Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	DYNAMICS
COURSE CODE	:	BNJ 20103 & BNT 20103
PROGRAMME CODE	:	BNG / BNM / BNT
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS.
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **OPEN BOOK.**
		3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) A train journey, which starts from station A and ends at station B is divided into 3 stages. In stage 1, the train starts from rest at station A and accelerates at 0.5 m/s^2 for 60 s. Afterwards in stage 2, it travels at a constant velocity for 15 min. Then in stage 3, it then decelerates at 1 m/s^2 until it is brought to rest at station B. *(Bear in mind the train travels continuously form station A to station B)*

(i) Determine the train speed at the end of Stage 1.

(1 mark)

(ii) Calculate the train's distance travel in Stage 1.

(1 mark)

(iii) Calculate the train's distance travel in Stage 2.

(2 mark)

(iv) Determine the total distance travelled by the train from station A to station B.

(3 marks)

(b) Starting from rest, a bicyclist travels around a horizontal circular path, $\rho = 10$ m, at a speed of $v = (0.09t^2 + 0.1t)$ m/s, where t is in seconds. When the bicyclist has traveled $s = 3\ m$,

(i) calculate time taken for the bicyclist to travel to distance $s = 3\ m$.

(4 marks)

(ii) Determine the magnitudes of acceleration of the bicyclist.

(7 marks)

(c) A helicopter in **Figure Q1 (c)** is flying with a constant horizontal velocity of 180 km/h and is directly above point A when a loose part begins to fall. The part lands 6.5 s later at point B on an inclined surface. Examine the initial height h, where the loose part starts to fall until it reaches point B.

(7 marks)

Q2 (a) A section of track for a roller coaster in **Figure Q2 (a)** consists of two circular arcs *AB* and *CD* joined by a straight portion *BC*. The radius of *AB* is 27 m and the radius of *CD* is 72 m. The car and its occupants, of total mass 250 kg, reach point *A* with practically no velocity ($v_A = 0\ m/s$) and then drop freely along the track. Ignore air resistance and rolling resistance. By using conservation of energy theorem,

(i) outline free body diagram complete with Newton's second law of the car at point *B*, then,

(3 marks)

(ii) analyze the car at point *B* and identify the normal force exerted by the track on the car.

(12 marks)

(b) A smooth can *C* in **Figure Q2 (b)**, having a mass of 3 kg, is lifted from a feed at *A* to a ramp at *B* by a rotating rod, which maintains a constant angular velocity of $\dot{\theta} = 0.5\ rad/s$. The ramp from *A* to *B* is circular, having a radius of 600 mm. Neglect the effects of friction in the calculation and the size of the can so that $r = 1.2\cos\theta$ m. At the instant $\theta = 30°$,

(i) calculate radial acceleration a_r and transverse acceleration a_θ of object can *C*, and

(5 marks)

(ii) determine the forces which the rod exerts on the can.

(5 marks)

Hint: use the formula given:

$r = 1.2\cos\theta$

$\dot{r} = -1.2\sin\theta\,\dot{\theta}$

$\ddot{r} = -1.2\cos\theta\,\dot{\theta}^2 - 1.2\sin\theta\,\ddot{\theta}$

Q3 (a) **Figure Q3 (a)** shows an unfortunate collision of 2 cars. Car *A* has a mass of 1000 kg and was moving at 50 km/hr. Car *B* weighs 1200 kg and was moving at 60 km/hr. The coefficient of restitution is $e = 0.4$. Find the velocities and directions of both cars after the collision.

(10 marks)

(b) Explain the difference between kinematics of rigid bodies and kinetics of rigid body by:

(i) their definitions,

(1 mark)

(ii) giving **ONE (1)** example each, and

(1 mark)

(iii) drawing the free body diagrams and kinetic diagrams of your examples in **Q3 (b) (ii)**.

(1 mark)

(c) A rod connects slider *A* and slider *B* has a length of 5 meters. The motion of *A* and *B* are confined as shown in **Figure Q3 (c)**. Given $\theta = 60°$. At this instant V_A is 2 m/s. Calculate the angular velocity magnitude and rotation direction of the rod by using:

(i) absolute motion analysis,

(3 marks)

(ii) relative motion analysis, and

(5 marks)

(iii) instantaneous center of zero velocity.

(4 marks)

Q4 (a) **Figure Q4 (a)** shows motor *A*, load *B*, pulley *C* and pulley *D*. Pulley *C* and *D* are fixed together. Motor *A* drives pulley *C* through a non-slip belt. The displacement of load *B* is given, *s*, as shown in **Figure Q4 (a)**. If the motor rotates with an angular acceleration, $\alpha_A = 5$ rad/s^2, determine the time, magnitudes of the velocity and acceleration of load B after pulley *D* has turned one revolution, with motor initial angular velocity 0.5 rad/s. Given r_A = 5cm, r_C = 15cm and r_D = 7.5cm.

(10 marks)

(b) **Figure Q4 (b)** shows a tall box on an inclination of the plane. Given the coefficient of static friction is, μ_s, is 0.75, the weight of the box is 500 N, width, w = 0.2 m and height, h = 1.0 m, θ = 30°.

(i) Calculate the box's reaction force and frictional force acting on the box. Hint: Draw the free body diagram (FBD) and kinetic diagram of the box.

(4 marks)

(ii) Determine if the box will slide.

(2 marks)

(iii) Determine if the box will tip.

(3 marks)

(iv) Give the equations for mass moment of inertia for rectangular plate. Then, give the parallel axis theorem.

(2 marks)

(v) Calculate the mass moment of inertia for the box at point G and point A.

(2 marks)

(vi) Calculate the the acceleration (if slide) **OR** the angular acceleration (if tip) of the box down the inclined plane.

(2 marks)

END OF QUESTIONS

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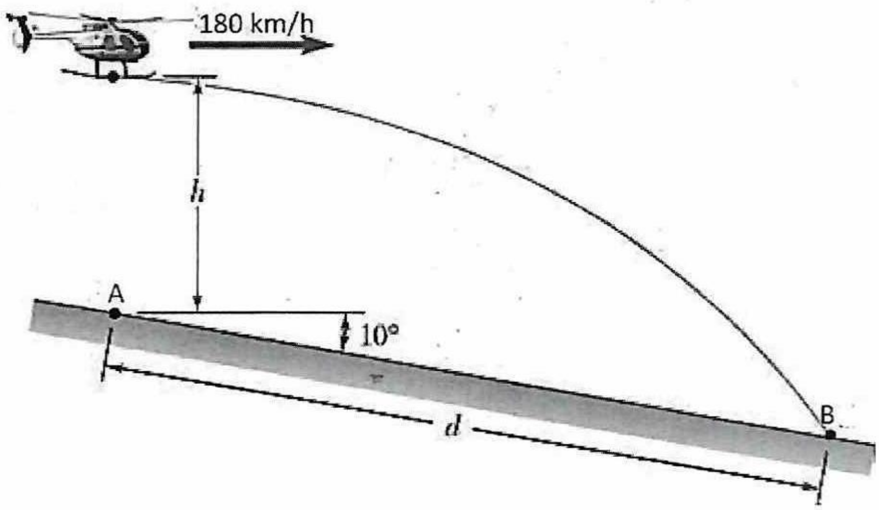

Figure Q1 (c)

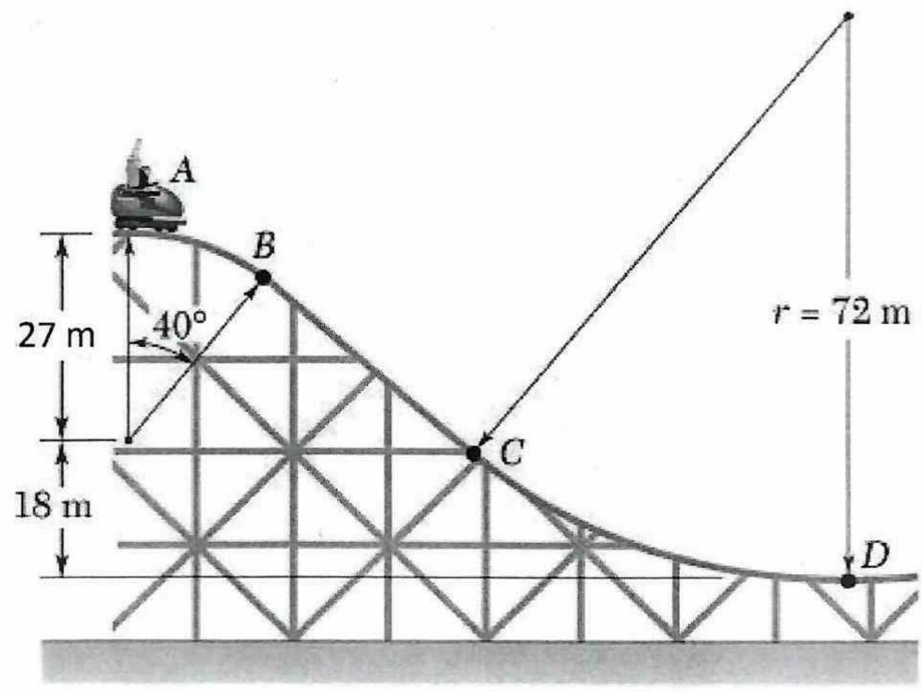

Figure Q2 (a)

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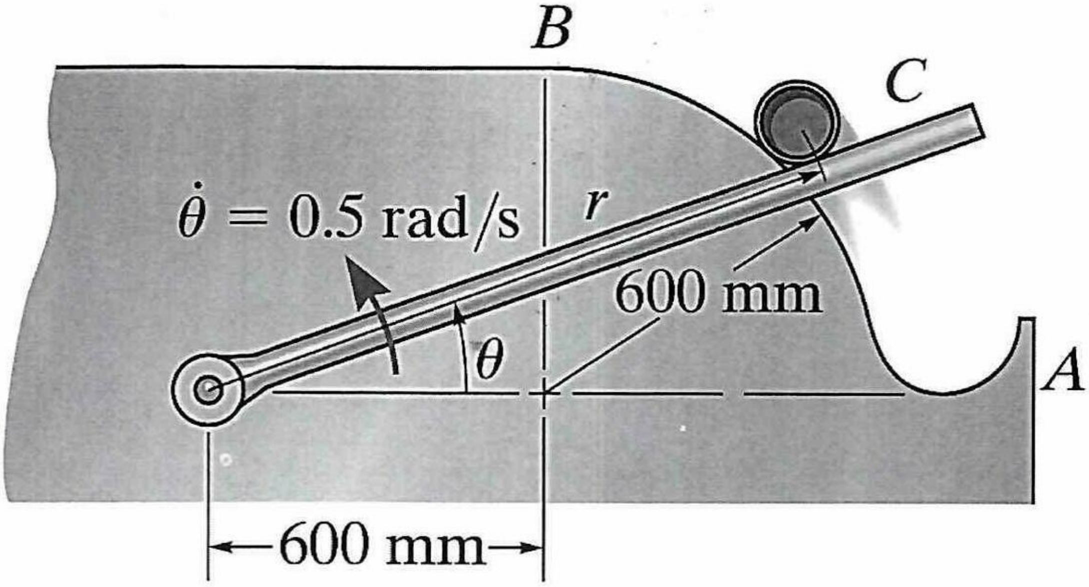

Figure Q2 (b)

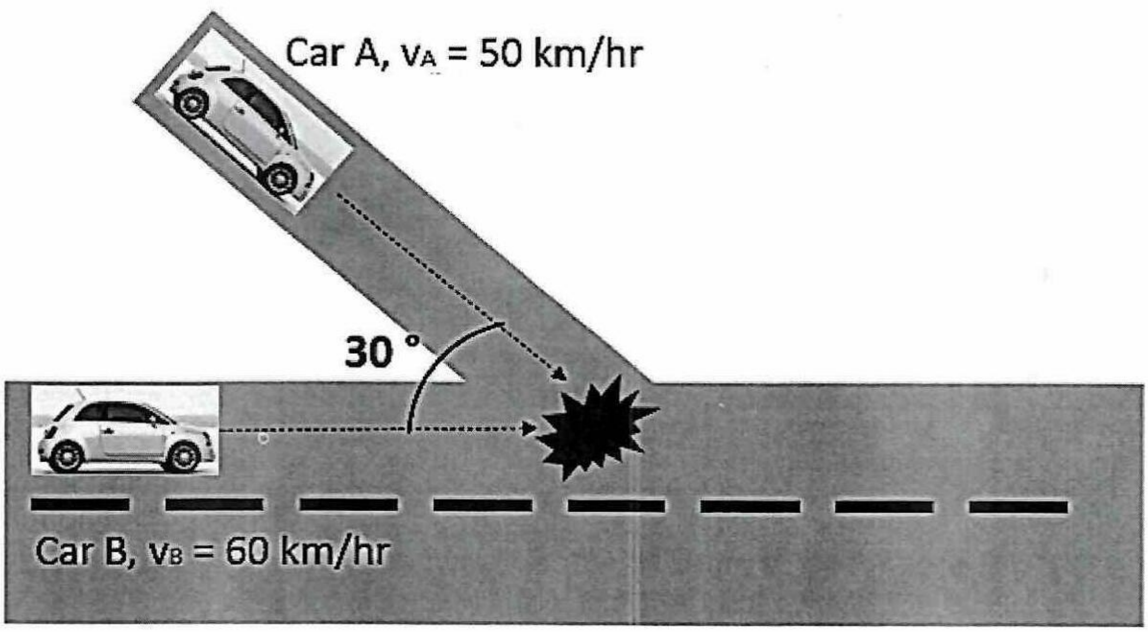

Figure Q3 (a)

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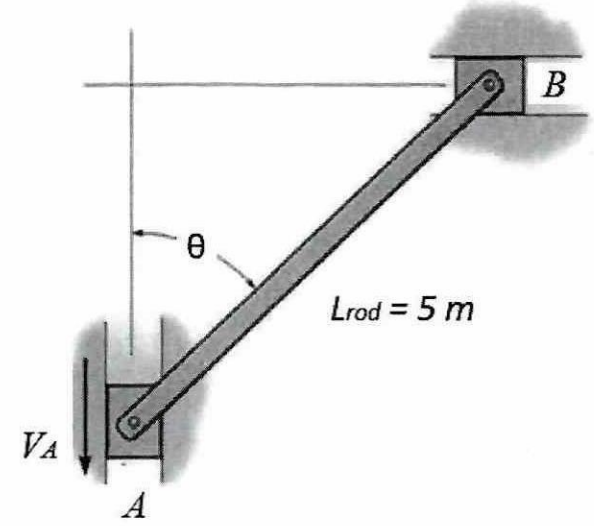

Figure Q3 (c)

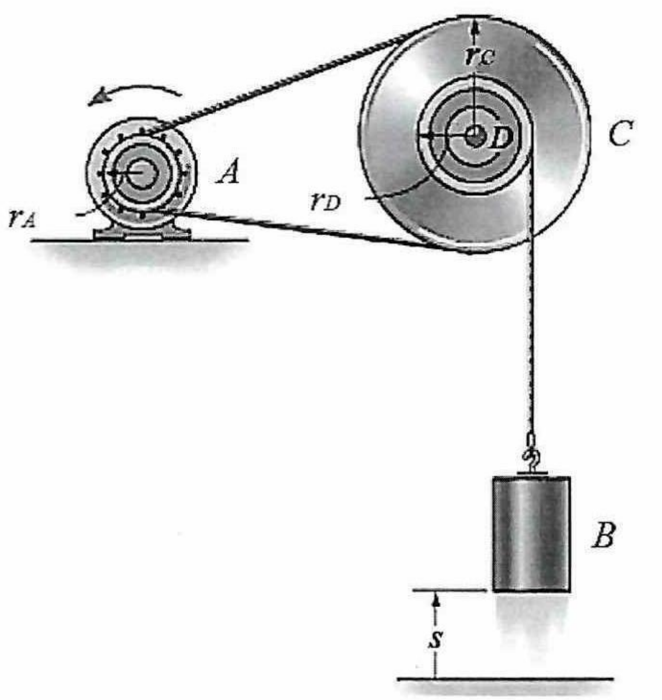

Figure Q4 (a)

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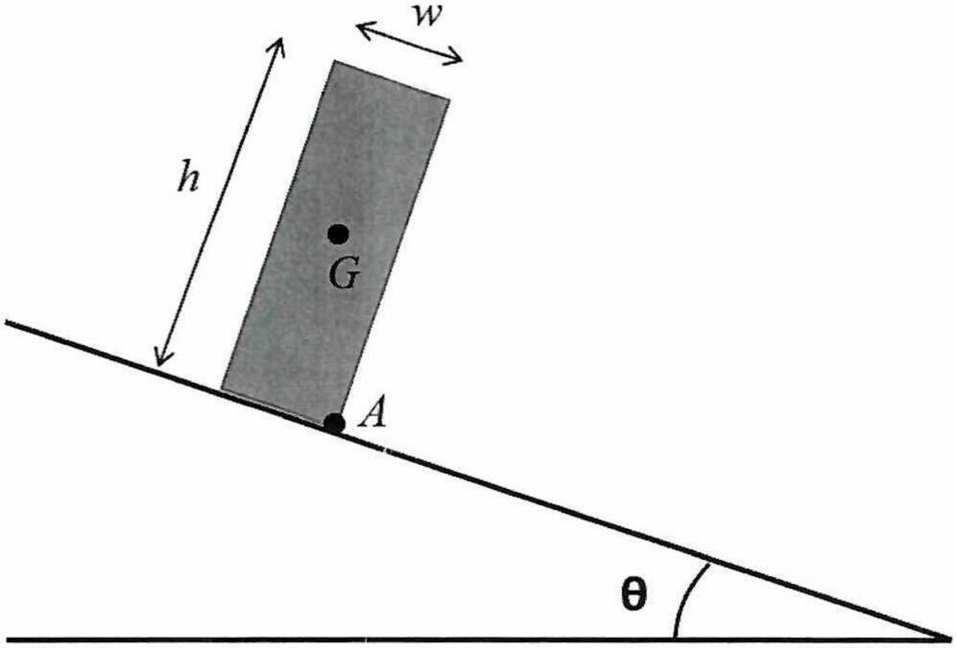

Figure Q4 (b)