UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	DYNAMICS
COURSE CODE	:	BNJ 20103
PROGRAMME	:	BNM/BNG/BNH/BNK/BNL
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIFTHTEEN (15)** PAGES

Q1 (a) **Figure Q1(a)** shows an elevator starts from rest at the first floor of the building. It can accelerate at rate, $a_1 = 1.5$ m/s^2 and then decelerate at rate, $a_2 = 0.6$ m/s^2. The elevator also starts from rest and then stops.

(i) Determine the shortest time it takes to reach a floor of distance $d = 12$ m above the ground. (4 marks)

(ii) Draw the *a-t* graphs for the motion. (2 marks)

(iii) Draw the *v-t* graphs for the motion. (4 marks)

(b) **Figure Q1(b)** shows a box travels along the industrial conveyor. The movements and the path of the conveyor are rectilinear and for a certain period are curvilinear. If the box starts from rest at A and increases its speed such that $a_t = (0.2t)$ m/s^2, determine the magnitude of its acceleration when it arrives at point B. (5 marks)

(c) **Figure Q1(c)** shows a truck is traveling along the horizontal circular curve of radius, *r= 60 m,* with a constant speed, *v=20 m/s*. Determine,

(i) The angular rate of rotation, $\dot{\theta}$ of the radial line *r= 60 m.* (2 marks)

(ii) The magnitude of the truck's acceleration. (3 marks)

Q2 (a) **Figure Q2(a)** shows a bicyclist *A,* is traveling at 7 m/s around the curve on the race track while increasing his speed at 0.5 m/s^2. Another bicyclist, *B* is traveling at 8.5 m/s along the straight-a-way and increasing his speed at 0.7 m/s^2.

(i) Determine the relative velocity of *A* with respect to *B* and its direction.
Hints :
- Draw the velocity triangle diagram
- Reference of velocity direction at *x-y* axis

(5 marks)

(ii) Define the normal acceleration, a_n at *A*. (1 marks)

(iii) Determine the relative acceleration of *A* with repect to *B* and its direction.
Hints :
- Draw the acceleration triangle diagram
- Reference of acceleration direction at *x-y* axis and *n-t* axis

(5 marks)

(b) **Figure Q2(b)** shows a 0.8 Mg car travels over the hill having the shape of a parabola. When the car is at point A, it is traveling at 9 m/s and increasing its speed at 3 m/s^2. Neglect the size of the car.

(i) Determine the slope angle θ at point A.

(2 marks)

(ii) Identify the radius of curvature ρ at point A.

(2 marks)

(iii) Sketch the free body diagram and define the resultant normal force, N and the resultant frictional force, F_f that all the wheels of the car exert on the road at this instant.

(5 marks)

Q3 (a) **Figure Q3(a)** shows the block of weight W = 25 N 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. By using the Principle Of Work and Energy, determine how far is the block compresses the spring before **stopping.**
Hints :

- Draw the FBD, to clarify the numbers of force acting on the block, when the block moved.

(5 marks)

(b) Calculate the power input for a motor necessary to lift a weight, W = 3000 N and at a constant speed rate, v = 2 m/s. Also given the efficiency of the motor is ε = 0.65

(2 marks)

(c) If the pendulum is released from the horizontal position as shown in **Figure Q3(c)** calculate the **velocity** of its bob in the vertical position.

(3 marks)

(d) **Figure Q3(d)** shows a cue ball A is given an initial velocity, $(v_A)_1$ = 5 m/s. If it makes a direct/central collision/impact with ball B (coefficient of restitution e = 0.8), each ball has a mass of 0.4 kg. Neglect the size of each ball.

(i) Find the final velocity at *A* and *B* when ball *A* strikes ball *B*.

(5 marks)

(ii) Analyze the velocity at B and the angle, θ just after it rebounds from the cushion at C (coefficient of restitution e = 0.6).

(5 marks)

Q4 (a) **Figure Q4(a)** shows a rigid body motion which disk A rotates from **rest** with constant angular acceleration, $\alpha_A = 2$ rad/s^2. Determine:

(i) The time taken by the disc to rotate by 10 revolutions. (2 marks)

(ii) The angular velocity and angular acceleration of disc B when disc A rotate by 10 revolution, if disc B is in contact with disc A without slipping, (3 marks)

(b) **Figure Q4(b)** shows a given Collar C is moving downward with a velocity of 2 m/s. Calculate the angular velocities of CB and AB at this instant.
Hints :
- Draw the kinematic diagram of link CB and AB
- Write the relative-velocity equation/ relative motion analysis

(5 marks)

(c) In each case of **Figure Q4(c-i)** and **Figure Q4(c-ii)** graphically draw the Instantaneous Center of zero velocity of link AB. (3 marks)

(d) **Figure Q4(d)** shows the mechanism used in a marine engine consists of a single crank AB and two connecting rods BC and BD. The instant the crank is in the position shown, it has an angular velocity, $\omega_{AB} = 5$ rad/s. Determine the velocity of the piston at C, using the Instantaneous Centre method. (7 marks)

Q5 (a) The spool has a mass of 50 kg and a radius of gyration, $k_0 = 0.280$ m as shown in **Figure Q5(a)**. If the 20-kg block A is released from rest,

(i) Determine the potential energy of the system from initial position (point 1) to any instant (point 2). (2 marks)

(ii) Calculate the kinetic energy of the system in term of velocity v. (3 marks)

(iii) Sketch the free body diagram and find the velocity of the block A when it descends 0.5 m. (3 marks)

(b) **Figure Q5(b)** show a spring having a stiffness of $k = 300$ N/m is attached to the end of the 15-kg rod. It is understand when $\theta = 0^\circ$. The motion is in the vertical plane. If the rod is released from the rest when $\theta = 0^\circ$,

(i) Illustrate the free body diagram and find the potential energy at the instant, $\theta = 30^\circ$. (6 marks)

(ii) Determine the kinetic energy at the instant $\theta = 30^{\circ}$ of the system in term of angular velocity ω. (4 marks)

(iii) Define the angular velocity at the instant $\theta = 30^{\circ}$ (2 marks)

- END OF QUESTIONS -

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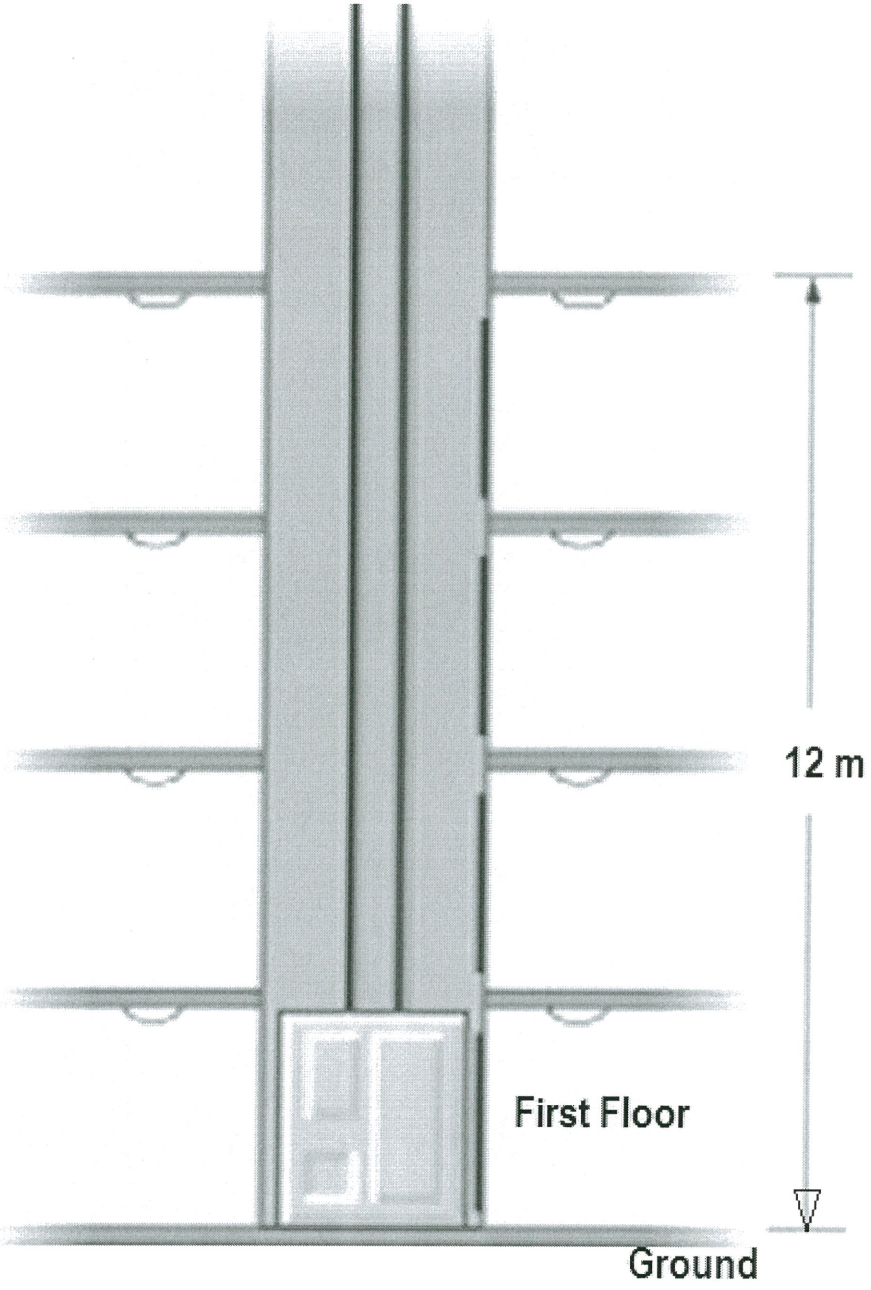

FIGURE Q1(a)

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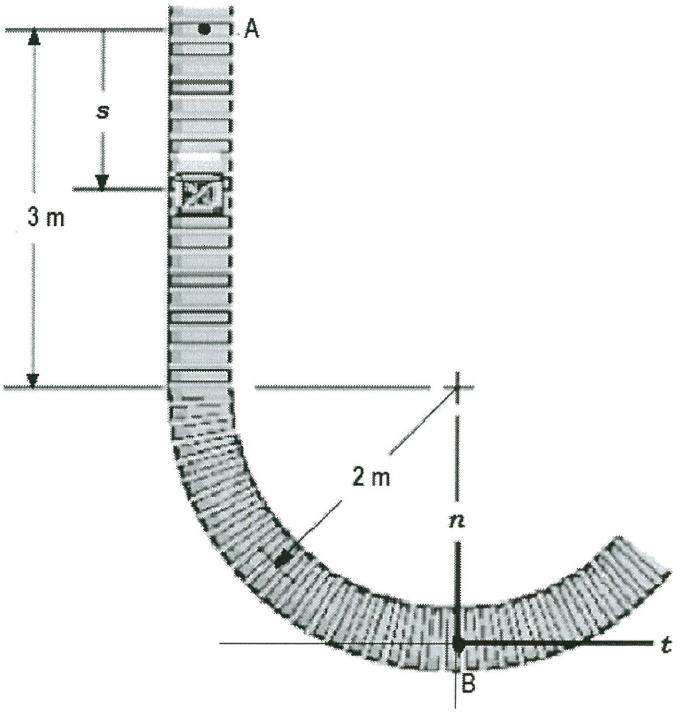

FIGURE Q1(b)

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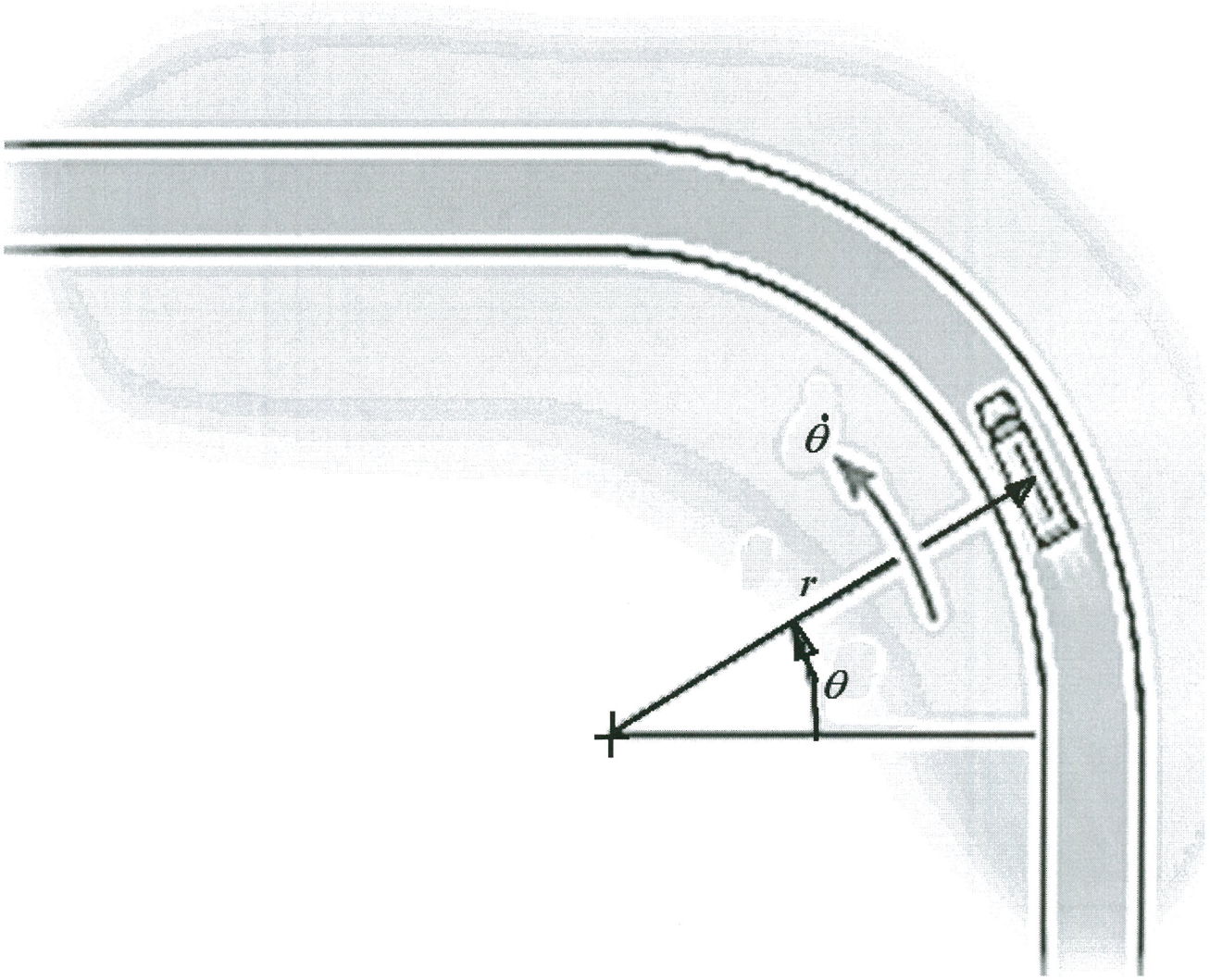

FIGURE Q1(c)

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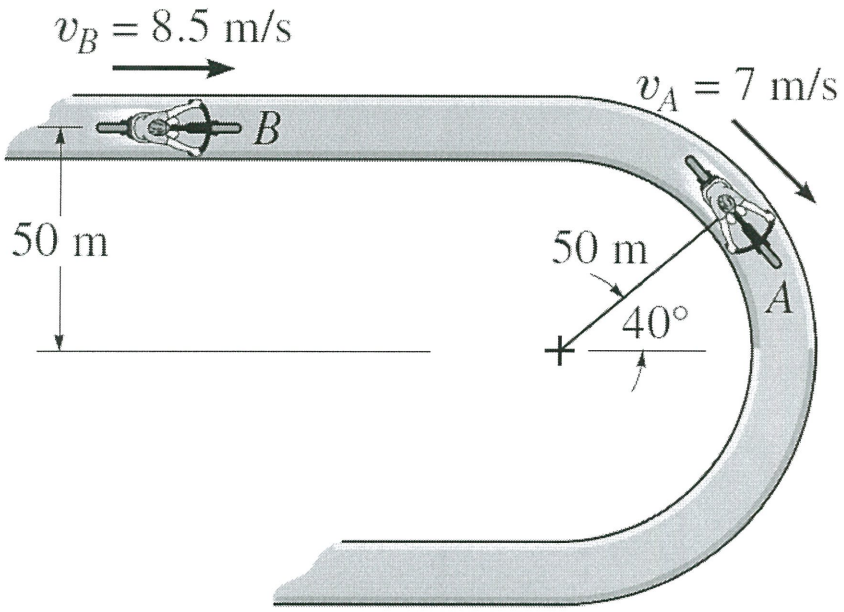

FIGURE Q2(a)

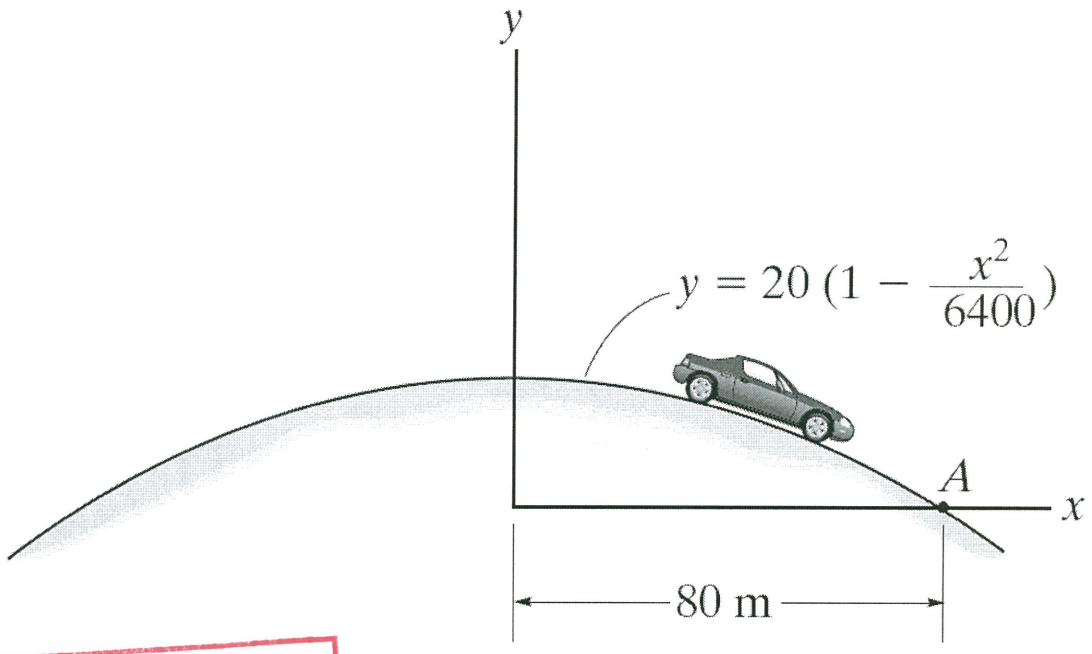

FIGURE Q2(b)

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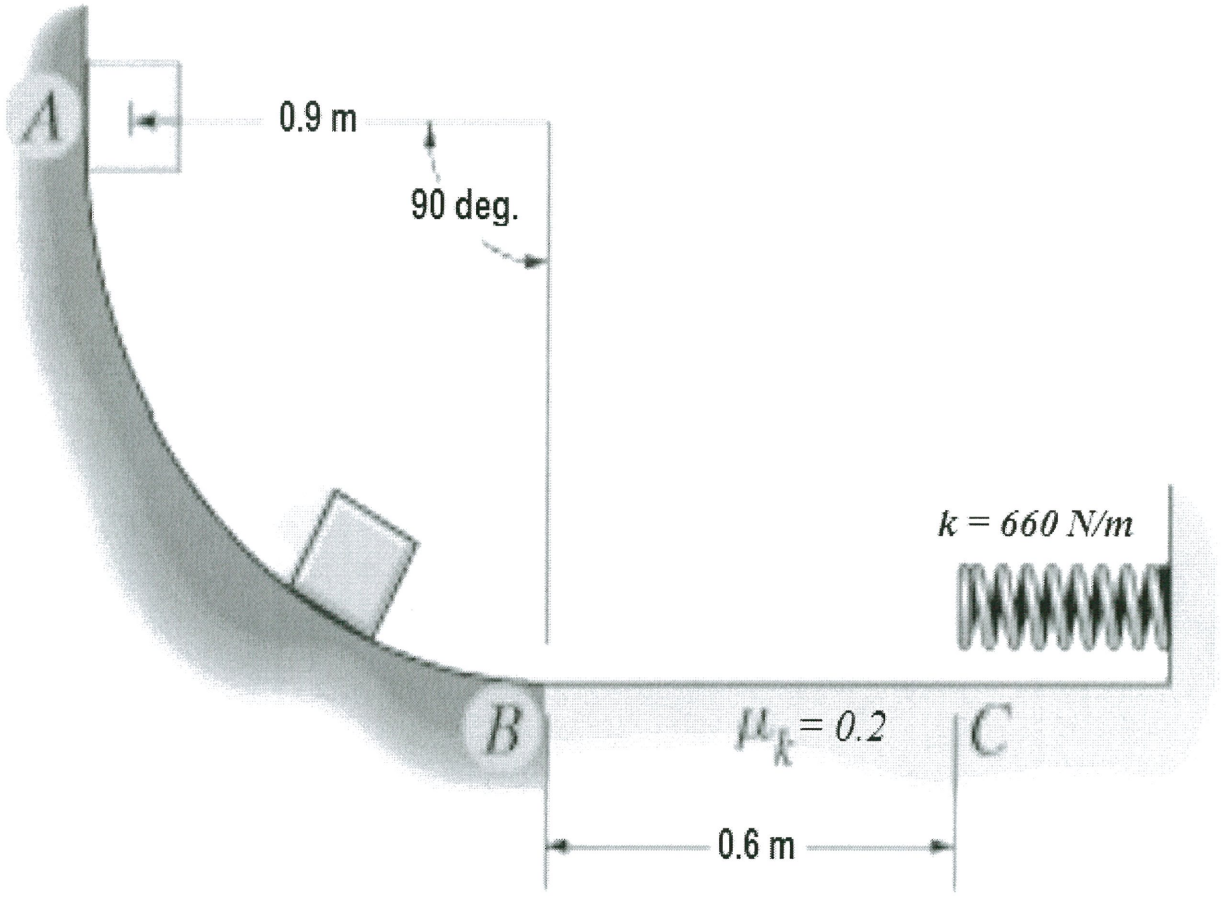

FIGURE Q3(a)

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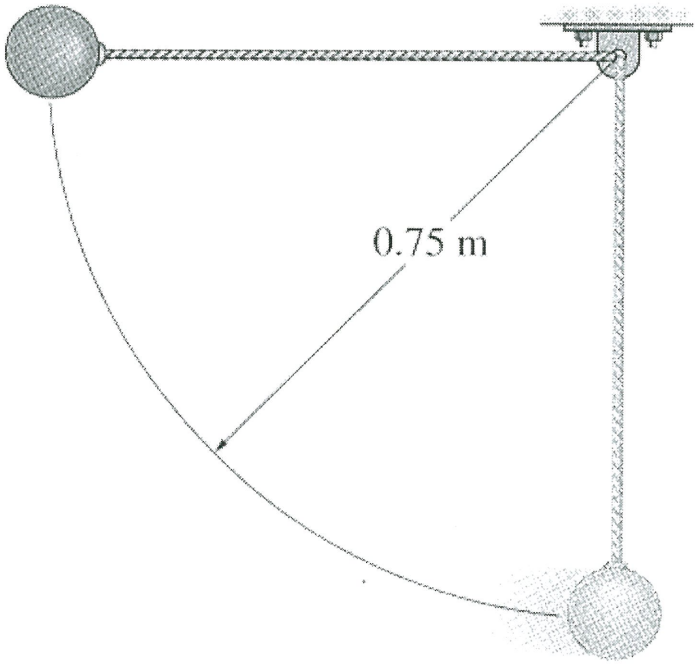

FIGURE Q3(c)

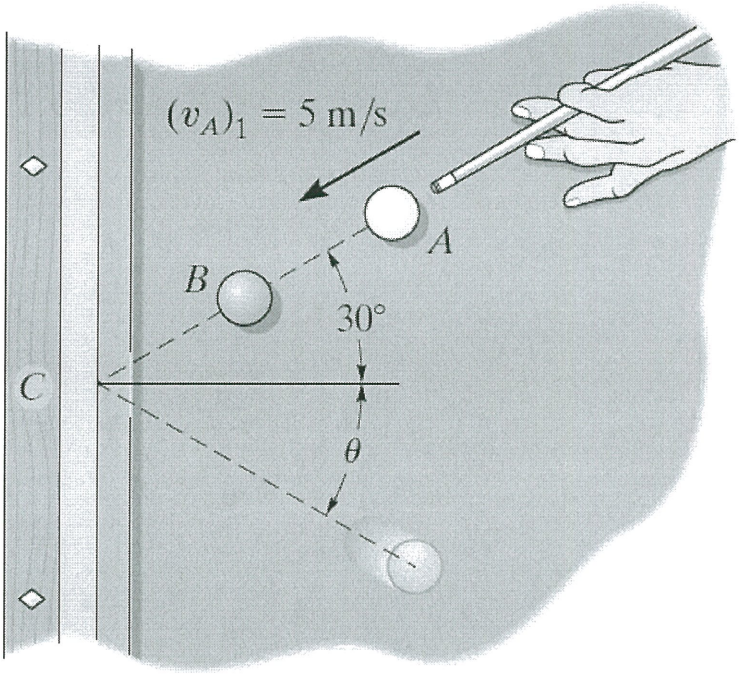

FIGURE Q3(d)

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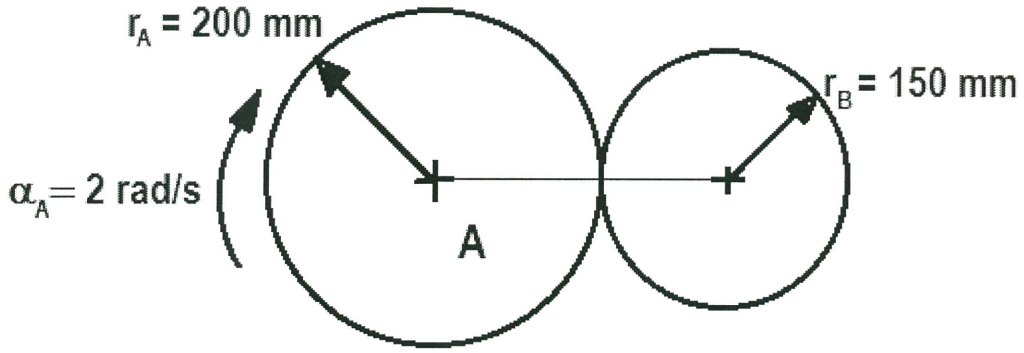

FIGURE Q4(a)

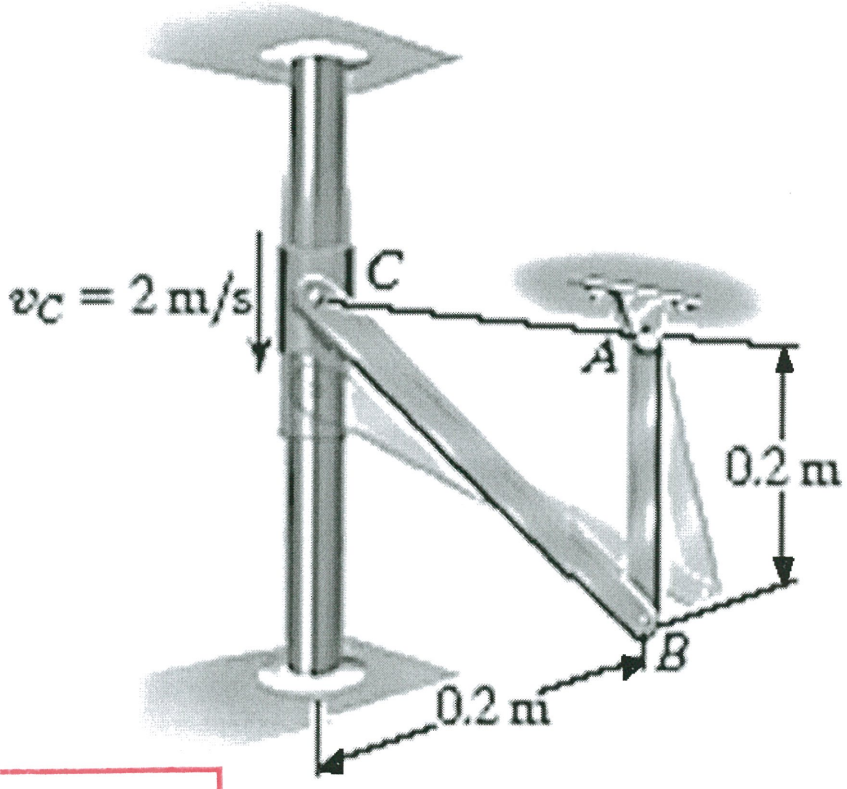

FIGURE Q4(b)

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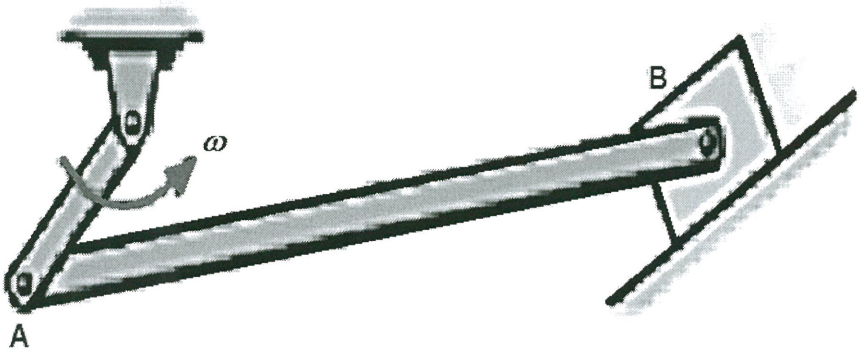

FIGURE Q4(c-i)

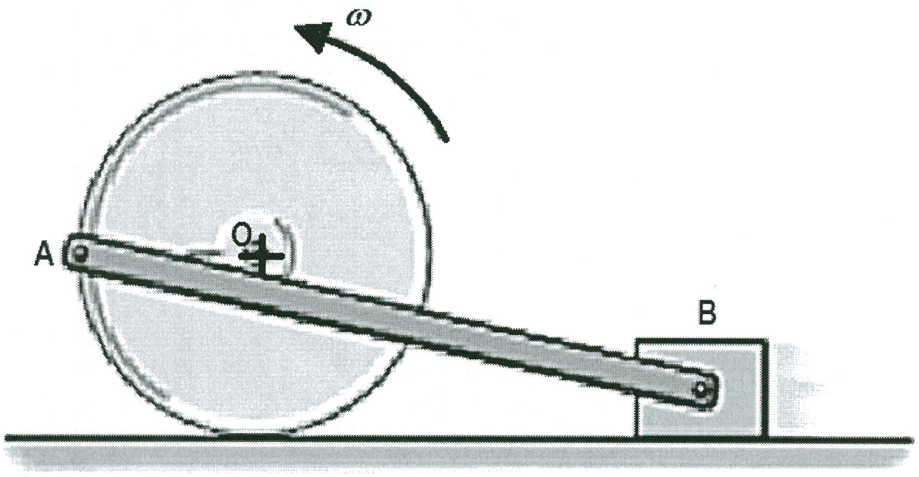

FIGURE Q4(c-ii)

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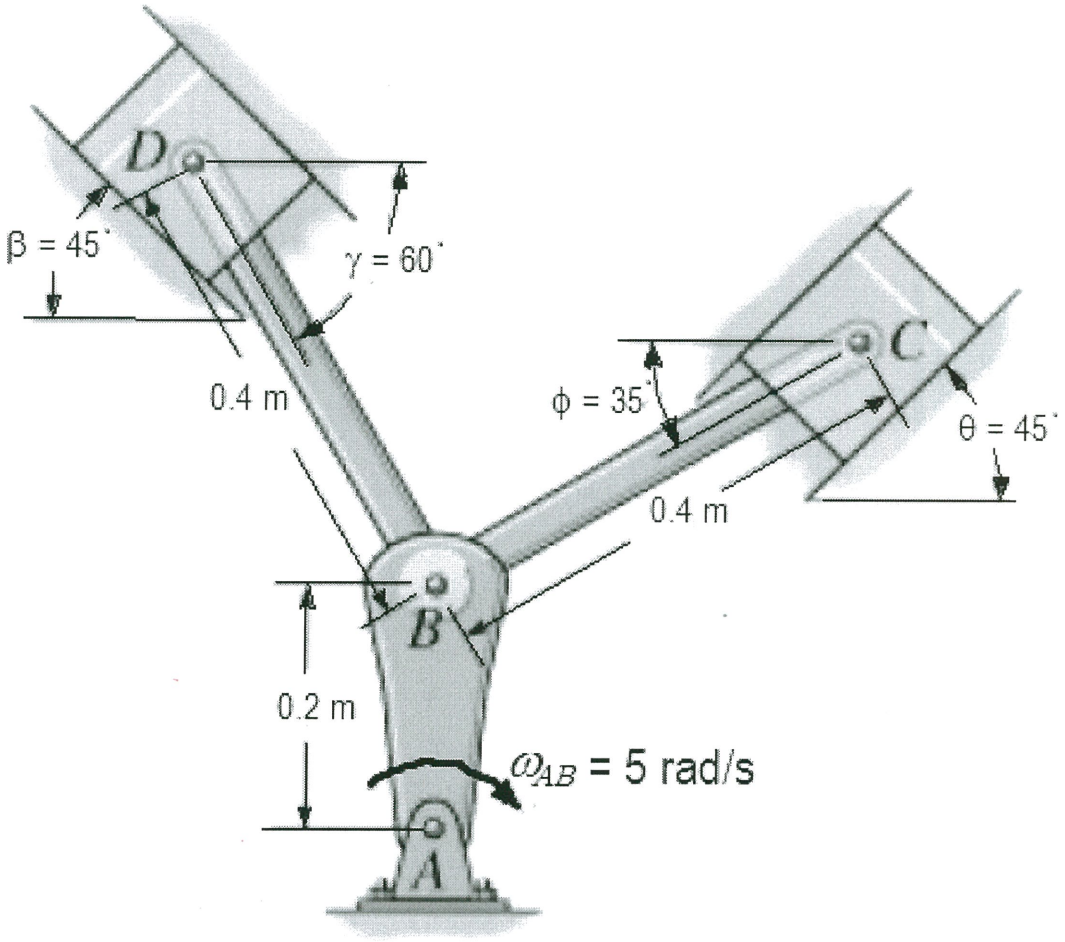

FIGURE Q4(d)

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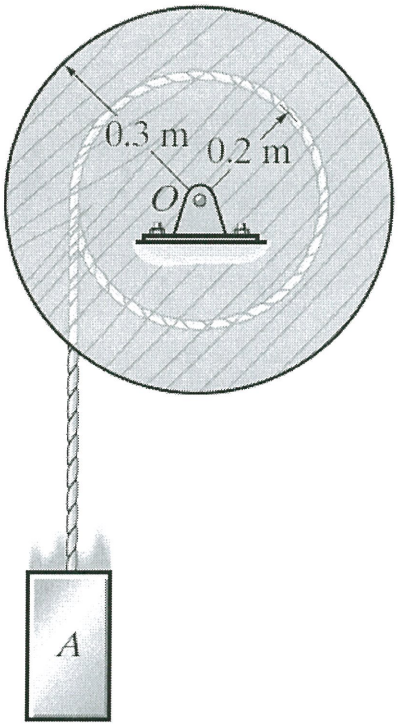

FIGURE Q5(a)

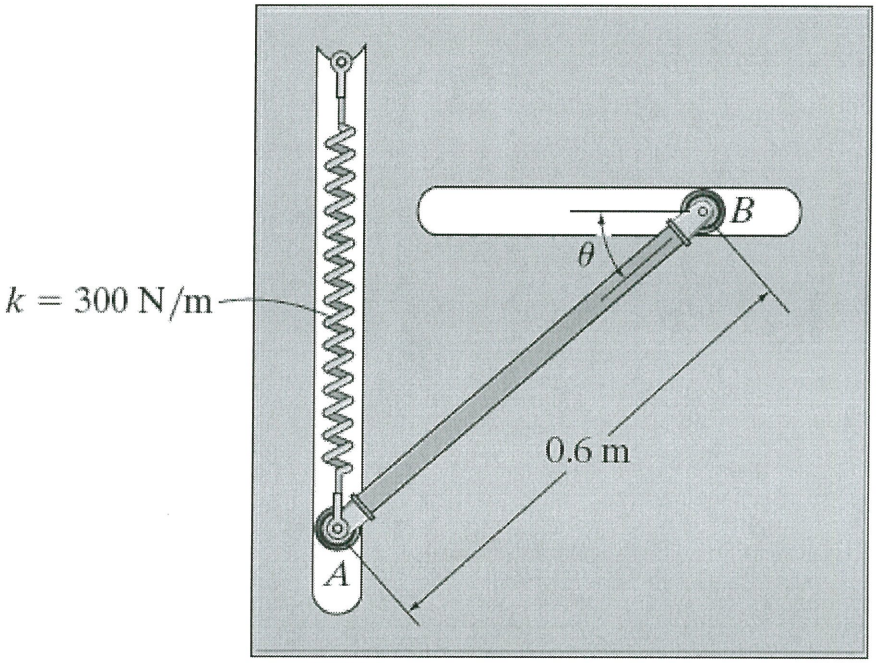

FIGURE Q5(b)