Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	DYNAMICS
COURSE CODE	:	BNJ 20103 / BNT 20103
PROGRAMME CODE	:	BNG / BNL / BNM / BNT
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) **Figure Q1 (a)** shows a ball K is thrown with an upward velocity of 7 m/s from the top of a 12 m high building. One second later ball L is thrown vertically from the ground with a velocity of 11 m/s. Ball K and ball L will pass each other at time ***T*** and certain height of ***D*** from the ground

(i) Express equation for vertical displacement of ball K from the ground
(ii) Express equation for vertical displacement of ball L
(iii) Calculate passing time ***T***
(iv) Calculate passing height ***D***

(9 marks)

(b) The initial velocity of the golf ball is 25 m/s as shown in **Figure 1Q (b)**.

(i) Express equation for horizontal distance of d_x
(ii) Express equation for vertical distance of d_y
(iii) Calculate time ***t*** from both **Q1 (b) (i)** and **Q1 (b) (ii)**
(iv) Calculate ***d*** using answer in **Q1 (b) (iii)**

(11 marks)

Q2 (a) The position of a cyclist travelling along a straight road is described as in **Figure 2Q (a)**.

(i) Construct a v-t graph for time interval of $0 < t < 20$ s
(ii) Describe information that can be extracted from graph in **Q2Q (a) (i)**

(6 marks)

(b) The spring has a stiffness k = 250 N/m and an unstretched length of 0.6 m as in **Figure Q2 (b).** It is confined by the plate and wall using cables so that its length is 0.5 m. A 1.5 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 uk = 0.2. If it strikes the plate and pushes it forward 0.1 m before stopping,

(i) Label forces of the free body diagram of block at the initial position
(ii) Calculate normal forces acted on block at the initial position
(iii) Calculate work involved on the block as it hits the plate
(iv) Apply principle of work and energy to find velocity at A, v_A, using answer in **Q2 (b) (iii)**

Neglect the mass of the plate and spring

(12 marks)

(c) (i) Give the definition of mechanical efficiency.
(ii) Describe why machine efficiency is always less than 1.

(2 marks)

Q3 (a) Forces F1 and F2 vary as shown by the graph in **Figure Q3 (a)**. Initially, a 3-kg smooth disk is travelling to the left with a speed of 3 m/s when t = 0 s. At the same time, forces F1 and F2 was acted to the disk. The duration is given $0 < t < 4$ s.

(i) Determine the impulse generated by force F1
(ii) Determine the impulse generated by force F2
(iii) Calculate the component of velocity in x-axis (v_x) using principle of impulse and answers in **Q3 (a) (i)** and **Q3 (a) (ii)**
(iv) Calculate the component of velocity in y-axis (v_y) using principle of impulse and answers in **Q3 (a) (i)** and **Q3 (a) (ii)**
(v) Determine the magnitude of the disk velocity

(9 marks)

(b) Two cars A and B was very unfortunated to involve into accident between them. The cars A and B have a mass of 1 Mg and 1.2 Mg respectively. During accident, both cars stick together while moving with a common speed of 30 km/h in the direction as in **Figure Q3 (b)**. By using conservation of linear momentum;

(i) Determine the velocity component of the cars A and B in x-axis
(ii) Calculate the velocity component of the cars A and B in y-axis
(iii) Calculate the velocities of Cars A and B using answers from **Q3 (b) (i)** and **Q3 (b) (ii)**

(8 marks)

(c) (i) When the sum of external impulses acting on a system of objects is _____, the linear impulse – momentum equation simplifies to $\Sigma m_i(v_i)_1 = \Sigma\, m_i(v_i)_2$.

(1 mark)

(ii) Identify differences between central impact and oblique impact.

(2 marks)

Q4 (a) Explain **FOUR (4)** types of planar rigid body motion with sketches.

(4 marks)

(b) A bevel gear is shown in **Figure Q4 (b)**. Gear A drives Gear B. The gears rotate about a fixed axis. If the constant angular acceleration of Gear A is 1.5 rad/s from a rest;

(i) Calculate the angular velocity of B after 3 seconds.
(ii) Calculate the angular displacement of Gear B.

Given: $r_A = 0.05$ m and $r_B = 0.15$ m

(6 marks)

(c) **Figure Q4 (c)** shows a simple piston system. Using the method of relative motion analysis, calculate the velocity of the piston C, if the angular velocity, ω_{AB} was 4 rad/s.

Given: $\theta = 60°$, $\Phi = 45°$, $a = 0.3$m, $b = 0.125$m

(10 marks)

Q5 (a) Explain the mass moment of inertia inclusive of its' equation.

(3 marks)

(b) **Figure Q5 (b)** shows a box sliding down an inclined plane. The dimensions of the box are given in **Figure Q5 (b)**. The weight of the box is 500N. The inclined plane has an angle of $\theta = 30°$. The coefficient of friction between the box and plane is 0.75.

(i) Draw the free body diagram (FBD) and kinetic diagram of the box.
(ii) Calculate the box's normal force and frictional force acting on the box and then determine if the box will tip or slide.
(iii) Calculate the moment of inertia at the point A by applying parallel axis theorem.
(iv) Calculate the acceleration (if slide) **OR** the angular acceleration (if tip) of the box down the inclined plane.

(10 marks)

(c) Explain the kinetic energy of a rigid body inclusive of its' equation.

(3 marks)

(d) **Figure Q5 (d)** shows a disc rolls on a frictionless surface. The disc has a counterclockwise angular velocity of 4 rad/s and its' center has velocity 0.5 m/s. Calculate the sum of its' kinetic energy if the mass of the disc is 20 kg, the radius of the disc is 0.5 m.

(4 marks)

-END OF QUESTIONS –

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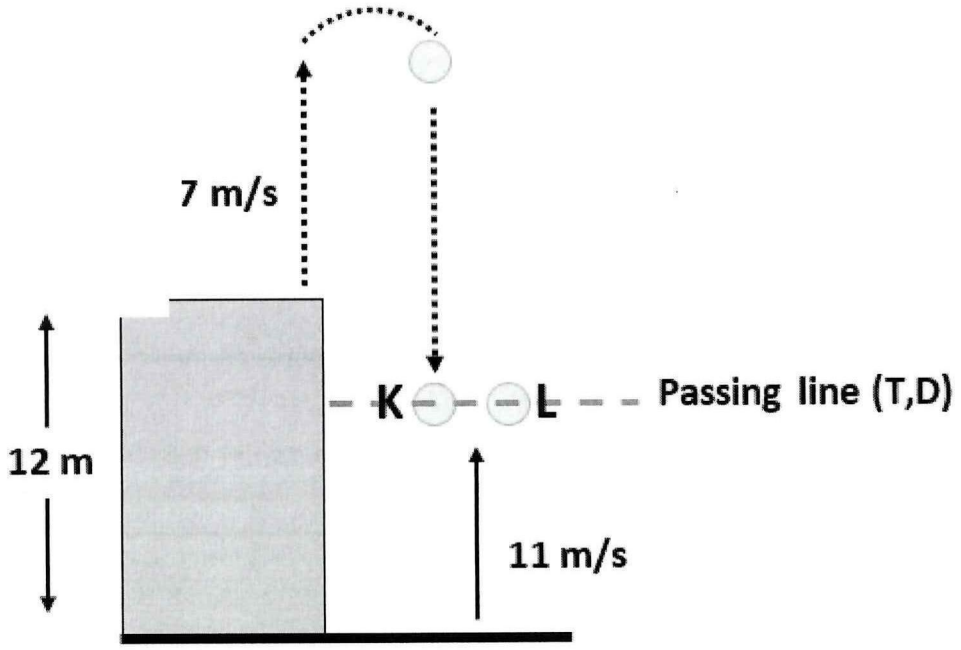

Figure Q1 (a)

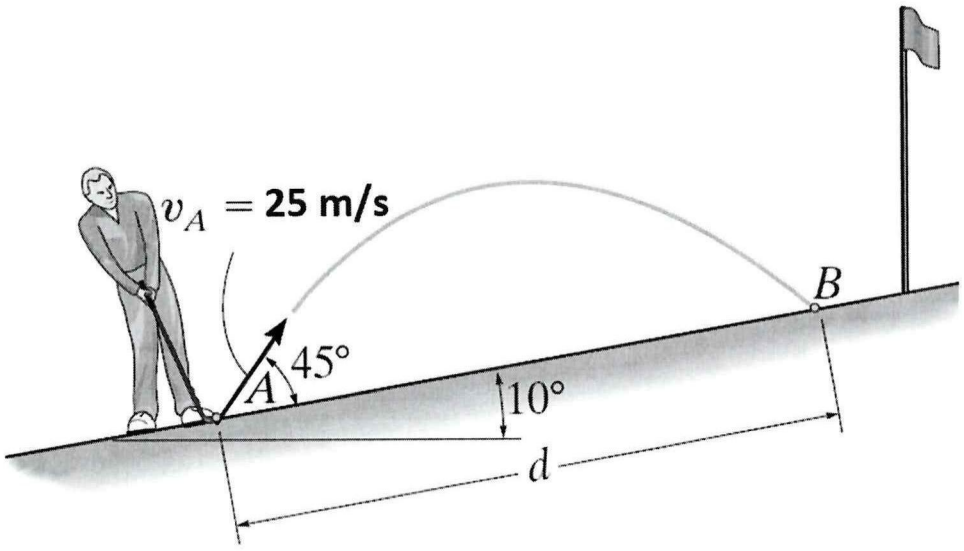

Figure Q1 (b)

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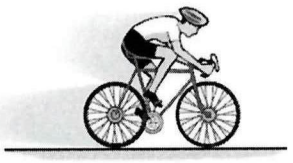

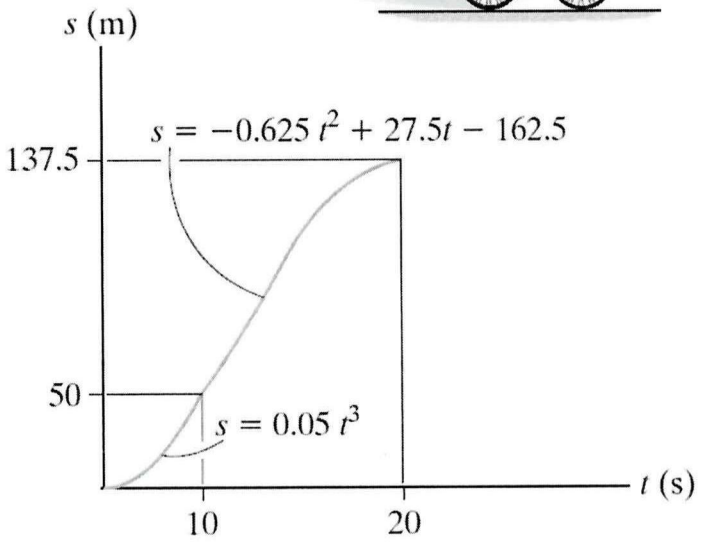

Figure Q2 (a)

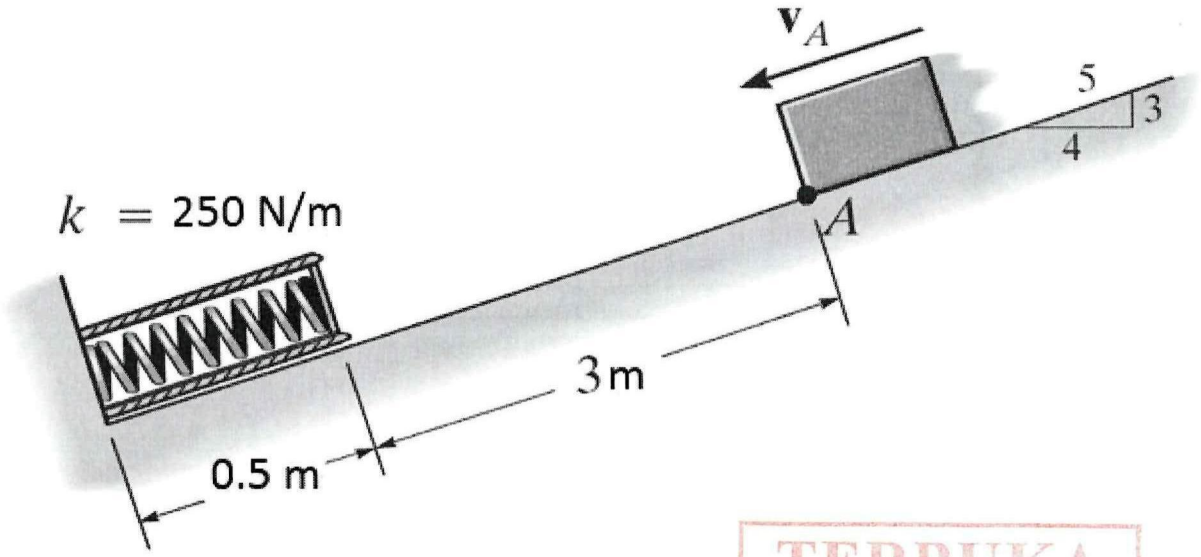

Figure Q2 (b)

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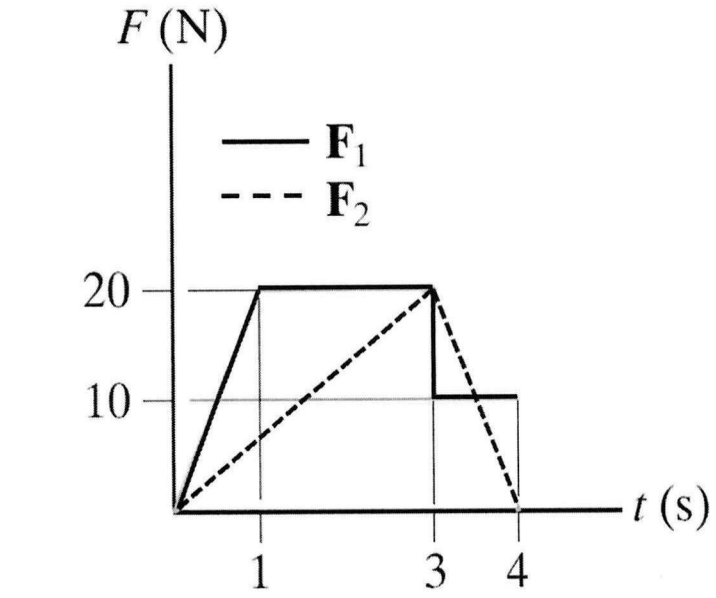

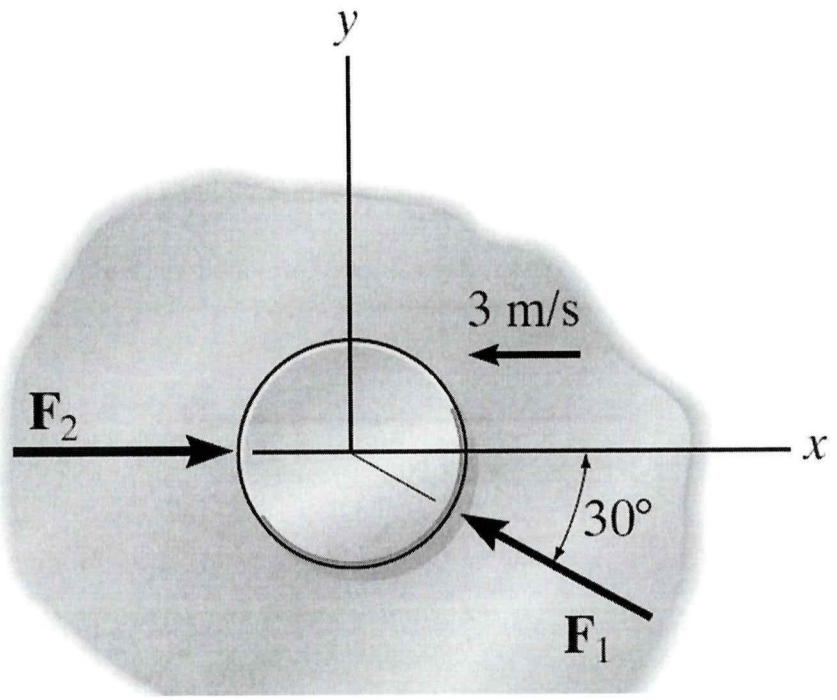

Figure Q3 (a)

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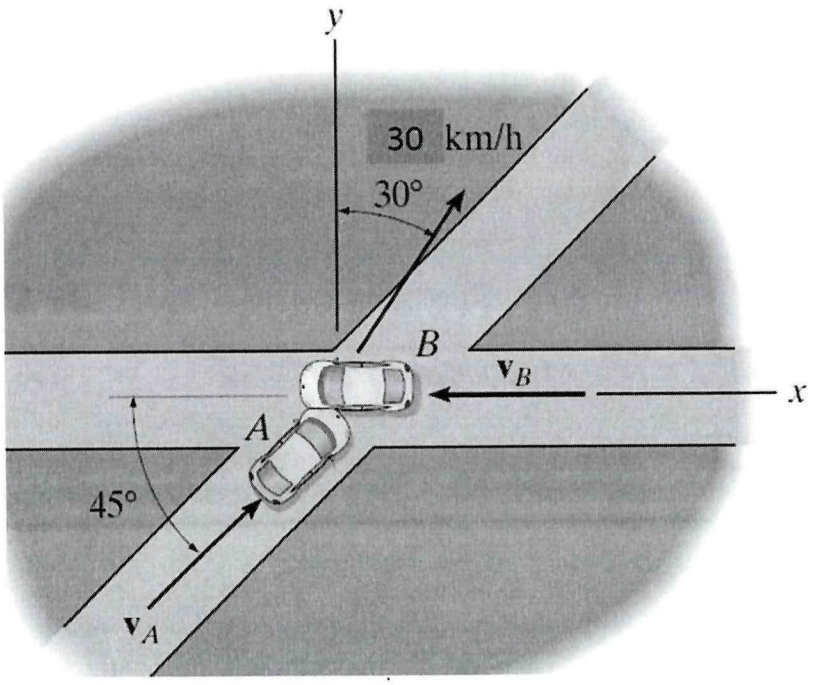

Figure Q3 (b)

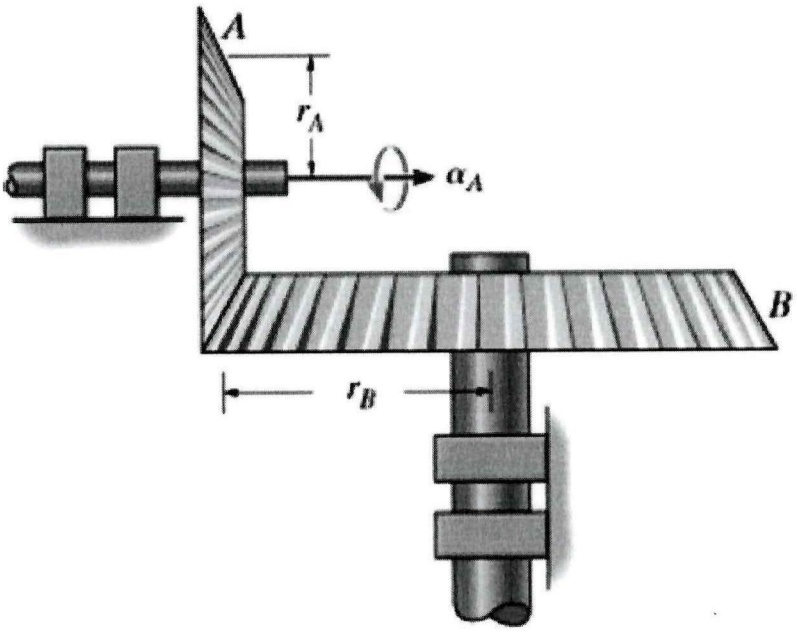

Figure Q4 (b)

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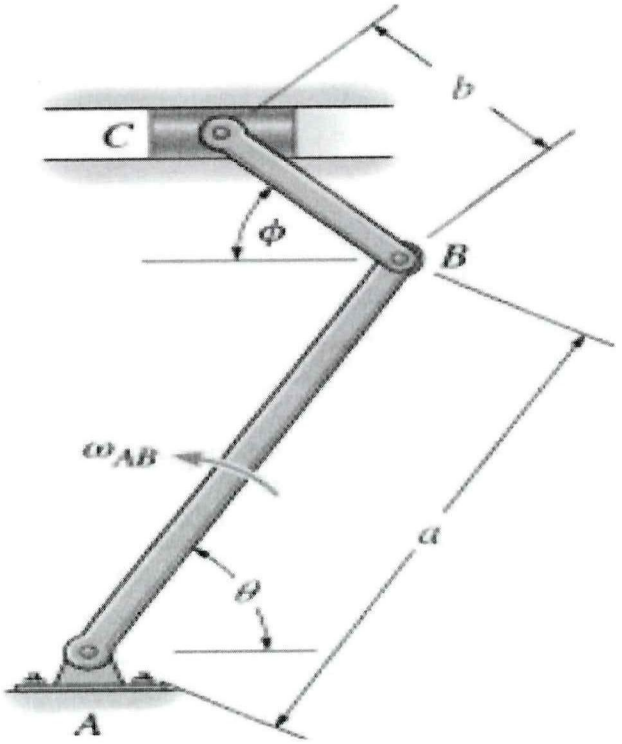

Figure Q4 (c)

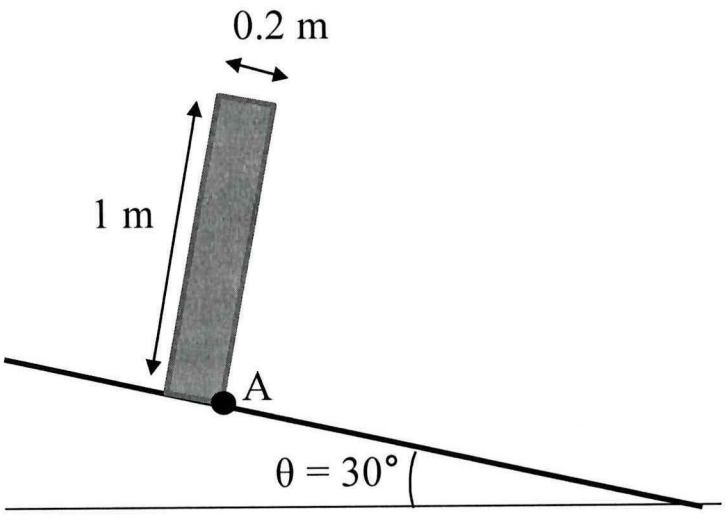

Figure Q5 (b)

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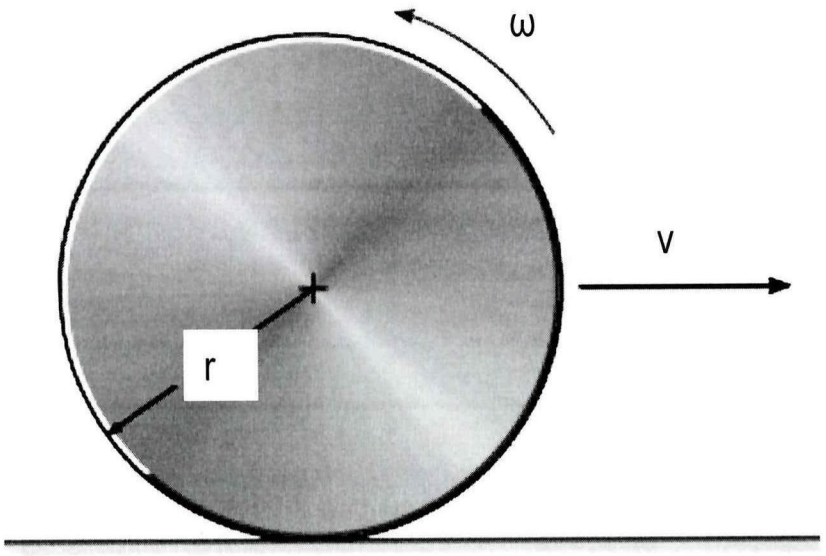

Figure Q5 (d)