrik di tengah dua zarah tersebut.*

(30 markah)



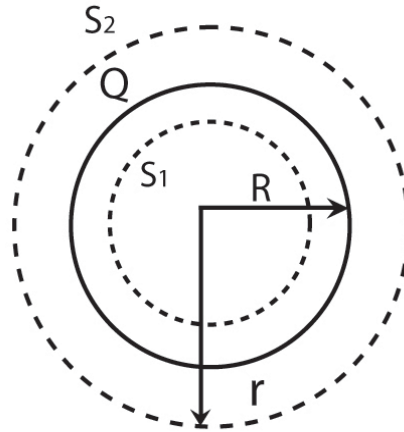
Rajah 2

(b) *Rajah 2, menunjukkan tiga zarah  $Q_1 = +2Q$ ,  $Q_2 = -2Q$  dan  $Q_3 = -4Q$  setiap satunya jarak  $d$  dari titik asalan. Apakah medan elektrik  $E$  di asalan?*

(40 markah)

2. (a) Nyatakan hukum Gauss menggunakan persamaan dan gambar rajah yang sesuai.

(20 markah)



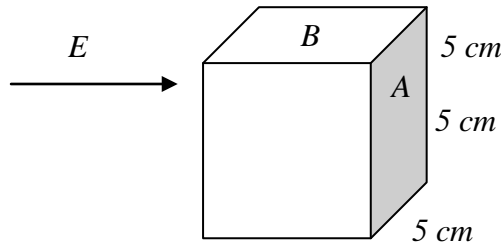
Rajah 3

- (b) Rajah 3 menunjukkan petala sfera dengan caj  $Q = 5.0 \times 10^{-19} \text{ C}$  berjejari  $R = 4 \text{ cm}$  dan dua permukaan Gaussian sfera,  $S_1$  dan  $S_2$ . Cari medan elektrik untuk

(i)  $r \geq R$

(ii)  $r < R$

(40 markah)



Rajah 4

- (c) Pertimbangkan satu kiub di dalam medan elektrik mendatar  $E = 8.0 \times 10^4 \text{ N/C}$  seperti pada Rajah 4.



- (i) Kirakan fluks elektrik melalui permukaan A dan B
- (ii) Kira fluks elektrik untuk seluruh kiub.

(40 markah)

3. (a) Tiga kapasitor,  $C_1 = 10 \text{ F}$ ,  $C_2 = 15 \text{ F}$  dan  $C_3 = 12 \text{ F}$  disambung secara selari. Kapasitor tersebut disambungkan kepada bekalan kuasa 50 V. Lakar litar dan hitung

- (i) kapasitans setara,
- (ii) jumlah caj dalam litar,
- (iii) jumlah tenaga tersimpan dalam kapasitor  $C_2$ .

(50 markah)

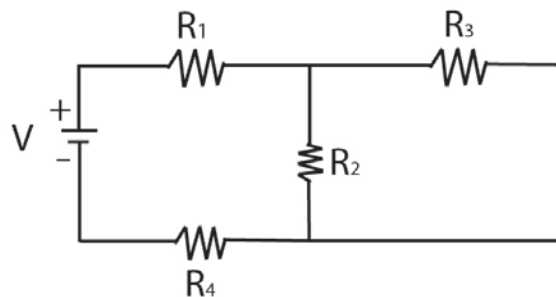
- (b) Jika ketiga-tiga kapasitor tersebut disambungkan secara sesiri. Hitung

- (i) kapasitans setara,
- (ii) jumlah caj dalam litar,
- (iii) jumlah tenaga tersimpan dalam kapasitor  $C_2$ .

(50 markah)

4. (a) Nyatakan hukum Kirchhoff.

(20 markah)



Rajah 5

- (b) *Rajah 5 menunjukkan satu litar mengandungi 12 V bateri dan empat perintang:*

*[Diberi  $R_1 = 20 \Omega$ ,  $R_2 = 20 \Omega$ ,  $R_3 = 30 \Omega$ , dan  $R_4 = 8 \Omega$ ]*

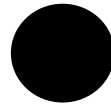
- (i) *Apakah rintangan setara untuk litar?*
- (ii) *Apakah nilai arus yang melalui litar?*
- (iii) *Apakah nilai arus yang melalui  $R_2$ ?*

*(80 markah)*

5.



A



B

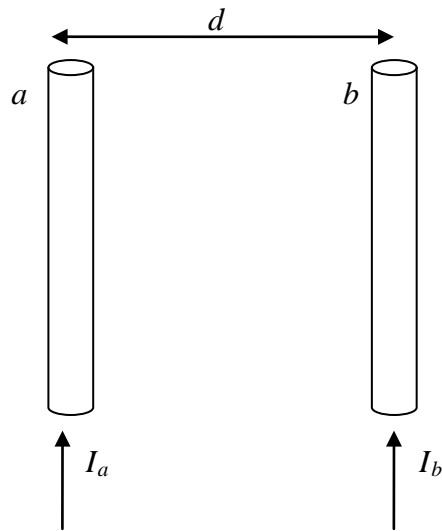
*Rajah 6*

- (a) *Lakar medan magnet yang disebabkan oleh arus dalam dawai seperti dalam Rajah 6.*

*(20 markah)*

- (b) *Cari nilai medan magnet yang dihasilkan oleh dawai lurus yang panjangnya pada jarak  $R = 0.200 \text{ m}$  dengan aliran arus  $I = 3.5 \text{ mA}$ .*

*(30 markah)*



Rajah 7

- (c) *Rajah 7 menunjukkan dua wayar selari membawa arus dalam arah yang sama menarik satu sama lain. Diberi nilai  $I_a = 2.5 \text{ mA}$ ,  $I_b = 3.0 \text{ mA}$ , panjang wayar  $L = 1.5 \text{ m}$  dan  $d = 1.5 \text{ cm}$ . Cari magnitud  $F_{ba}$ .*

(50 markah)