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UNIVERSITI SAINS MALAYSIA

Final Examination  
2015/2016 Academic Session

May/June 2016

**JIF 103 – Physics 1/ Practical 1a**  
*[Fizik 1/ Amali 1a]*

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

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Please ensure that this examination paper has **SEVEN** printed pages before you answer any questions.

Answer **FIVE** 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, the English version shall be used.

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

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

*Baca setiap arahan dengan teliti sebelum menjawab.*

*Setiap soalan bernilai 20 markah.*

*Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.*

Constants

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

Charge of electron,  $e = 1.6 \times 10^{-19} \text{ C}$

Mass of electron,  $m_e = 9.11 \times 10^{-31} \text{ kg}$

Mass of positron,  $m_e = 9.11 \times 10^{-31} \text{ kg}$

Mass of proton,  $m_p = 1.67 \times 10^{-27} \text{ kg}$

Planck constant,  $h = 6.63 \times 10^{-34} \text{ J s} = 4.14 \times 10^{-15} \text{ eV s}$

Permittivity of free space,  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^2$

Answer **ANY FIVE** questions.

1. With appropriate illustration/equation (if any), give your comments on the **truthfulness** of the following statements:

(a) A moving ruler is contracted according to an observer at rest. Something is wrong with the ruler.

(5 marks)

(b) An astronomer on earth sees a meteor hit the Moon at exactly the same time as he sees a solar flare erupt on the sun. The solar flare and the meteor impact are simultaneous events in the astronomer's reference frame.

(5 marks)

(c) A massless particle has zero momentum.

(5 marks)

(d) A photon is a particle.

(5 marks)

2. A drone passes by you.
- (a) If you measure its length to be 6 m long and speed  $0.5c$ , will you be able to park it in a 6.5 m hangar? Justify your answer.  
(10 marks)
- (b) Is it possible for 20 s to elapse on the drone's watch when 10 s have passed on yours? Justify your answer.  
(10 marks)
3. A gold cathode with work function 5.1 eV is illuminated with a 250 nm light. It is found that the photoelectron current is zero when the anode-cathode potential difference is zero. Would the photoelectron current change if the
- (a) light intensity is doubled? Explain your answer.  
(5 marks)
- (b) anode-cathode potential difference is increased to 5.5 V? Justify your answer.  
(10 marks)
- (c) cathode is changed to aluminum (work function = 4.3 eV)? Justify your answer.  
(5 marks)
4. An electron and a positron, each moving at  $0.2c$ , collide head-on and both vanish, with only electromagnetic radiation appearing after the collision.
- (a) Why is it possible for both particles to vanish?  
(5 marks)

- (b) What is the energy of the electromagnetic radiation?  
(10 marks)
- (c) What is the speed of the electromagnetic radiation?  
(5 marks)
5. (a) Do electrons behave like waves? Justify your answer with the aid of a diagram and equations (if any).  
(10 marks)
- (b) What is the momentum of an electron whose kinetic energy equals to its rest energy?  
(10 marks)
6. (a) Explain why the orbital radius of an electron in a hydrogen atom cannot be equal to 0.1 nm.  
(10 marks)
- (b) An electron is confined to a 0.21 nm region.
- (i) What is the range of speed of the electron?  
(5 marks)
- (ii) Explain why there should be a range of speed instead of a single specific speed.  
(5 marks)

Pemalar

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

Cas elektron,  $e = 1.6 \times 10^{-19} \text{ C}$

Jisim elektron,  $m_e = 9.11 \times 10^{-31} \text{ kg}$

Jisim positron,  $m_e = 9.11 \times 10^{-31} \text{ kg}$

Jisim proton,  $m_p = 1.67 \times 10^{-27} \text{ kg}$

Pemalar Planck,  $h = 6.63 \times 10^{-34} \text{ J s} = 4.14 \times 10^{-15} \text{ eV s}$

Ketelusan ruang bebas,  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^2$

Jawab **MANA-MANA LIMA** soalan.

1. Dengan menggunakan ilustrasi/rumus yang bersesuaian (jika ada), berikan komen anda terhadap **kebenaran** pernyataan berikut:
  - (a) Suatu pembaris yang bergerak mengecut pada pandangan seorang pemerhati pegun. Sesuatu tidak kena pada pembaris tersebut.
 

(5 markah)
  - (b) Seorang ahli astronomer di bumi melihat meteor menghentam bulan pada ketika yang sama dengan dia melihat nyalaan suria meletup di matahari. Nyalaan suria dan hentaman meteor adalah peristiwa serentak dalam rangka rujukan ahli astronomer.
 

(5 markah)
  - (c) Zarah tanpa jisim mempunyai momentum sifar.
 

(5 markah)
  - (d) Foton adalah satu zarah.
 

(5 markah)

2. Satu dron melintasi anda.
- (a) Jika anda mengukur panjangnya 6 m dan lajunya  $0.5c$ , adakah anda boleh menyimpannya di dalam hangar 6.5 m? Justifikasikan jawapan anda.  
(10 markah)
- (b) Adakah mungkin 20 s berlalu pada jam dron dengan 10 s berlalu pada jam anda? Justifikasikan jawapan anda.  
(10 markah)
3. Suatu katod emas dengan fungsi kerja 5.1 eV disinari dengan suatu cahaya 250 nm. Didapati arus fotoelektron adalah sifar apabila perbezaan keupayaan anod-katod bersamaan sifar. Adakah arus fotoelektron akan berubah jika
- (a) keamatan cahaya digandakan dua kali? Jelaskan jawapan anda.  
(5 markah)
- (b) perbezaan keupayaan anod-katod ditingkatkan ke 5.5 V? Justifikasikan jawapan anda.  
(10 markah)
- (c) katod digantikan dengan aluminum (fungsi kerja = 4.3 eV)? Justifikasikan jawapan anda.  
(5 markah)
4. Satu elektron dan satu positron, setiap satunya bergerak  $0.2c$ , langgar berdepan dan kedua-duanya lenyap, dengan hanya radiasi elektromagnetik terpancar selepas perlanggaran.
- (a) Mengapakah kedua-dua zarah tersebut boleh lenyap?  
(5 markah)

- (b) Berapakah tenaga radiasi elektromagnetik tersebut?  
(10 markah)
- (c) Berapakah laju radiasi elektromagnetik tersebut?  
(5 markah)
5. (a) Adakah elektron berkelakuan seperti gelombang? Justifikasikan jawapan anda dengan bantuan gambar rajah dan rumus (jika ada).  
(10 markah)
- (b) Berapakah momentum elektron yang tenaga kinetiknya bersamaan dengan tenaga rehatnya?  
(10 markah)
6. (a) Jelaskan mengapa jejari orbit elektron dalam atom hidrogen tidak boleh bersamaan dengan 0.1 nm.  
(10 markah)
- (b) Satu elektron dihadkan pada satu kawasan 0.21 nm.
- (i) Berapakah julat laju bagi elektron tersebut?  
(5 markah)
- (ii) Jelaskan mengapa perlu ada julat laju dan bukannya satu laju spesifik.  
(5 markah)