
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009
*Peperiksaan Semester Pertama
Sidang Akademik 2008/2009*

November 2008
November 2008

EMM 101/3 – Engineering Mechanics
Mekanik Kejuruteraan

Duration : 3 hours
Masa : 3 jam

INSTRUCTIONS TO CANDIDATE:
ARAHAN KEPADA CALON :

Please check that this paper contains **FOURTEEN (14)** printed pages and **EIGHT (8)** questions before you begin the examination.

*Sila pastikan bahawa kertas soalan ini mengandungi **EMPAT BELAS (14)** mukasurat dan **LAPAN (8)** soalan yang bercetak sebelum anda memulakan peperiksaan.*

Answer **FIVE (5)** questions.
*Jawab **LIMA (5)** soalan.*

Answer **TWO (2)** questions from each **SECTION A** and **SECTION B**, and choose **ONE (1)** question from either **SECTION A** or **SECTION B**.

*Sila jawab **DUA (2)** soalan dari setiap **BAHAGIAN A** dan **BAHAGIAN B**, dan pilih **SATU (1)** soalan dari mana-mana **BAHAGIAN A** atau **BAHAGIAN B**.*

Answer all questions in **English** or **Bahasa Malaysia** or a combination of both.

*Calon boleh menjawab semua soalan dalam **Bahasa Malaysia** atau **Bahasa Inggeris** atau kombinasi kedua-duanya.*

Start answering each question in a new page.

Setiap soalan mestilah dimulakan pada mukasurat yang baru.

BAHAGIAN A

- Q1. [a]** A wall hook shown in Figure Q1[a] is subjected to three force components F_1 , F_2 and F_3 acting along the cables. If the resultant of the three forces acts along the positive y axis with a magnitude of 600 N, determine:

Satu penyangkut dinding seperti yang ditunjukkan dalam Rajah S1[a] dikenakan tiga komponen daya F_1 , F_2 dan F_3 bertindak sepanjang kabel. Jika panduan ketiga-tiga daya tersebut bertindak sepanjang paksi y positif dengan magnitud 600 N, tentukan:

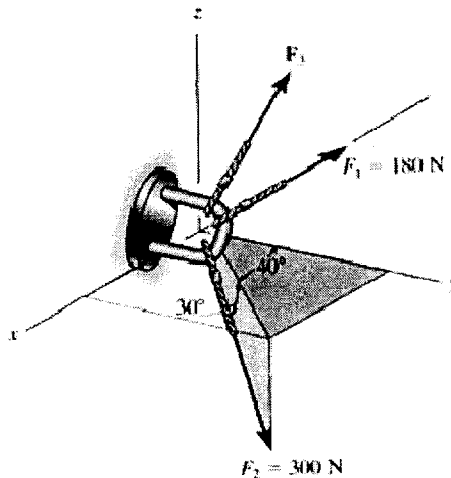


Figure Q1[a]
Rajah S1[a]

- (i) The magnitude of force F_3

Magnitud daya F_3

(25 marks/markah)

- (ii) The coordinate direction angles of force F_3

Arah sudut koordinat bagi daya F_3

(15 marks/markah)

- [b]** The chandelier as shown in Figure Q1[b] is supported by three chains which are concurrent at point O . If the force in each chain has a magnitude of 300 N:

Sebuah lampu candelier seperti yang dalam Rajah S1[b] disokong dengan tiga rantai setemu pada titik O . Jika daya pada setiap rantai mempunyai magnitud 300 N:

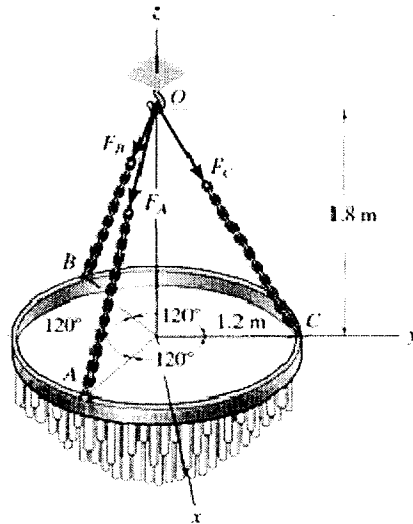


Figure Q1[b]
Rajah S1[b]

- (i) Express each force as a Cartesian vector

Nyatakan setiap force dalam vector Kartesian

(45 marks/markah)

- (ii) Determine the magnitude and coordinate direction angles of the resultant force.

Tentukan magnitud dan arah sudut koordinat bagi daya paduan.

(15 marks/markah)

- Q2. [a] Figure Q2[a] shows a curved rod lies in the x - y plane and has a radius of 3 m. If a force of $F = 80$ N acts at its end (point A) as shown, determine the moment of this force about point O .

Rajah Q2[a] menunjukkan satu rod lengkung berada pada satah x - y dan mempunyai jejari 3 m. Jika satu daya $F = 80$ N bertindak pada hujungnya (titik A) seperti yang ditunjukkan, tentukan gandingan bagi daya ini pada titik O .

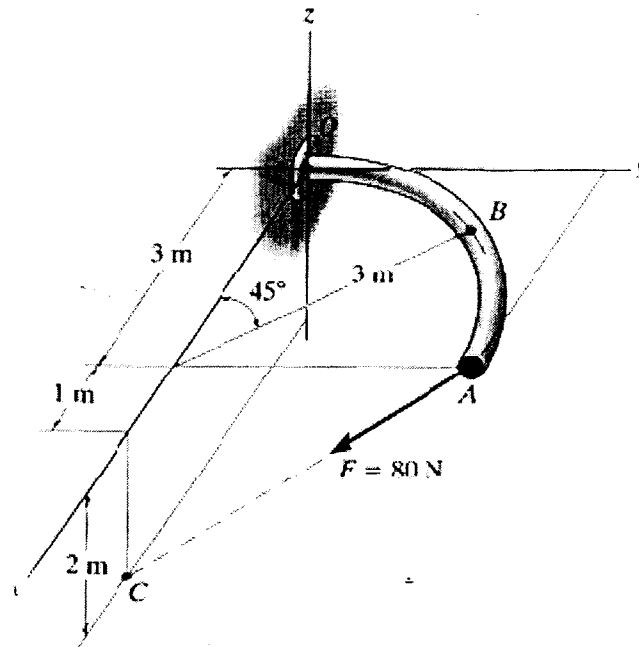


Figure Q2[a]
Rajah S2[a]

(40 marks/markah)

- [b] The building slab as shown in Figure Q2[b] is subjected to four parallel column loadings. Determine the equivalent resultant force and specify its location (x, y) on the slab. Given $F_1 = 30 \text{ kN}$ and $F_2 = 40 \text{ kN}$.

Sebuah papan batu bangunan seperti dalam Rajah S2[b] dikenakan empat daya selari. Tentukan daya paduan sama dan tentukan lokasinya (x, y) pada papan batu tersebut. Diberi $F_1 = 30 \text{ kN}$ dan $F_2 = 40 \text{ kN}$.

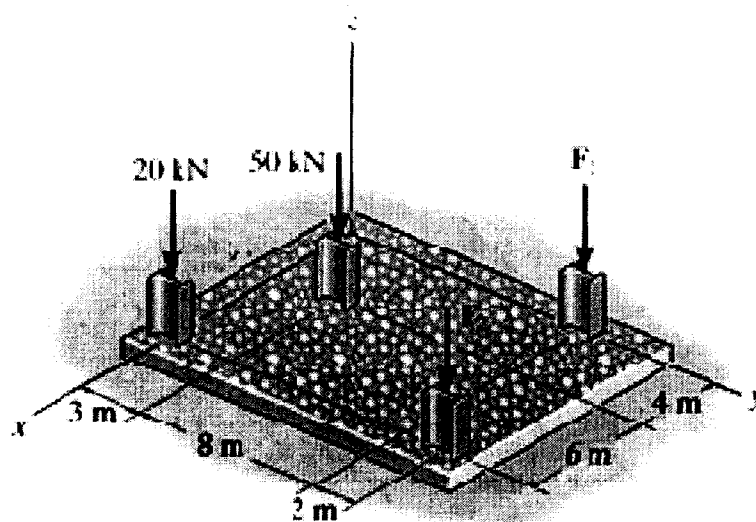


Figure Q2[b]
Rajah S2[b]

(60 marks/markah)

Q3. [a] Explain the procedure for drawing a free body diagram.

Terangkan prosedur untuk melukis rajah jasad bebas.

(10 marks/markah)

[b] Draw a free body diagram and describe the loads involved for each system in Figures Q3[b](i), (ii) and (iii).

Lukis rajah jasad bebas dan jelaskan beban-beban yang terlibat untuk sistem dalam Rajah S3[b](i), (ii) dan (iii).

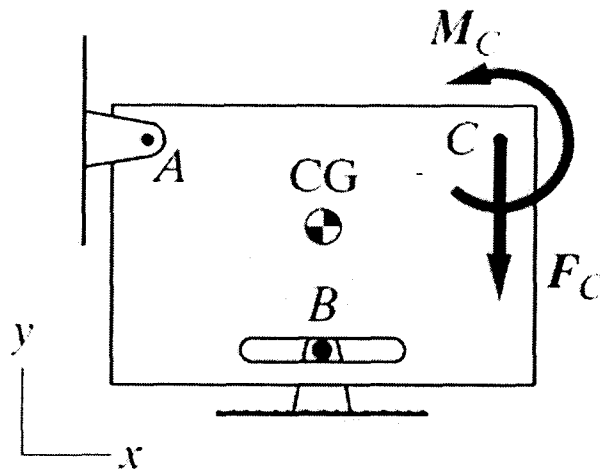


Figure Q3[b](i)
Rajah S3[b](i)

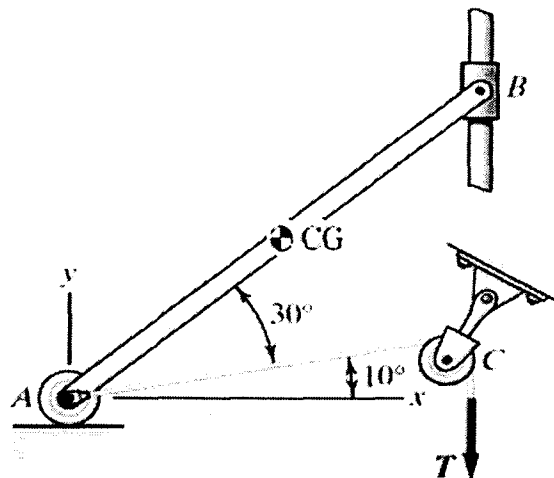


Figure Q3[b](ii)
Rajah S3[b](ii)

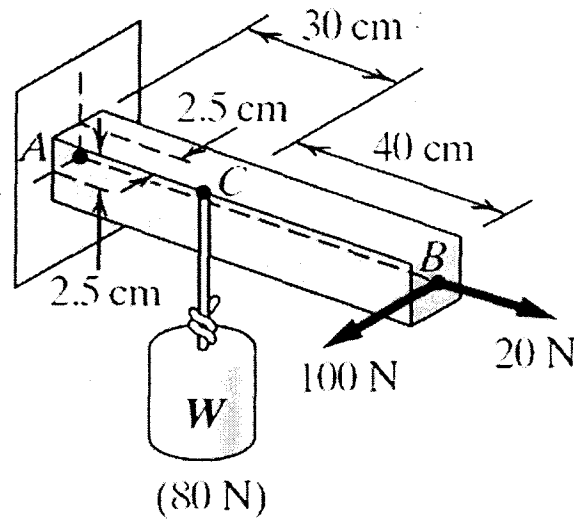


Figure Q3[b](iii)
Rajah S3[b](iii)

(30 marks/markah)

[c] State the condition for a system of forces to be in equilibrium.

Nyatakan syarat untuk sistem daya berada dalam keseimbangan.

(10 marks/markah)

[d] A 350 N force acts on a brake pedal as shown in Figure Q3[d].

- Daya 350 N bertindak pada injak brek seperti dalam Rajah S3[d].

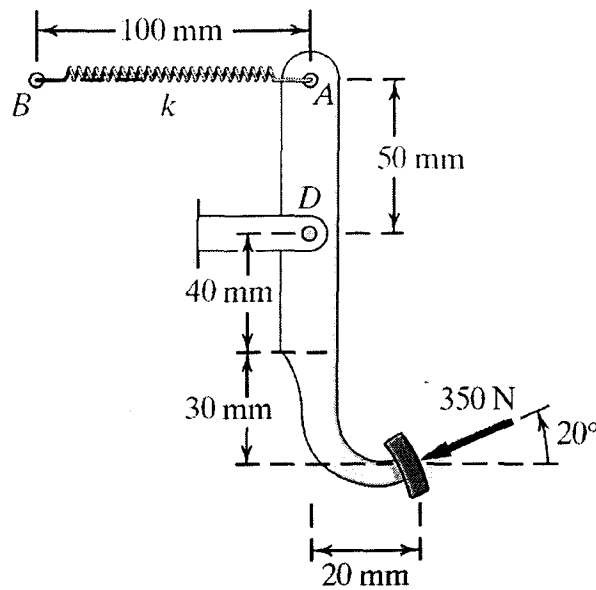


Figure Q3[d]
Rajah S3[d]

- (i) **Draw a free body diagram of the brake system.**

Lukis rajah jasad bebas sistem brek

- (ii) **If the pedal is in equilibrium in the position as Figure Q3[d], what is the tension in the spring?**

Jika injak berada dalam keseimbangan seperti kedudukan dalam Rajah S3[d], berapakah ketegangan pegas?

- (iii) **What is the magnitude of the force acting at the pin connection at D?**

Berapakah magnitud daya yang bertindak pada sambungan pin di D?

- (iv) **If the total deflection at A is to be limited to 5 mm when the 350 N pedal force is applied, what is the minimum required spring stiffness k ?**

Jika jumlah anjakan di A dihadkan sebanyak 5 mm apabila daya 350 N dikenakan pada injak, berapakah nilai kekakuan pegas minimum yang diperlukan?

(50 marks/markah)

- Q4. [a] State a general rule for reactions that occur at supports and point of support between bodies subjected to a force system.**

Nyatakan peraturan umum untuk tindakbalas yang terjana pada penyokong dan pada titik penyokong antara jasad yang ditindaki sistem daya.

(10 marks/markah)

- [b] A bent bar is welded to the wall at end A and carries the loads shown in Figure Q4[b]. Determine the loads acting on the bar at end A, when it is in equilibrium.**

Bar bengkok di kimpal pada dinding di hujung A dan dikenakan beban seperti dalam Rajah S4[b]. Tentukan beban yang bertindak ke atas bar di hujung A apabila ianya dalam keseimbangan.

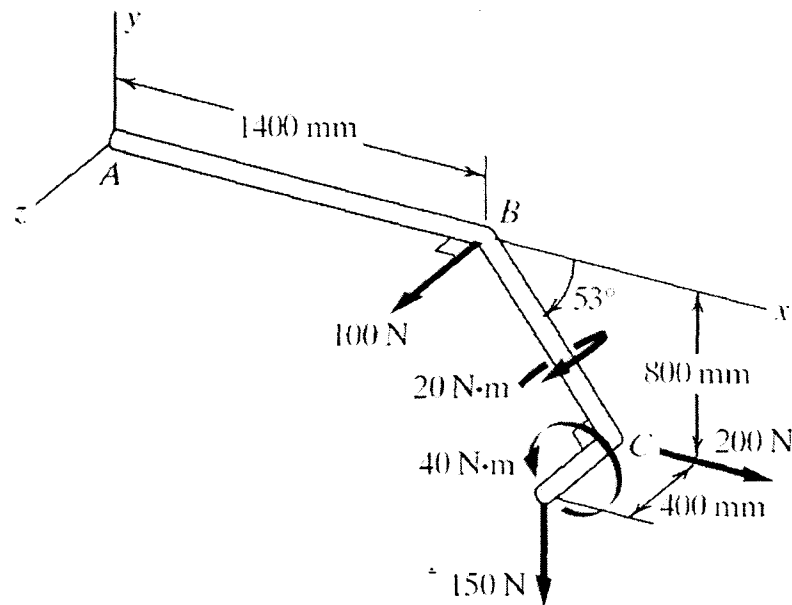


Figure Q4[b]
Rajah S4[b]

(50 marks/markah)

- [c] (i) Calculate the area of the shaded region in Figure Q4[c] and locate the centroid of the shaded region.

Kira luas bahagian berlorek dalam Rajah S4[c] dan lokasi sentroid bahagian berlorek.

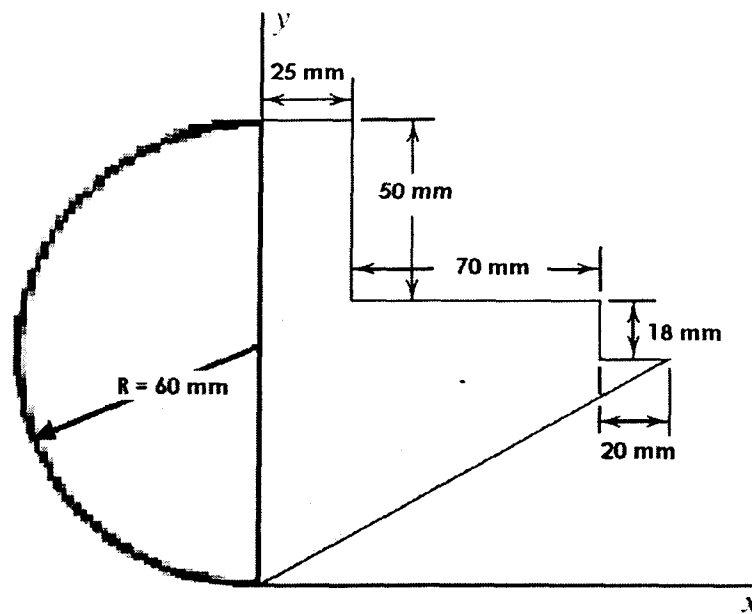


Figure Q4[c]
Rajah S4[c]

- (ii) Determine the second moment of area of the shaded region about the x - axis.

Tentukan luas momen kedua bahagian berlorek di sekitar paksi x

(40 marks/markah)

BAHAGIAN B

- Q5. [a] If $s_x = t(5t^2 + 2)$ m and $s_y = 4t^2$ m at time t . Find the magnitude and direction of the velocity and acceleration when $t = 10$ s.

Sekiranya $s_x = t(5t^2 + 2)$ m dan $s_y = 4t^2$ m pada masa t . Cari nilai dan arah bagi halaju dan pecutan pada masa $t = 10$ s.

(40 markah/markah)

- [b] A fireman wishes to project water from the hose at the maximum height on the wall as shown in Figure Q5[b]. At that instant, find the maximum height, h and the angle, θ should he hold the hose?

Seorang ahli bomba ingin memacutkan air daripada hos ke ketinggian maksimum pada dinding seperti yang ditunjukkan dalam Rajah S5[b]. Pada ketika itu, carikan ketinggian maksimum, h dan sudut pancutan hos, θ yang sepatutnya beliau halakan?

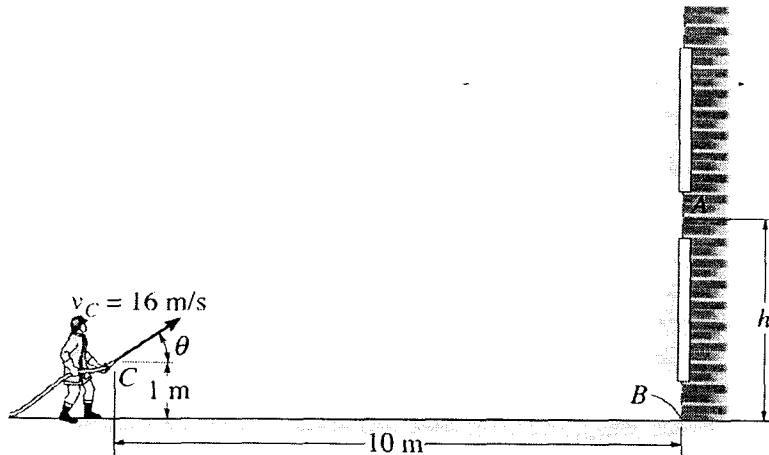


Figure Q5[b]
Rajah S5[b]

(60 markah/markah)

- Q6. [a] The train engine at A has a speed of 15 m/s and acceleration of 10 m/s^2 acting in the direction shown in Figure Q6[a]. Determine

Enjin keretapi pada A mempunyai laju 15 m/s dan pecutan 10 m/s^2 seperti yang ditunjukkan dalam Rajah Q6[a]. Tentukan

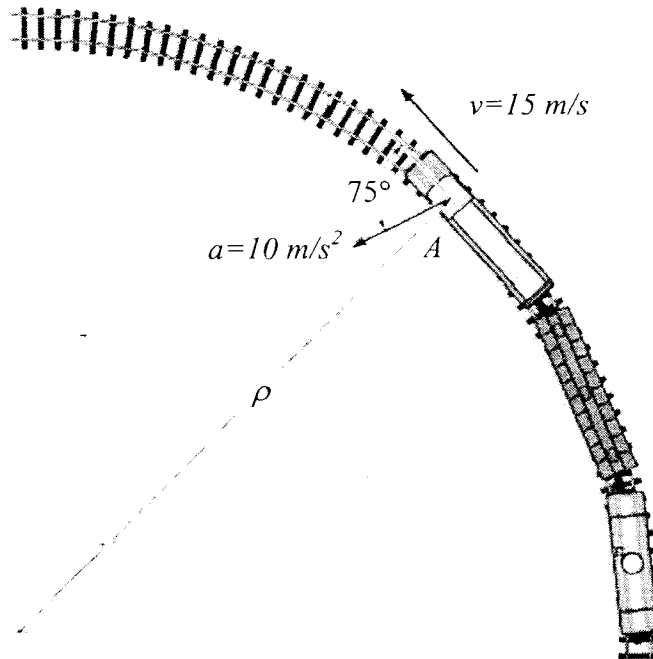


Figure Q6[a]
Rajah S6[a]

- (i) the rate of increase in the train's speed, and

kadar pertambahan laju keretapi, dan

(10 marks/markah)

- (ii) the radius of curvature, ρ of the path.

jejari kelengkungan, ρ laluan.

(15 marks/markah)

- [b] The jet plane is travelling at a constant speed of 250 m/s along the curve $y = 50(10^{-5})x^2 + 1450$ as shown in Figure Q6[b], where x and y are in meters. If the pilot has a weight of 700 N, determine the normal and tangential components of the force the seat exerts on the pilot when $y = 4000$ m.

Sebuah jet bergerak dengan laju malar iaitu 250 m/s sepanjang garis lengkung $y = 50(10^{-5})x^2 + 1450$ seperti ditunjukkan dalam Rajah Q6[b], di mana x dan y adalah dalam meter. Sekiranya juruterbang mempunyai berat 700 N, tentukan komponen-komponen normal dan tanjen daya pada kerusi yang bertindak ke atas juruterbang apabila $y = 4000$ m.

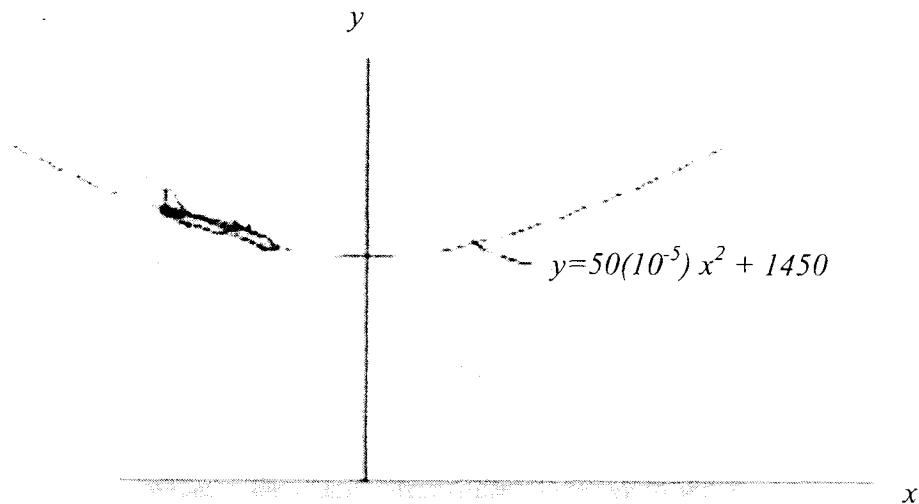


Figure Q6[b]
Rajah S6[b]

$$\text{Given } \rho = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}$$

$$\text{Diberi } \rho = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}$$

(75 marks/markah)

- Q7. [a] The spring has a stiffness $k = 800 \text{ N/m}$ and has original length of 0.66 m . As shown in Figure Q7[a], it is confined by the plate and wall using cables so that its length is 0.5 m . A 10 N block is given a speed v_A when it is at A, and it slides down the incline having a coefficient of kinetic friction, $\mu_k = 0.2$. If it strikes the plate and pushes it further 0.05 m before stopping, determine its speed at A. Neglect the mass of the plate and spring.

Sebuah pegas mempunyai kekakuan $k = 800 \text{ N/m}$ dan panjang asal 0.66 m . Seperti ditunjukkan dalam Rajah S7[a], pegas tersebut ditutup dengan plat dan dinding supaya panjangnya adalah 0.5 m . Sebuah blok 10 N diberikan laju v_A ketika di A dan menuruni cerun yang mempunyai pemalar geseran kinetik $\mu_k = 0.2$. Jika blok berkenaan menghentam plat dan menolaknya lagi sejauh 0.05 m ke hadapan sebelum berhenti, tentukan lajunya di A. Abaikan jisim plat dan pegas.

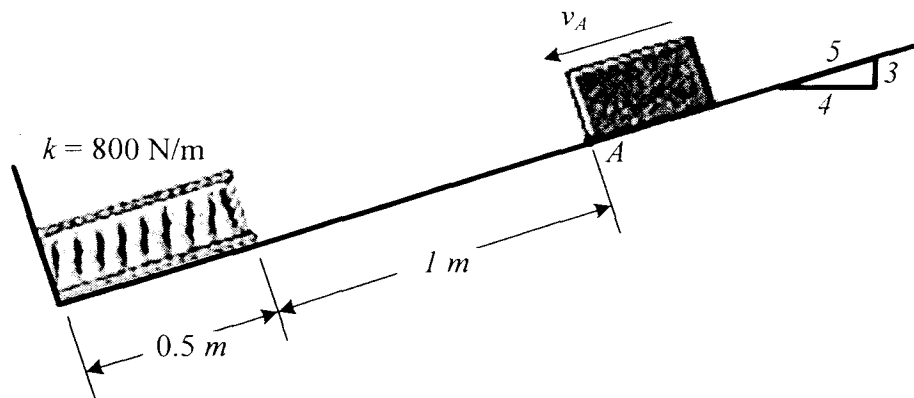


Figure Q7[a]
Rajah S7[a]

(40 marks/markah)

- [b] The bob of the pendulum has a mass of 0.3 kg and is released from rest when it is in the horizontal position shown in Figure Q7[b].

Sebuah bandul mempunyai jisim 0.3 kg dan dilepaskan ketika dalam keadaan mendatar seperti ditunjukkan pada Rajah S7[b].

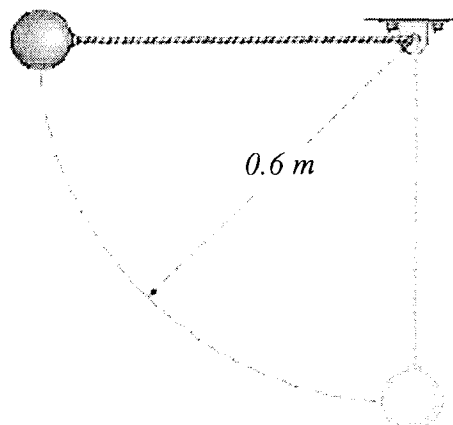


Figure Q7[b]
Rajah S7[b]

- (i) Determine its speed and the tension in the cord at the instant the bob passes through its lowest position.

Tentukan laju dan tegangan tali ketika bandul tersebut melepasi kedudukan paling rendah.

(20 marks/markah)

- (ii) If the tension in the cord is 2.5 times the weight of the bob during 30° from the vertical axis, find the velocity and the acceleration of the bob in that position.

Jika tegangan tali adalah 2.5 kali berat bandul semasa berada pada kedudukan 30° daripada paksi menegak, cari halaju dan pecutan bandul ketika bandul berada pada kedudukan tersebut.

(40 marks/markah)

- Q8. [a] The particle, P is acted upon by its weight of 50 N and forces F_1 and F_2 as shown in Figure Q8[a], where t is in seconds. If the particle originally has a velocity of $v = \{4i + 3j - k\}$ m/s, determine its speed after 5 s.

Suatu zarah, P dengan berat 50 N dikenakan daya-daya F_1 dan F_2 seperti ditunjukkan dalam Rajah S8[a], di mana t adalah dalam saat. Jika zarah tersebut mempunyai halaju $v = \{4i + 3j - k\}$ m/s, tentukan lajunya selepas 5 saat.

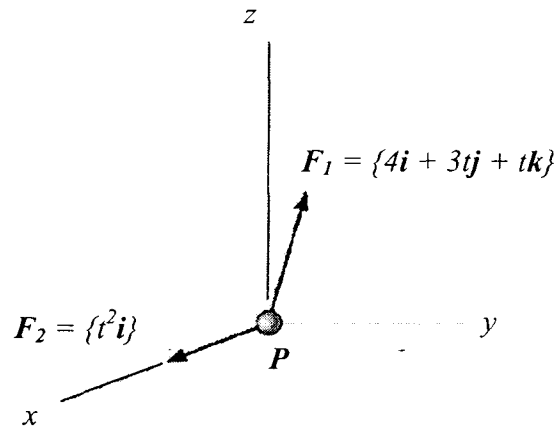


Figure Q8[a]
Rajah S8[a]

(60 marks/markah)

- [b] The 200 g billiard ball is moving with a speed of 3 m/s when it strikes the side of the pool table at A. If the coefficient of restitution between the ball and the side of table is $e = 0.60$, determine the speed of the ball just after striking the table twice, i.e., at A then at B. Neglect the size of the ball.

Bola billiard berjisim 200 g bergerak dengan kelajuan 3 m/s semasa berlanggar dengan tepi meja di A. Jika pemalar restituti di antara bola dan tepi meja adalah $e = 0.60$, tentukan kelajuan bola berkenaan selepas berlanggar dengan meja sebanyak dua kali iaitu di A dan B. Abaikan saiz bola tersebut.

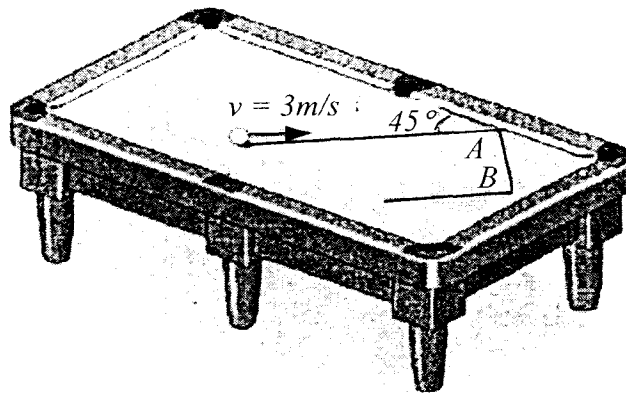


Figure Q8[b]
Rajah S8[b]

(40 marks/markah)