UNIVERSITI SAINS MALAYSIA

Course Examination During Long Vacation
Academic Session 2008/2009
Peperiksaan Kursus Semasa Cuti Panjang
Sidang Akademik 2008/2009

June 2009
Jun 2009

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 **FIFTEEN (15)** printed pages, and **EIGHT (8)** questions before you begin the examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **LIMA BELAS (15)** mukasurat bercetak dan **LAPAN (8)** soalan sebelum anda memulakan peperiksaan.*

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

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.*

Each question must begin from a new page.
Setiap soalan mestilah dimulakan pada mukasurat yang baru.

Q1. [a] **Determine the magnitude of the resultant force $F_R = F_1 + F_2$ and its direction, measured counterclockwise from the positive x axis by summing the rectangular or x, y components of the forces to obtain the resultant force.** ***(Given: F_1 = 600 N, F_2 = 800 N, F_3 = 450 N, θ_1 = 60 deg, θ_2 = 45 deg and θ_3 = 75 deg).***

Tentukan magnitud daya paduan $F_R = F_1 + F_2$ beserta dengan arahnya, diukur lawan arah jam daripada paksi x positif dengan menjumlahkan komponen-komponen daya x dan y untuk mendapatkan daya paduan. (Diberi: F_1 = 600 N, F_2 = 800 N, F_3 = 450 N, θ_1 = 60 deg, θ_2 = 45 deg and θ_3 = 75 deg).

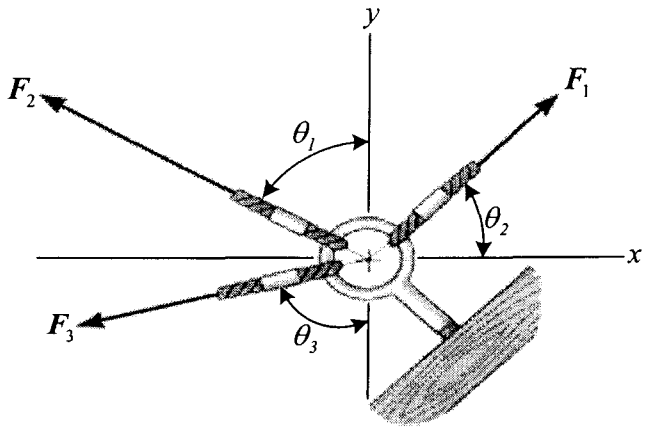

Figure Q1[a]
Rajah S1[a]

(50 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:**

(i) **Express each force as a Cartesian vector**

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

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

(i) Nyatakan setiap force dalam vektor Kartesian

(ii) Tentukan magnitud dan arah sudut koordinat bagi daya paduan.

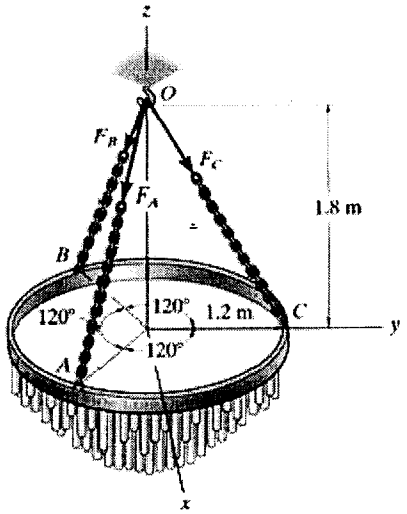

Figure Q1[b]
Rajah S1[b]

(50 marks/*markah*)

Q2. [a] A post in Figure Q2[a] is subjected to three forces F_1, F_2 and F_3. Using Cartesian vector analysis, determine the resultant moment of the tree forces about the base of the post at A. Take $F_1 = \{ 400\,i + 300\,j + 120\,k \}N$.

Satu tiang dalam Rajah S2[a]dikenakan tiga daya F_1, F_2 and F_3. Dengan menggunakan analisis vektor Kartesian, tentukan momen paduan ketiga-tiga daya di sekitar dasar tiang di A. Ambil $F_1 = \{ 400\,i + 300\,j + 120\,k \}N$.

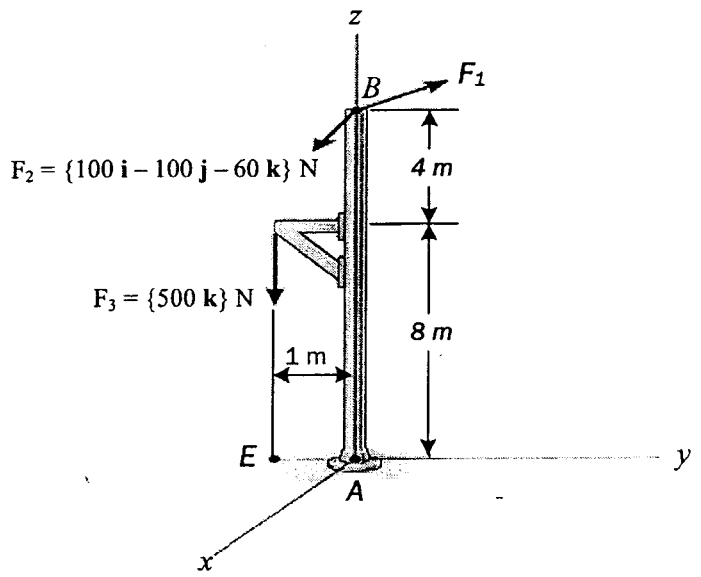

Figure Q2[a]
Rajah S2[a]

(50 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 kN and F_2 = 40 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 kN dan F_2 = 40 kN.

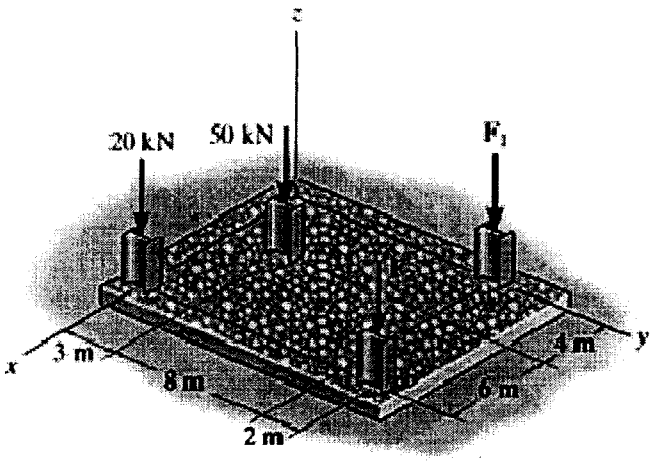

Figure Q2[b]
Rajah S2[b]

(50 marks/*markah*)

Q3. [a] (i) **Figure Q3[a](i) shows a frame consisting of members AB and CD supports the pulley, cable and block L. Draw a free body diagram for the whole frame, members CD and AB.**

Rajah S3[a](i) menunjukkan satu kerangka terdiri dari anggota AB dan CD yang menyokong takal, kabel dan blok L. Lukis rajah badan bebas keseluruhan kerangka, anggota CD dan anggota AB.

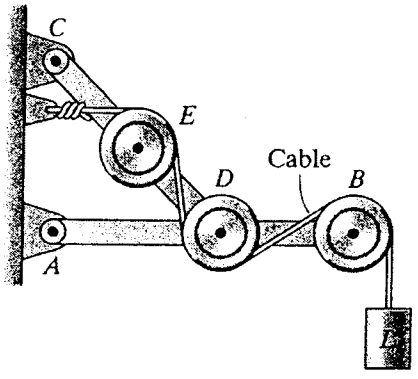

Figure Q3[a](i)
Rajah S3[a](i)

(20 marks/*markah*)

(ii) **A uniform beam weighing 20 kg, pinned at A and resting against a roller at B, is loaded by a 2 kN force and a 2.4 kNm moments as in Figure Q3[a](ii). Draw a free body diagram of the beam.**

Sebuah rasuk seragam berjisim 20 kg di pin di A dan berada atas rola di B. Rasuk dikenakan daya 2 kN dan momen 2.4 kNm seperti dalam Rajah S3[a](ii). Lukis rajah badan bebas rasuk berkenaan.

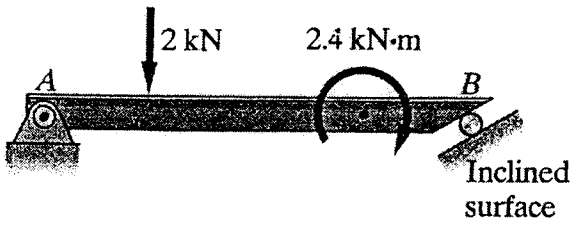

Figure Q3[a](ii)
Rajah S3[a](ii)

(10 marks/*markah*)

(iii) A force acts on a brake pedal is shown in Figure Q3[a](iii). Draw a free body diagram of the frame.

Satu daya dikenakan pada injak brek seperti Rajah S3[a](iii). Lukis rajah badan bebas untuk kerangka berkenaan.

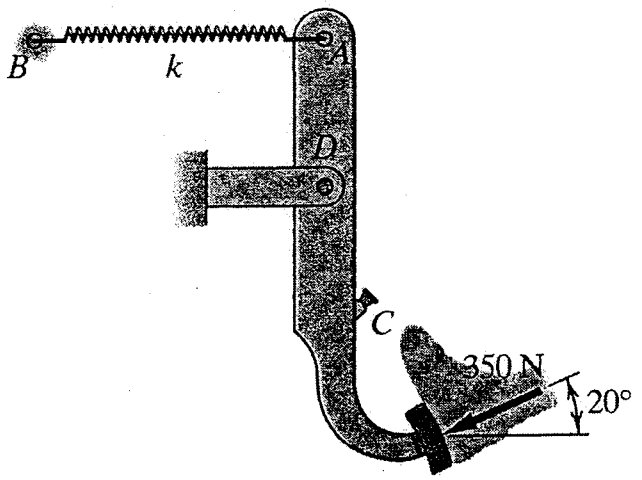

Figure Q3[a](iii)
Rajah S3[a](iii)

(10 marks/*markah*)

(iv) The uniform arm AB in Figure Q3[a](iv) weighs 60 N and is pulled on by a rope at *A*. The system consist of an arm which is constrained horizontally at B and the wheel at *A*. Draw the free body diagram of the system.

Sebuah lengan seragam AB dalam Rajah S3[a](iv) seberat 60 N ditarik oleh tali di A. Sistem terdiri dari lengan yang dikekang pergerakan mendatar di B dan roda di A. Lukis rajah badan bebas sistem tersebut.

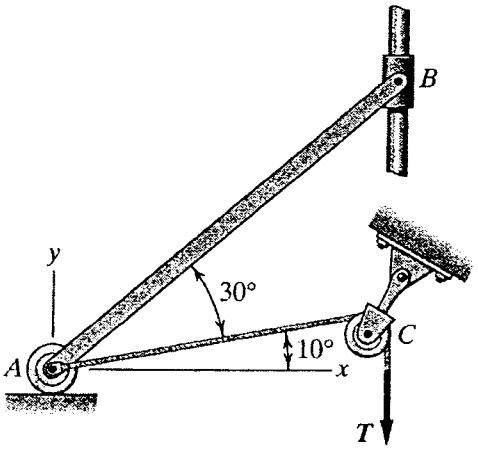

Figure Q3[a](iv)
Rajah S3[a](iv)

(10 marks/*markah*)

[b] **Figure Q3[b] shows a member AB which is pin jointed at A and has a slotted end at B. A member BC is attached to a spring at C and is allowed to move horizontally at B along the slotted end of member AB. The spring stiffness is given as 600 N/m and the unstretched length of the spring is 80 mm.**

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

(ii) Determine the reactions at A and B.

Rajah S3[b] menunjukkan sebuah anggota AB yang disokong pin di A dan mempunyai hujung beralur di B. Anggota BC diikat pada pegas di C dan dibenarkan bergerak secara mendatar di B sepanjang alur pada hujung anggota AB. Kekakuan pegas diberi sebanyak 600 N/m dan panjang asal pegas ialah 80 mm.

(i) Tentukan tindakbalas di A dan B.

(ii) Lukis rajah badan bebas sistem tersebut.

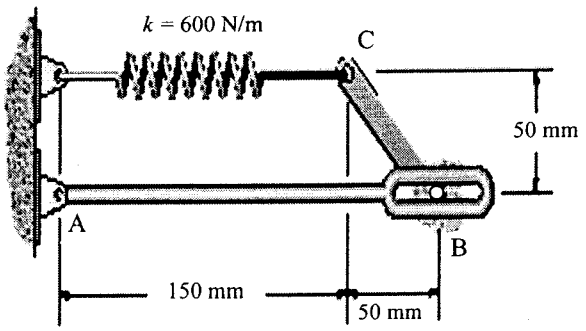

Figure Q3[b]
Rajah S3[b]

(50 marks/*markah*)

Q4. [a] Figure Q4[a] shows a cross-sectional area of a beam. Determine:

(i) the centroid coordinates of the sectional area.

(ii) the second moment of area I_{xx} and I_{yy} about the centroidal axis x and y.

Rajah S4[a] menunjukkan satu keratan luas suatu rasuk. Tentukan:

(i) koordinat sentroid luas keratan.

(ii) momen luas kedua keratan I_{xx} dan I_{yy} iaitu di sekitar paksi sentroid x dan y.

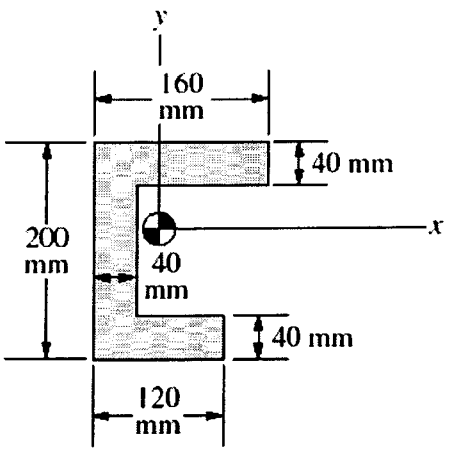

Figure Q4[a]
Rajah S4[a]

(40 marks/*markah*)

[b] **A telecommunication tower of height 70 m was erected by USM students from School of Mechanical Engineering as shown in Figure Q4[b]. The base of the tower A is treated as a built-in support. The tension in each cable is 2 kN. Determine the force and moment reactions at A.**

Sebuah pemancar telekomunikasi setinggi 70 m dibina oleh pelajar USM dari Pusat Pengajian Kejuruteraan Mekanik, seperti Rajah S4[b]. Dasar pemancar di A diambil sebagai penyokong hujung terikat. Ketegangan setiap kabel ialah 2 kN. Tentukan tindakbalas daya dan tindakbalas momen di A.

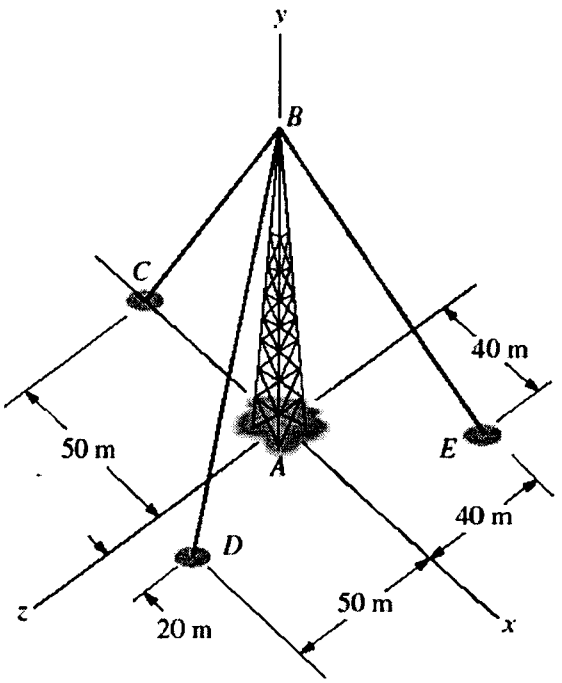

Figure Q4[b]
Rajah S4[b]

(60 marks/*markah*)

Q5. [a] **The velocity of a particle is given by $v = \{12\,t^2\,\mathbf{i} + 3\,t^3\,\mathbf{j} + (6\,t + 3)\,\mathbf{k}\}$ m/s, where t is in seconds. If the particle is at origin when $t = 0$, determine**

(i) the magnitude of the particle's acceleration when $t = 3$ s, and

Halaju zarah diberikan sebagai $v = \{12\,t^2\,\mathbf{i} + 3\,t^3\,\mathbf{j} + (6\,t + 3)\,\mathbf{k}\}$ m/s, di mana t adalah dalam saat. Sekiranya zarah berada pada kedudukan asal apabila $t = 0$, tentukan

(i) nilai pecutan zarah apabila $t = 3$ s, dan

(20 marks/*markah*)

(ii) What is the coordinate position of the particle at this instant?

apakah koordinat kedudukan zarah pada waktu ini?

(20 marks/*markah*)

[b] **The girl throws the toy at an angle of 30° from point A as shown in Figure Q5[b]. Determine the maximum and minimum speed v_A it can have so that it lands in the pool.**

Seorang budak perempuan membaling patung mainan pada sudut 30° daripada A seperti dalam Rajah S5[b]. Tentukan kelajuan maksima dan minima yang diperlukan supaya mainan tersebut dapat jatuh dan masuk ke dalam kolam berkenaan.

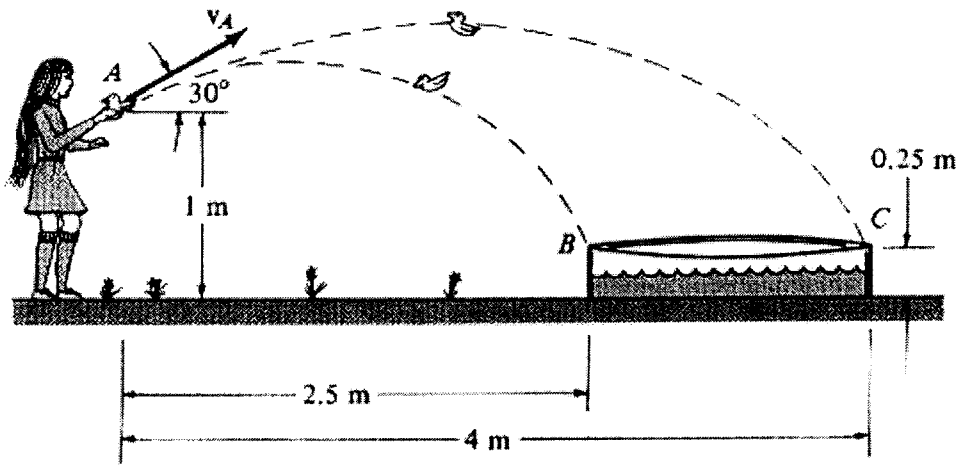

Figure Q5[b]
Rajah S5[b]

(60 marks/*markah*)

Q6. [a] **The 100 kg crate is hoisted up the incline using the cable and motor M as in Figure Q6[a]. The force in the cable is $F = 600\ t^2$ N, where t is in seconds. If the crate has an initial velocity $v_1 = 2$ m/s when $t = 0$, determine its velocity when $t = 2$s. The coefficient of kinetic friction between the crate and the incline is $\mu_k = 0.3$.**

Sebuah bongkah yang jisimnya 100 kg ditarik sepanjang satah condong menggunakan kabel dan motor M seperti yang ditunjukan dalam Rajah S6[a]. Daya pada kabel adalah $F = 600\ t^2$ N, di mana t adalah dalam saat. Sekiranya bongkah berkenaan mempunyai halaju awal $v_1 = 2$ m/s semasa $t = 0$, tentukan halajunya apabila $t = 2$ s. Pemalar geseran kinetik di antara bongkah dan satah adalah $\mu_k = 0.3$.

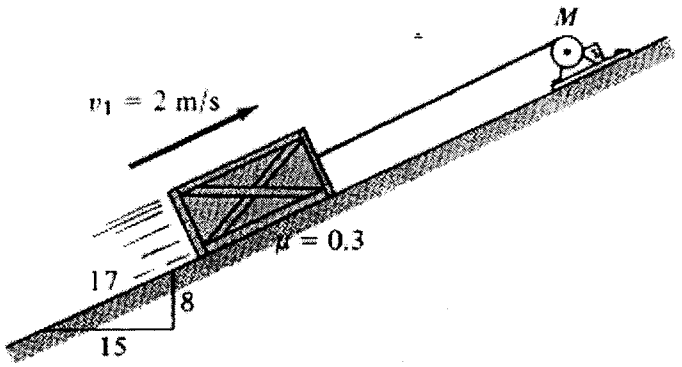

Figure Q6[a]
Rajah S6[a]

(50 marks/*markah*)

[b] **Figure Q6[b] shows a motorcyclist encounters the slight bump, which has a radius of curvature $\rho = 15$ m, determine the maximum constant speed at which he can travel without leaving the surface of the road. Neglect the size of the motorcycle and rider in the calculation. The rider and his motorcycle have a total weight of 250 kg.**

Rajah S6[b] menunjukkan seorang penunggang motorsikal menempuh bonggol berjejari kelengkungan $\rho = 15$ m, tentukan laju malar maksima yang perlu dilakukannya supaya dapat melaluinya tanpa meninggalkan permukaan jalan berkenaan. Abaikan saiz motorsikal dan penunggang tersebut dalam pengiraan. Jumlah jisim bagi penunggang dan motorsikal adalah 250 kg.

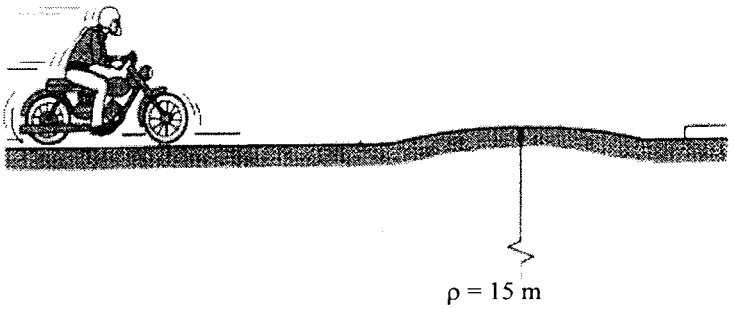

Figure Q6[b]
Rajah S6[b]

(50 marks/*markah*)

Q7 [a] **The collar in Figure Q7[a] has a mass of 30 kg and is supported on the rod having a coefficient of kinetic friction μ_k = 0.4. The attached spring has unstretched length of 0.2 m and a stiffness k = 50 N/m. Determine the speed of the collar after the applied force F = 200 N causes it to be displaced x = 1.5 m from point A. When x = 0 the collar is held at rest. Neglect the size of the collar.**

Sebuah relang di dalam Rajah S7[a] berjisim 30 kg dan disokong di atas rod yang mempunyai pekali geseran kinetik μ_k = 0.4. Spring yang bersambung mempunyai panjang tidak regang 0.2 m dan kekakuan k = 50 N/m. Tentukan halaju relang selepas daya F = 200 N yang dikenakan menyebabkan ia dianjak x = 1.5 m dari titik A. Pada x = 0 relang itu dipegang diam. Abaikan saiz relang.

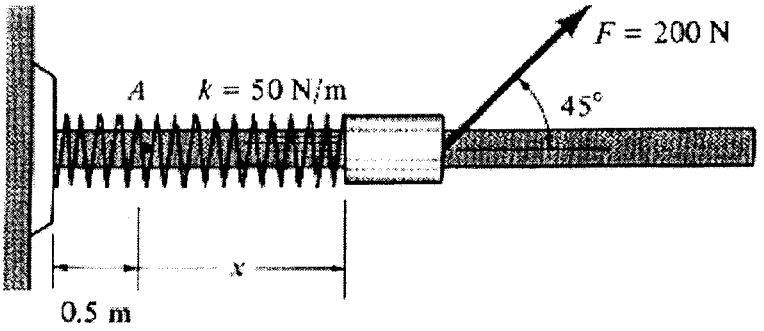

Figure Q7[a]
Rajah S7[a]

(40 marks/*markah*)

[b] **The 5-kg block in Figure Q7[b] is released from rest at A and slides down the smooth circular surface AB. It then continues to slide along the horizontal rough surface until it strikes the spring. Determine how far it compresses the spring before stopping.**

Sebuah blok 5 kg di dalam Rajah S7[b] dilepaskan dari diam pada A dan menggelongsor ke bawah di atas permukaan licin dan bulat AB. Ia kemudian terus menggelongsor sepanjang permukaan kasar mendatar sehingga mengenai pegas. Tentukan sejauh mana blok itu memampat pegas sebelum ia berhenti.

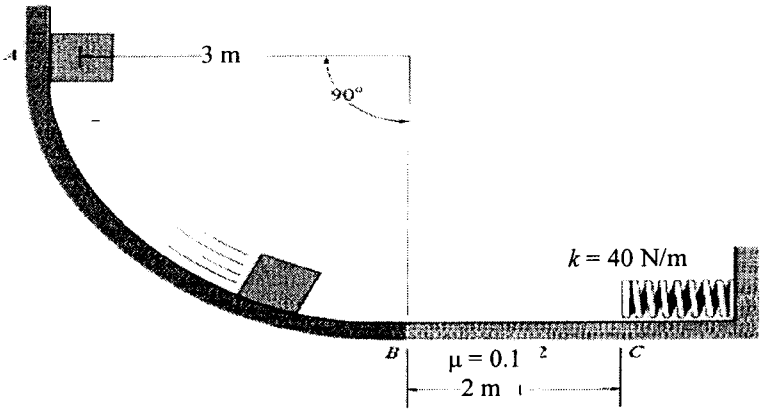

Figure Q7[b]
Rajah S7[b]

(60 marks/*markah*)

Q8 [a] **The particle, P is acted upon by its weight of 80 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= {4 i +3 j - k} m/s, determine its speed after 8 s.**

Suatu zarah, P dengan berat 80 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 8 saat.

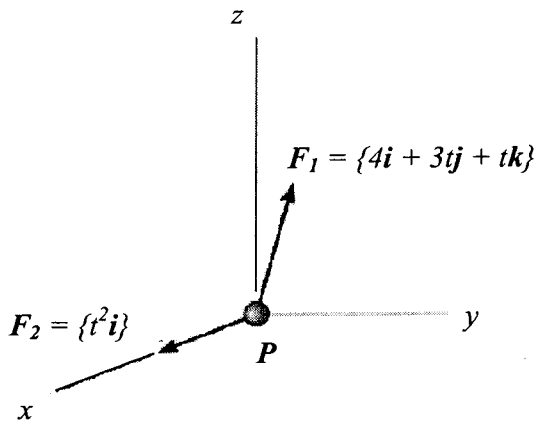

Figure Q8[a]
Rajah S8[a]

(60 marks/*markah*)

[b] **The car in Figure Q8[b] is traveling at 14 m/s when it is 5 m away from a wall. The driver applies the brakes to all four wheels at this point and skids toward the wall. If the crash into the wall takes 0.2 s, determine the average net impulsive force of the wall on the car. The car has a mass of 1.5 Mg and the coefficient of friction between the road and the tires is μ = 0.6. Include the friction impulse acting on the car during the collision.**

Kereta di dalam Rajah S8[b] bergerak pada kelajuan 14 m/s bila ia berada sejauh 5 m dari dinding. Pemandu mengenakan brek pada keempat-empat roda pada titik ini lalu terseret ke arah dinding. Jika lagaan dengan dinding mengambil 0.2 s, tentukan purata daya dedenyut bersih dinding ke atas kereta. Kereta itu berjisim 1.5 Mg dan pekali geseran di antara tayar dan jalan ialah μ = 0.6. Rangkumkan dedenyut geseran yang bertindak ke atas kereta semasa lagaan.

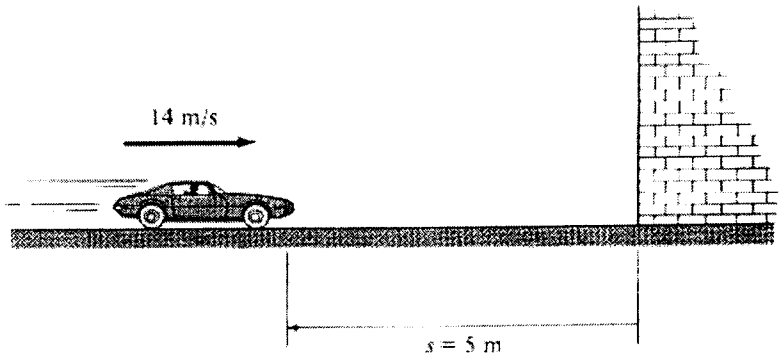

Figure Q8[b]
Rajah S8[b]

(40 marks/*markah*)

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