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UNIVERSITI SAINS MALAYSIA

First Semester Examination  
2011/2012 Academic Session

January 2012

**EMM 101/3 – Engineering Mechanics**  
*[Mekanik Kejuruteraan]*

Duration : 3 hours  
*Masa : 3 jam*

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**INSTRUCTIONS TO CANDIDATE:**  
**ARAHAN KEPADA CALON:**

Please check that this paper contains **TEN (10)** printed pages, **ONE (1)** page appendix and **FIVE (5)** questions before you begin the examination.

*Sila pastikan bahawa kertas soalan ini mengandungi **SEPULUH (10)** mukasurat bercetak, **SATU (1)** mukasurat lampiran dan **LIMA (5)** soalan sebelum anda memulakan peperiksaan.*

Answer **ALL** questions.  
*Jawab **SEMUA** soalan.*

**Appendix/Lampiran :**

1. Centroid and Second Moment of Area of Common Shapes [1 page/mukasurat]

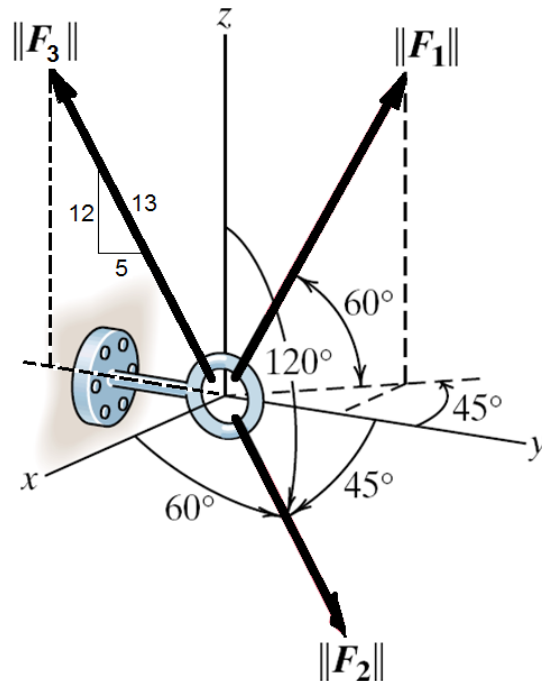
You may answer all questions in **English** OR **Bahasa Malaysia** OR a combination of both.  
*Calon boleh menjawab semua soalan dalam **Bahasa Malaysia** ATAU **Bahasa Inggeris** ATAU kombinasi kedua-duanya.*

Answer to each question must begin from a new page.  
*Jawapan untuk setiap soalan mestilah dimulakan pada mukasurat yang baru.*

In the event of any discrepancies, the English version shall be used.  
*Seandainya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.*

- Q1. [a] Three forces  $F_1$ ,  $F_2$  and  $F_3$  are applied to an eyelet as shown in Figure Q1[a]. Express each force in vector notation.**

*Tiga daya  $F_1$ ,  $F_2$  dan  $F_3$  dikenakan pada lelubang seperti Rajah S1[a]. Nyatakan setiap daya dalam tatatanda vektor.*



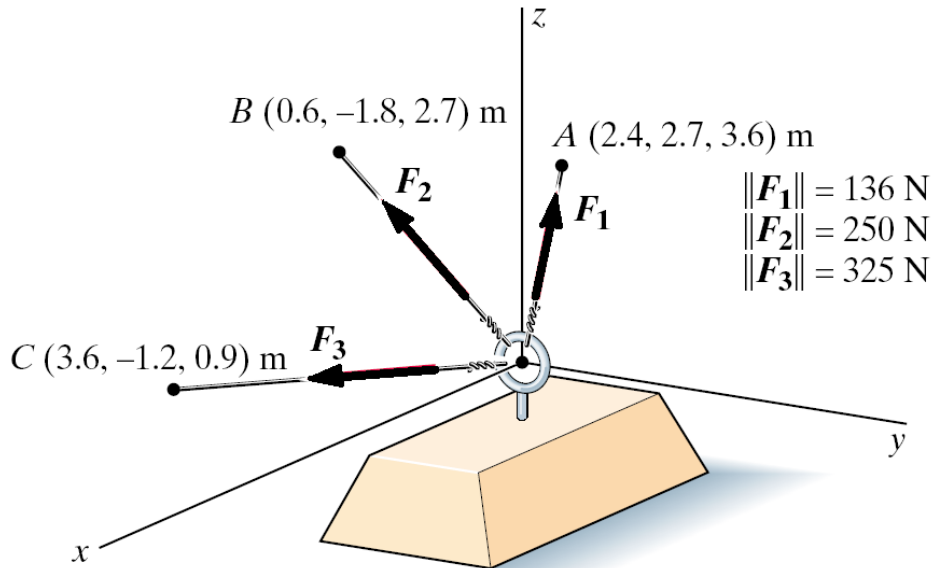
**Figure Q1[a]**  
*Rajah S1[a]*

(20 marks/markah)

- [b] Three forces are applied with cables to the anchor block as shown in Figure Q1[b].**
- Write each force in vector notation.**
  - Determine the resultant force of the three cables and also its direction.**

*Tiga daya dikenakan melalui kabel pada blok penambat seperti dalam Rajah S1[b].*

- Tuliskan setiap daya dalam tatatanda vektor.*
- Tentukan daya paduan ketiga-tiga kabel dan juga arahnya.*

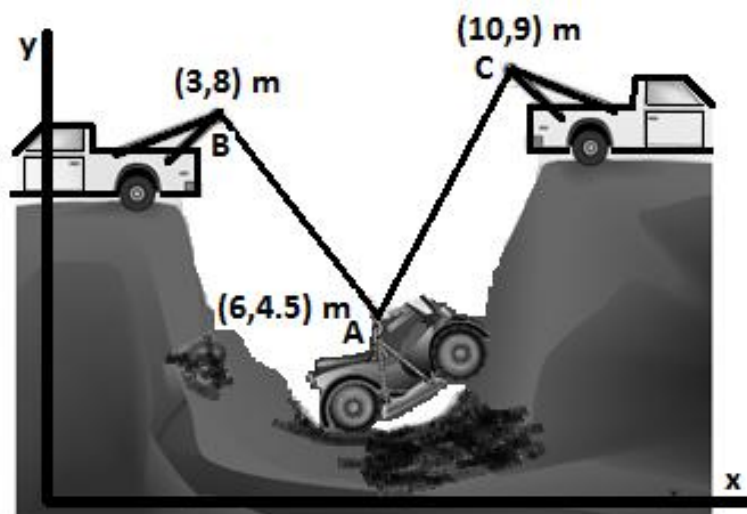


**Figure Q1[b]**  
Rajah S1[b]

(40 marks/markah)

- [c] Two tow trucks lift a motorcycle out of a ravine following an accident. If the 100 kg motorcycle is in equilibrium in the position shown in Figure Q1[c], what are the tensions in cables AB and AC?

Dua trak pengangkut mengangkat motosikal dari gaung disebabkan kemalangan. Jika motosikal yang berjisim 100 kg dalam keseimbangan seperti dalam Rajah S1[c], berapakah tegangan dalam kabel AB dan AC?



**Figure Q1[c]**  
Rajah S1[c]

(40 marks/markah)

**Q2. [a] State the principle of moments and illustrate your statement with a diagram.**

*Nyatakan prinsip momen dan tunjukkan kenyataan anda melalui rajah.*

**(15 marks/markah)**

**[b] Define a couple and state the characteristics of a couple moments.**

*Beri definasi untuk ganding dan sebutkan ciri-ciri untuk momen ganding.*

**(20 marks/markah)**

**[c] The tension in cables AB and CD in Figure Q2[c] is 500 N.**

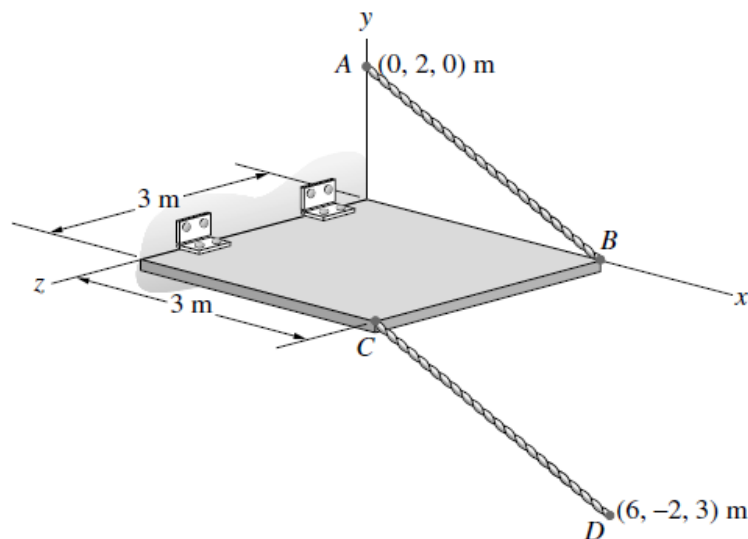
**(i) Show that the two forces exerted by the cables on the rectangular hatch at B and C form a couple.**

**(ii) What is the moment exerted on the plate by the cables?**

*Ketegangan kabel AB dan CD dalam Rajah S2[c] ialah 500 N.*

*(i) Tunjukkan bahawa kedua-dua daya dalam kabel yang bertindak pada hach bentuk segiempat di B dan C membentuk suatu ganding.*

*(ii) Berapakah momen yang ditindaki pada plat oleh kedua-dua kabel?*



**Figure Q2[c]**

*Rajah S2[c]*

**(30 marks/markah)**

**[d] Forces are applied at points A, B, and C on the bar fixed at O as shown in Figure Q2[d]. Replace the forces with the equivalent force and moment acting at O in vector notation.**

*Beberapa daya dikenakan pada titik A, B, dan C pada bar yang ditetapkan pada O seperti Rajah S2[d]. Gantikan daya-daya berkenaan dengan daya dan momen setara yang bertindak pada titik O dalam tatatanda vektor.*

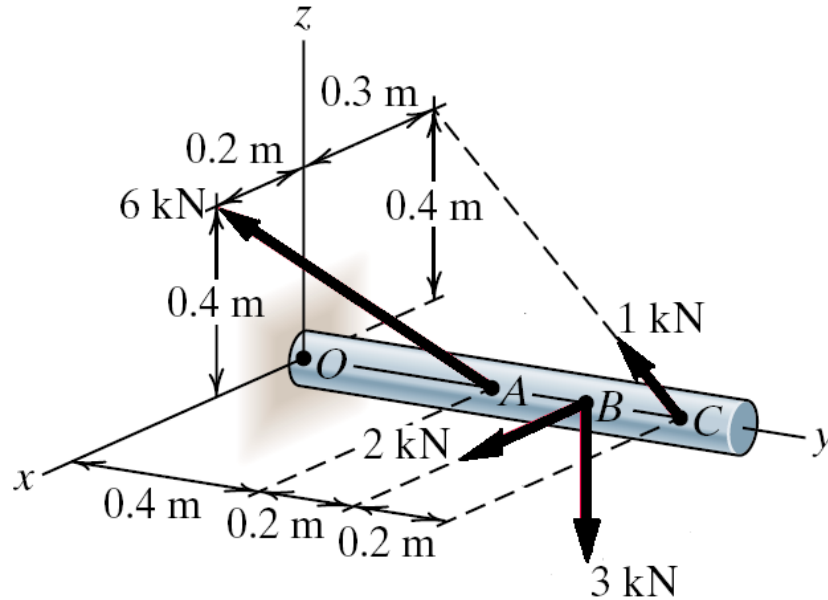


Figure Q2[d]  
Rajah S2[d]

(35 marks/markah)

- Q3. [a] State the general rule for support reaction which is subjected to a force system.

*Nyatakan hukum umum untuk tindakbalas pada penyokong apabila dikenakan sistem daya.*

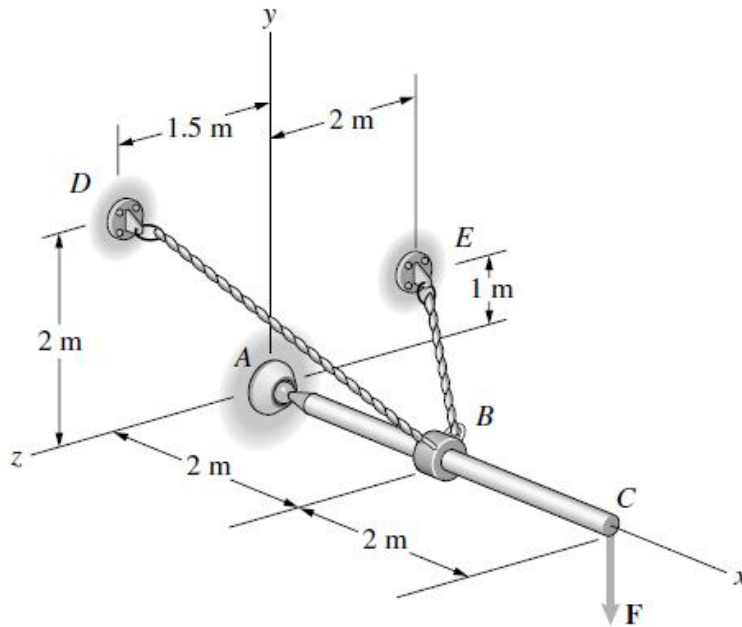
(15 marks/markah)

- [b] The boom ABC in Figure Q3[b] is subjected to a force  $F = -15j$  kN at C and is supported by a ball and socket at A and the cables BD and BE.

- (i) Draw a free body diagram of the boom.
- (ii) Determine the tension in the cables and the reaction at A.

*Boom ABC dalam Rajah S3[b] dikenakan daya  $F = -15j$  kN di C dan disokong oleh penyokong bola dan soket di A dan kabel BD dan BE.*

- (i) Lukis rajah jasad bebas boom.
- (ii) Tentukan ketegangan kabel dan tindakbalas di A.

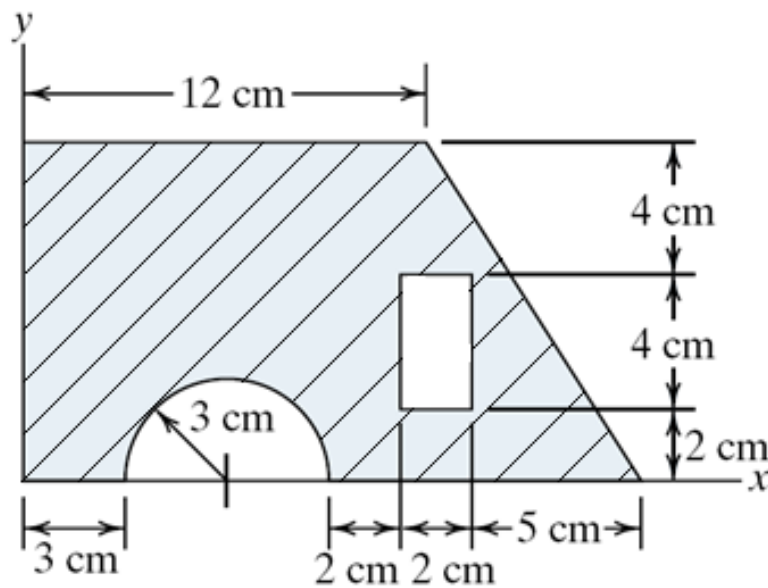


**Figure Q3[b]**  
Rajah S3[b]

(40 marks/markah)

- [c] Calculate the area of the shaded region in Figure Q3[c] and locate its centroid. Also determine the second moment of area of the shaded region about the x-axis.

*Kira luas kawasan berlorek dalam Rajah S3[c] dan dapatkan lokasi sentroidnya. Juga tentukan momen luas kedua kawasan berlorek di sekitar paksi x.*

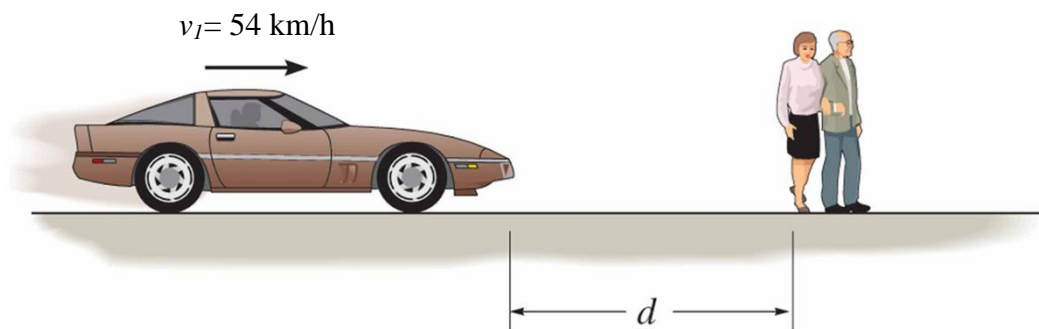


**Figure Q3[c]**  
Rajah S3[c]

(45 marks/markah)

- Q4. [a]** Tests reveal that a normal driver takes  $0.75\text{ s}$  before he or she can *react* to a situation to avoid a collision. It takes  $3\text{ s}$  for a driver having  $0.1\%$  alcohol in his system to do the same. As seen in Figure Q4[a], if such drivers are traveling on a straight road at  $54\text{ km/h}$  and their cars can decelerate at  $0.6\text{ m/s}^2$ , determine the shortest stopping distance  $d$  for each from the moment they see the pedestrians.

*Ujian menunjukkan bahawa seorang pemandu biasa mengambil masa  $0.75\text{ s}$  sebelum dia boleh bertindak untuk mengelak daripada pelanggaran. Bagi seorang pemandu yang mempunyai  $0.1\%$  alkohol dalam sistemnya, ia mengambil masa  $3\text{ s}$  untuk melakukan proses yang sama. Seperti yang tertera di dalam Rajah S4[a], jika pemandu-pemandu sedemikian memandu selaju  $54\text{ km/h}$  di jalan lurus dan kereta mereka boleh menyahpecut dengan kadar  $0.6\text{ m/s}^2$ . Tentukan jarak berhenti minimum  $d$  untuk kedua-dua situasi di atas ketika mereka melihat pejalan-pejalan kaki.*

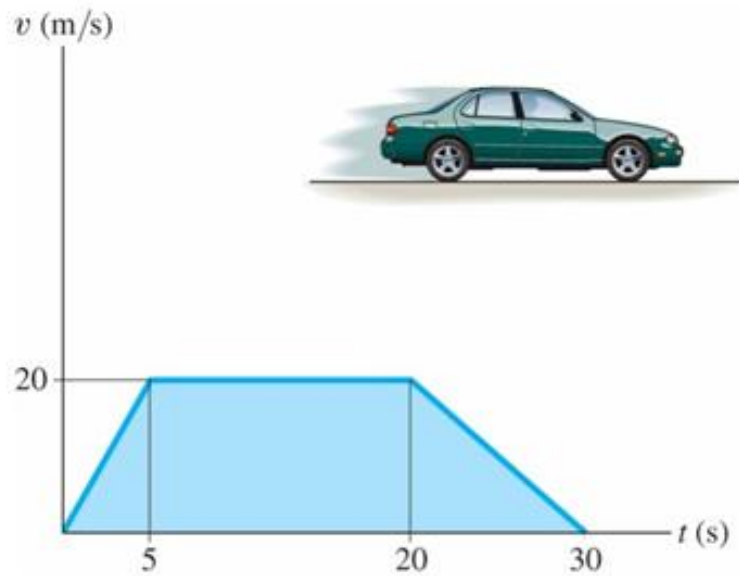


**Figure Q4[a]**  
Rajah S4[a]

(20 marks/markah)

- [b]** The  $v$ - $t$  graph of a car while traveling along a road is shown in Figure Q4[b]. Draw the  $a$ - $t$  graphs for the motion.

*Graf  $v$ - $t$  bagi sebuah kereta semasa perjalanan ditunjukkan dalam Rajah S4[b]. Lukiskan graf  $a$ - $t$  untuk perjalanan ini.*

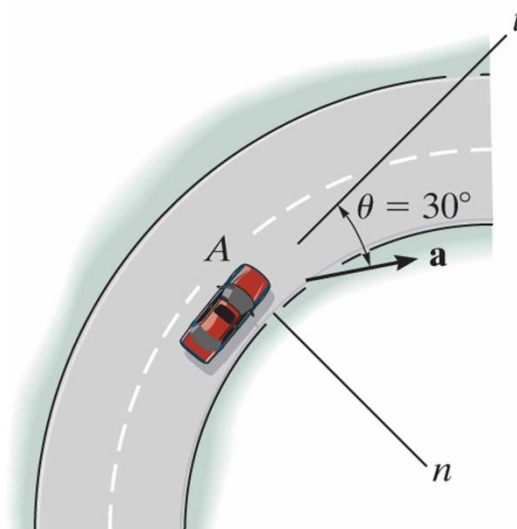


**Figure Q4[b]**  
Rajah S4[b]

(15 marks/markah)

- [c] The automobile has a speed of 24 m/s at point A and an acceleration  $a$  having a magnitude of  $3 \text{ m/s}^2$ , acting in the direction shown in Figure Q4[c]. Determine the radius of curvature of the path at point A and the tangential component of acceleration.

*Sebuah kereta mempunyai kelajuan 24 m/s di titik A dan pemecutan  $a$  sebanyak  $3 \text{ m/s}^2$ , bertindak ke arah yang ditunjukkan di dalam Rajah S4[c]. Tentukan jejari kelengkungan titik A dan komponen tangen pecutan.*



**Figure Q4[c]**  
Rajah S4[c]

(15 marks/markah)



- [d] The smooth block  $B$  in Figure Q4[d], having a mass of 0.2 kg, is attached to the vertex  $A$  of the right circular cone using a light cord. If the block has a speed of 0.5 m/s around the cone, determine the tension in the cord and the reaction which the cone exerts on the block. Neglect the size of the block.

*Blok B yang bermuka licin di dalam Rajah S4[d] mempunyai jisim 0.2 kg, dilekatkan di bucu A kon bulat tegak dengan seutas tali ringan. Jika blok mempunyai kelajuan 0.5 m/s sekitar kon, tentukan ketegangan tali dan tindakbalas kon atas blok. Abaikan saiz blok.*

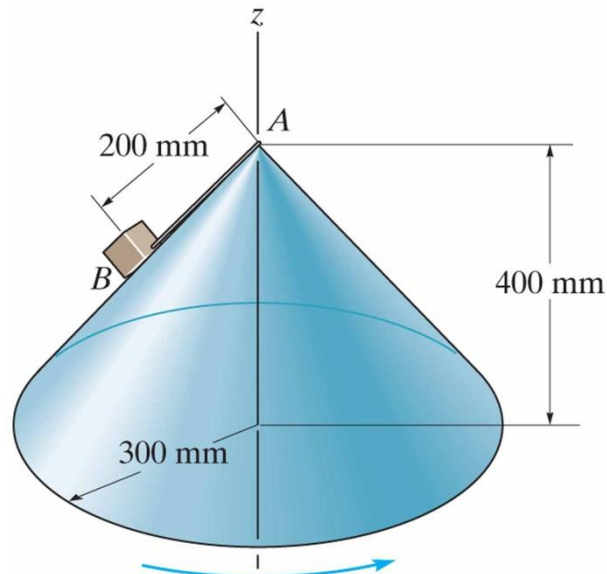


Figure Q4[d]  
Rajah S4[d]

(50 marks/markah)

- Q5. [a] The 5 kg block is released from rest at  $A$  as depicted in Figure Q5[a]. Determine the compression of each of the springs after the block strikes the platform and is brought momentarily to rest. Initially both springs are unstretched. Assume the platform has a negligible mass.

*Blok seberat 5 kg dilepaskan dari rehat di A seperti yang tertera di dalam Rajah S5[a]. Tentukan kemampatan setiap spring selepas blok menghentam pelantar dan menyebabkan ia berehat seketika. Pada mulanya, kedua-dua spring bebas dari anjakan. Jisim platform boleh diabaikan.*

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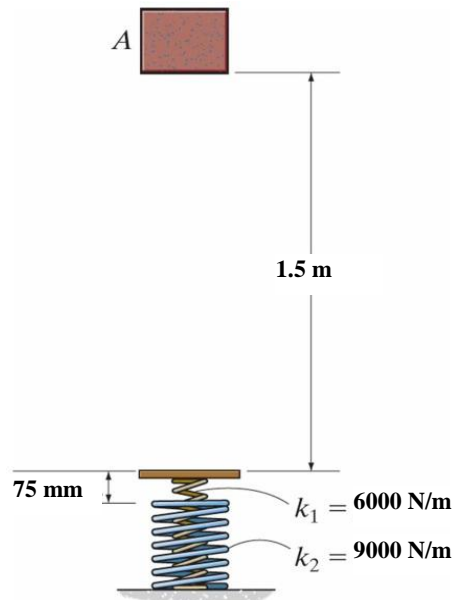


Figure Q5[a]  
Rajah S5[a]

(50 marks/markah)

- [b] The 15 kg suitcase *A* is released from rest at *C* as depicted in Figure Q5[b]. After it slides down the smooth ramp, it strikes the 10 kg suitcase *B*, which is originally at rest. If the coefficient of restitution between the suitcases is  $e = 0.3$  and the coefficient of kinetic friction between the floor *DE* and each suitcase is  $\mu_k = 0.4$ , determine (i) the velocity of *A* just before impact, (ii) the velocities of *A* and *B* just after impact, and (iii) the distance *B* slides before coming to rest.

Beg *A* (15 kg) dilepaskan dari rehat di *C* seperti yang tertera di dalam Rajah S5[b]. Selepas ia meluncur di atas anjakan yang licin, ia melanda beg *B* (10 kg) yang berada dalam keadaan rehat. Jika pekali pemulihan antara beg adalah  $e = 0.3$  dan pekali geseran kinetik antara lantai *DE* dan setiap beg adalah  $\mu_k = 0.4$ . Tentukan (i) halaju *A* hanya sebelum hentaman, (ii) halaju-halaju *A* and *B* selepas sahaja hentaman, dan (iii) jarak *B* meluncur sebelum berhenti.

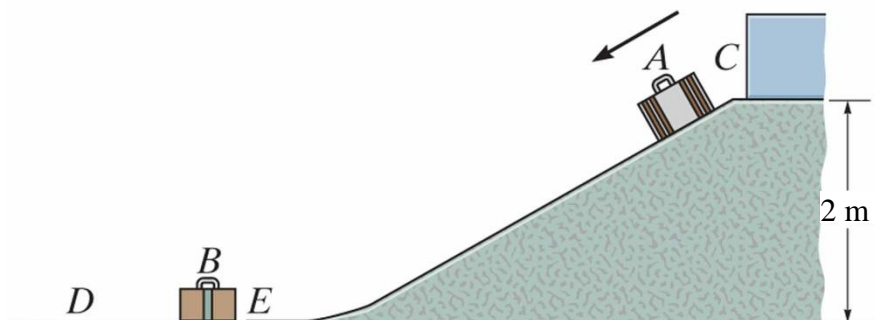
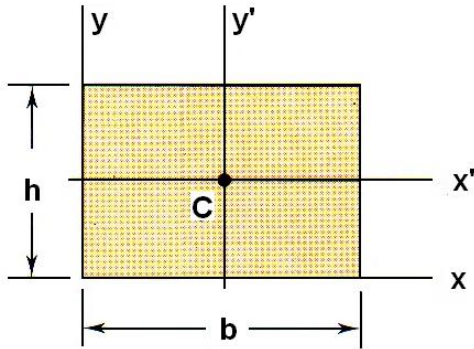


Figure Q5[b]  
Rajah S5[b]

(50 marks/markah)

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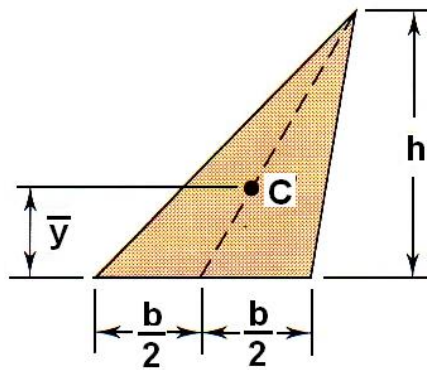
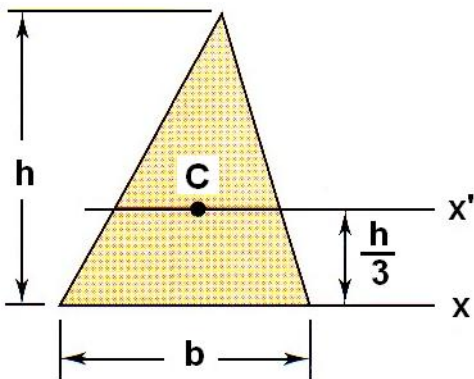
**Centroid and Second Moment of Area of Common Shapes**



**Rectangular**

$$\bar{I}_{x'} = \frac{bh^3}{12}, \quad I_x = \frac{bh^3}{3}$$

$$J_C = \frac{bh}{12} (b^2 + h^2)$$

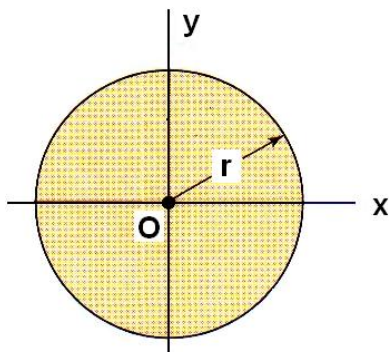


**Triangular**

$$\bar{I}_{x'} = \frac{bh^3}{36},$$

$$I_x = \frac{bh^3}{12}$$

$$\bar{y} = h/3$$



**Circular**

$$\bar{I}_x = \bar{I}_y = \frac{\pi r^4}{4}, \quad J_o = \frac{\pi r^4}{2}$$

**Semicircular**

$$I_x = I_y = \frac{\pi r^4}{8}, \quad J_o = \frac{\pi r^4}{4}$$

$$\bar{y} = \frac{4r}{3\pi}$$

**Quarter-circular**

$$I_x = I_y = \frac{\pi r^4}{16}, \quad J_o = \frac{\pi r^4}{8}, \quad \bar{x} = \bar{y} = \frac{4r}{3\pi}$$

