UNIVERSITI SAINS MALAYSIA

Final Examination
Academic Session 2007/2008

April 2008

JIF 104 – Physics II/ Practical Ib
[JIF 104 – Fizik II/Amali Ib]

Time : 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.

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

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

Baca arahan dengan teliti sebelum anda menjawab soalan.

Setiap soalan diperuntukkan 20 markah.

Constants:

Density of water = 1000 kg m^{-3}

Gravitational acceleration = 9.8 m s^{-2}

Gas constant R = 8.31 J mol^{-1} K^{-1}

1 atm = 1.013×10^5 N m^{-2}

1 Pa = 1 N m^{-2}

1 poise = 10^{-1} N s m^{-2}

Density of mercury = 13.6 g cm^{-3}

Avogadro's number N_A = 6.02×10^{23} mol^{-1}

Boltzmann's constant k = 1.38×10^{-23} J K^{-1}

Mass of hydrogen atom = 1.67×10^{-27} kg

1. (a) The potential energy U between two particles is typically given by

$$U = -\frac{4}{r} + \frac{5}{r^2}$$

where r is the inter-particle separation.

(i) Determine the value of r when U is a minimum.

(ii) Plot U as a function of r.

(iii) Plot $\frac{dU}{dr}$ as a function of r. What can you say about the curve of $\frac{dU}{dr}$?

(10 marks)

(b) Sketch a labelled typical phase diagram of a material.

(i) Define the critical point T_c of the material.

(ii) Define the triple point of the material.

(iii) What is the state of the material at temperatures above the critical temperature T_c?

(10 marks)

2. (a) If 10% of a block containing a material A is of Frenkel's defects, how would the density of this block compare with another block of the same material but free from these defects? Why?

(4 marks)

(b) The spacing between the principal planes in a crystal of NaCl is 2.82 Å. It is found that the first order Bragg reflection of a monochromatic beam of x-rays occurs at 10°.

(i) What is the wavelength of the x-rays?

(ii) At what angle would a second order reflection occur?

(8 marks)

(c) Describe how Ge or Si can be made into a p-type semiconductor. Discuss how it conducts electricity.

(8 marks)

3. (a) Sketch a typical stress-strain curve of a solid material. On the sketch, label

(i) the proportional limit

(ii) the elastic limit

(iii) the fracture point

(iv) the plastic region

(6 marks)

(b) Sketch a typical stress-strain curve of a rubberised material. Based on the structure of molecules in a rubberised material, discuss how the shape of the curve differs from that of a solid material in (a).

(4 marks)

(c) State the three types of fracture. Discuss how they are formed.

(10 marks)

4. (a) A dolphin of length 191 cm is found to be able to swim at 830 cm s^{-1} at its maximum speed. What is the Reynold's number at this speed?

(4 marks)

(b) A loop of fine thread is placed upon a plane soap film and the film inside the loop is then punctured.

(i) Show that the loop will form into a circle.

(ii) Derive an expression for the tension in the thread in terms of the free surface energy γ of the soap film and the radius r of the loop.

(10 marks)

(c) In a normal adult, the average speed of the blood through the aorta (which has a radius of 0.9 cm) is 0.33 m s^{-1}. From the aorta the blood goes into 30 major arteries, each with a radius of 0.5 cm. Calculate the speed of the blood through the arteries.

(6 marks)

5. (a) Discuss

(i) the ideal gas law,

(ii) the Dalton's law.

(6 marks)

(b) State <u>five</u> assumptions in the kinetic theory of gas.

(5 marks)

(c) Sketch the Maxwell's distribution of molecular speeds curve showing the maximum speed v_m, the root-mean-square speed v_{rms}, and the average speed $\bar{v}$. Describe the meaning of the speeds and the relationship between them.

(9 marks)

Pemalar-pemalar:

Ketumpatan air $= 1000\ kg\ m^{-3}$

Pecutan kegravitian $= 9.8\ m\ s^{-2}$

Pemalar gas $R = 8.31\ J\ mol^{-1}\ K^{-1}$

$1\ atm = 1.013 \times 10^{5}\ N\ m^{-2}$

$1\ Pa = 1\ N\ m^{-2}$

$1\ poise = 10^{-1}\ N\ s\ m^{-2}$

Ketumpatan raksa $= 13.6\ g\ cm^{-3}$

Nombor Avogadro $N_A = 6.02 \times 10^{23}\ mol^{-1}$

Pemalar Boltzmann $k = 1.38 \times 10^{-23}\ J\ K^{-1}$

Jisim atom hidrogen $= 1.67 \times 10^{-27}\ kg$

1. (a) *Tenaga keupayaan U antara dua zarah lazimnya diberikan oleh*

$$U = -\frac{4}{r} + \frac{5}{r^2}$$

di mana r adalah pemisahan antara zarah.

(i) *Tentukan nilai r di mana U adalah suatu minimum.*

(ii) *Plot U sebagai fungsi r.*

(iii) *Plot* $\frac{dU}{dr}$ *sebagai fungsi r. Apakah yang anda boleh katakan tentang lengkungan* $\frac{dU}{dr}$ *ini?*

(10 markah)

(b) *Lakarkan suatu gambarajah fasa tipikal berlabel bagi suatu bahan.*

(i) *Takrifkan titik genting* T_c *bahan itu.*

(ii) *Takrifkan titik tigaan bahan itu.*

(iii) *Apakah keadaan bahan tersebut pada suhu-suhu di atas suhu genting* T_c*?*

(10 markah)

2. (a) *Jika 10% suatu bongkah yang mengandungi bahan A adalah kecacatan Frenkel, bagaimanakah ketumpatan bongkah ini berbanding satu bongkah lain daripada bahan yang sama tetapi bebas daripada kecacatan ini? Mengapa?*

(4 markah)

(b) *Ruang di antara satah-satah utama suatu hablur NaCl ialah 2.82 Å. Didapati pantulan Bragg tertib pertama suatu alur sinar-x monokromatik berlaku pada 10°.*

(i) *Berapakah panjang gelombang sinar-x itu?*

(ii) *Pada sudut berapakah pantulan tertib kedua akan berlaku?*

(8 markah)

(c) *Perihalkan bagaimana Ge atau Si boleh dijadikan kepada suatu semikonduktor jenis-p. Bincangkan bagaimana ia mengalirkan elektrik.*

(8 markah)

3. (a) *Lakarkan suatu lengkungan ketegasan-keterikan tipikal bagi suatu bahan pejal. Pada lakaran itu, labelkan*

(i) *had kekadaran*

(ii) *had kekenyalan*

(iii) *titik rekah*

(iv) *rantau plastik*

(6 markah)

(b) *Lakarkan suatu lengkungan ketegasan-keterikan tipikal bagi suatu bahan bergetah. Berdasarkan struktur molekul yang terdapat dalam bahan bergetah, bincangkan bagaimana bentuk lengkungan ini berbeza daripada bentuk lengkungan bahan pejal dalam (a).*

(4 markah)

(c) *Nyatakan tiga jenis rekahan. Bincangkan bagaimana rekahan-rekahan ini terjadi.*

(10 markah)

4. (a) *Seekor ikan dolfin panjang 191 cm didapati mampu berenang pada kelajuan maksimum 830 cm* s^{-1}. *Berapakah nombor Reynold pada kelajuan ini?*

(4 markah)

(b) *Suatu gegelung benang halus diletakkan ke atas suatu satah filem sabun dan kemudian filem di dalam gegelung itu dipecahkan.*

(i) *Tunjukkan bahawa gegelung itu akan membentuk suatu bulatan.*

(ii) *Terbitkan suatu ungkapan bagi tegangan benang dalam sebutan tenaga permukaan bebas γ filem sabun dan jejari r gegelung.*

(10 markah)

(c) *Bagi seorang dewasa sihat, laju purata darah dalam aorta (dengan jejari 0.9 cm) ialah 0.33 m s^{-1}. Dari aorta darah tersebut masuk ke dalam 30 arteri utama, setiapnya mempunyai jejari 0.5 cm. Hitung kelajuan dalam arteri-arteri itu.*

(6 markah)

5. (a) *Bincangkan*

(i) *hukum gas unggul,*

(ii) *hukum Dalton.*

(6 markah)

(b) *Nyatakan lima anggapan yang dibuat dalam teori kinetik gas.*

[5 markah]

(c) *Lakarkan lengkungan taburan kelajuan molekul Maxwell dengan menunjukkan kelajuan maksimum v_m, kelajuan punca-min-kuasa-dua v_{rms}, dan kelajuan purata $\bar{v}$. Perihalkan maksud kelajuan-kelajuan tersebut dan perhubungan antara mereka.*

(9 markah)

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