CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
SEPTEMBER 2016 SEMESTER

COURSE CODE	:	LGB 10203
COURSE NAME	:	ENGINEERING SCIENCE
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	BACHELOR
DATE	:	19 JANUARY 2017
TIME	:	9.00 am – 12.00 pm
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. Answer only FOUR (4) questions.
4. Please write your answers in the answer booklet provided.
5. Answer all questions in English language ONLY.
6. Table of formulae has been appended for your reference.

THERE ARE 9 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

INSTRUCTION: Answer only FOUR (4) questions.
Please use the answer booklet provided.

Question 1

An object is moving along the *x* - axis according to the velocity - time graph in Figure 1.

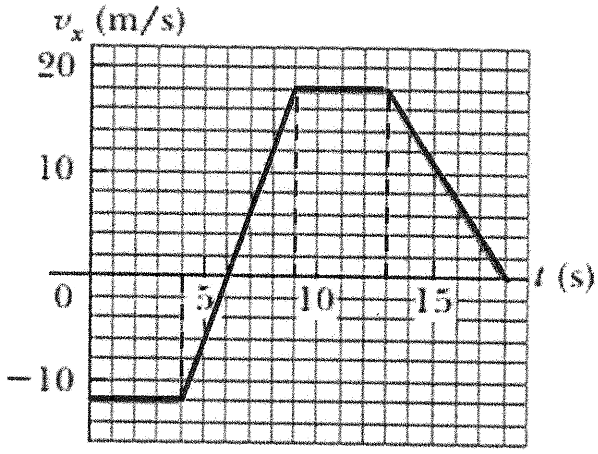


Figure 1 : Velocity – time graph

(a) Sketch a displacement – time graph for the object from $t = 0$ to $t = 18$ s.
*(**Show all the calculation involved)*

(10 marks)

(b) Sketch a graph of acceleration versus time for the entire motion.
*(**Show all the calculation involved)*

(9 marks)

(c) Determine the total distance the object moved between $t = 0$ to $t = 18$ s.

(3 marks)

(d) Calculate the average speed of the object.

(3 marks)

Question 2

(a) State Newton's First Law and Newton's Second Law of motion.

(6 marks)

(b) Steel block, m_1 = 8 kg and copper block, m_2 = 6 kg connected by a light string passing over a smooth pulley. Block m_1 rest on a horizontal plane with coefficient of friction of 0.23, while m_2 lie on the rough plane that is inclined at 30° angle. When the system is released, both objects will accelerate in the direction as shown in Figure 2.

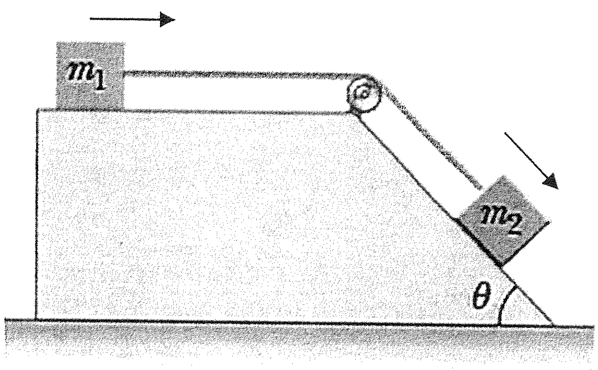


Figure 2 : A pulley system

i. Calculate the coefficient of friction between block m_2 and the inclined plane if the frictional force for m_2 is 10 N.

(5 marks)

ii. Determine the tensional force in the string and the acceleration of both objects.

(14 marks)

Question 3

(a) A cylinder of radius r and mass m rolls on a floor without slipping with an initial speed of 2.5 m/s. The cylinder then rolls up an inclined plane as in Figure 3. Assume it rolls smoothly and that frictional energy losses are negligible.

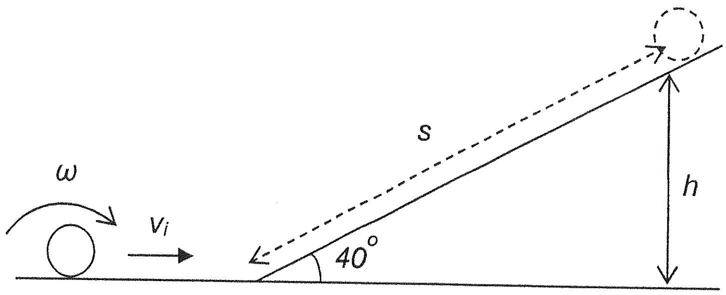


Figure 3 : A cylinder rolls up an inclined plane

i. Determine the maximum height, h reach by the cylinder.

(5 marks)

ii. If the inclination angle of the plane is 40°, calculate the time taken for the cylinder to roll down the plane from the height, h. Assume the cylinder has the same speed (2.5 m/s) as it reaches the bottom of the plane.

(7 marks)

(b) Figure 4 shows a uniform disk (M = 3 kg) with a radius 15 cm mounted on a fixed horizontal axle. A load, m of 2 kg hangs from a massless cord wrapped around the disk. Compute the linear acceleration of the system and angular acceleration of the disk when the system is released.

(13 marks)

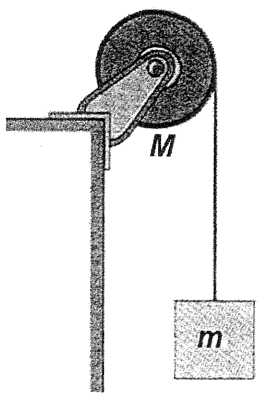


Figure 4 : A load suspended from a disc

Question 4

(a) Differentiate between free oscillation and forced oscillation.

(4 marks)

(b) i. Describe damped harmonic motion.

(4 marks)

ii. Using $x - t$ graph, explain critical damping and overdamping.

(6 marks)

(c) The displacement, x of particle undergoing simple harmonic motion is given by :

$$x = 18\, sin\ (10\pi\, t + \frac{\pi}{2})$$

Where x and t are in unit centimeter and second.

i. Calculate the time taken for the particle to perform 20 complete oscillations.

(4 marks)

ii. Determine the magnitude of velocity and acceleration when the particle is 10 cm from the equilibrium position.

(4 marks)

iii. Calculate the displacement at $t = 5$ s.

(3 marks)

Question 5

(a) Hydraulic lift works according to Pascal's Principle. Describe Pascal's Principle using hydraulic lift as an example.

(5 marks)

(b) Explain the concept of Buoyancy and the Archimedes' Principle.

(5 marks)

(c) The gravitational force exerted on a solid object is 5 N as in Figure 5a. When the object is suspended from a spring scale and submerged in water (Figure 5b), the scale reads 3.5 N. (The density of water = 1000 kg/m^3)

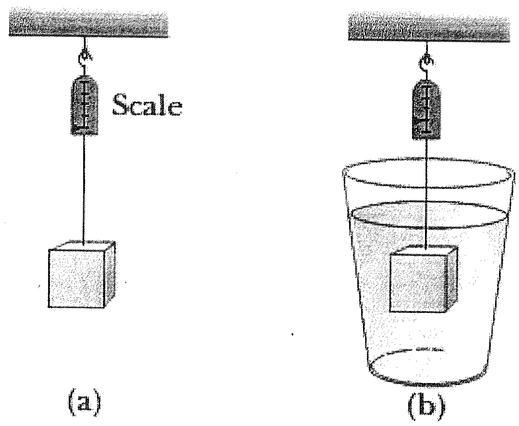


Figure 5 : Object suspended from a spring scale

i. Determine the tensional force of the spring scale when the object is immersed in water.

(6 marks)

ii. Calculate the volume displacement of the water.

(3 marks)

iii. Compute the specific gravity (SG) of the object.

(6 marks)

Question 6

(a) Using *P–V* graph, describe adiabatic process and show how to obtain the work done by the gas using the First Law of Thermodynamics.

(7 marks)

(b) Two (2) moles of Helium gas initially at 300 K and 0.4 atm is compressed isothermally to 1.2 atm. If the Helium behaves like an ideal gas, compute :

i. the final volume of the gas

(8 marks)

ii. heat lost during compression

(5 marks)

(c) A Carnot Engine operates between 235°C and 115°C absorbing 6.3×10^4 J per cycle at the higher temperature.

i. Determine the efficiency of the engine.

ii. Calculate the work that the engine capable to perform.

(5 marks)

END OF EXAMINATION PAPER

APPENDIX

1. TABLE OF FORMULAE

$v = u + at$	$s = ut + \frac{1}{2}at^2$	$v^2 = u^2 + 2as$
$F = ma$	$F_f = \mu F_N$	$W = mg$
$\omega = \omega_0 + \alpha t$	$\omega^2 = \omega_0{}^2 + 2\alpha\theta$	$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
$s = r\,\theta$	$v = \mathrm{r}\omega$	$a = \mathrm{r}\alpha$
$\tau = F\,x\,d$	$\tau = I\alpha$	$PE = mgh$
$KE_T = \frac{1}{2}mv^2$	$KE_R = \frac{1}{2}I\omega^2$	$f = \frac{1}{T}$
$\omega = 2\pi\,f$	$v = \omega\sqrt{x_o^2 - x^2}$	$a = \omega^2 x$
$\rho = \frac{m}{V}$	$F_B = \rho_f V_f g$	$Q = mc\Delta T$
$\Delta U = Q - W$	$W = P\Delta V$	$W = nRT\ln(\frac{V_f}{V_i})$
$\Delta U = \frac{3}{2}nR(T_f - T_i)$	$Q_H = W + Q_L$	$e = \frac{W}{Q_H}$

2. CONSTANT VALUES:

Gravitational acceleration, g = 9.81 m/s^2

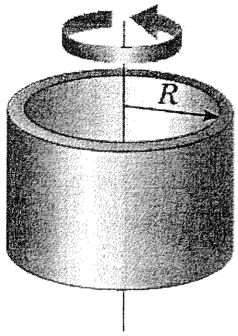
Universal gas constant, R = 8.314 J/mol.K

Standard Temperature Pressure, STP conditions: P = 1 atm = 1.013 x 10^5 Pa
T = 273 K

3. MOMENT OF INERTIA OF HOMOGENEOUS RIGID OBJECT

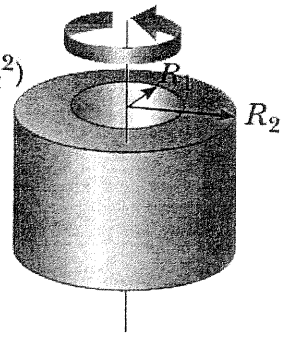
Hoop or thin cylindrical shell

$I_{CM} = MR^2$



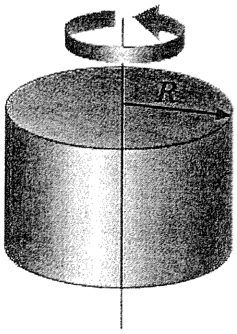
Hollow cylinder

$I_{CM} = \frac{1}{2}M(R_1^2 + R_2^2)$



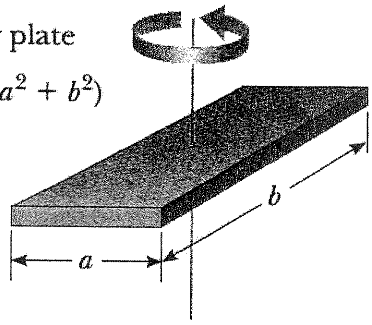
Solid cylinder or disk

$I_{CM} = \frac{1}{2}MR^2$



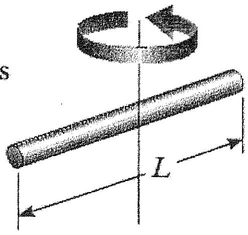
Rectangular plate

$I_{CM} = \frac{1}{12}M(a^2 + b^2)$



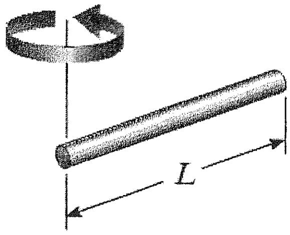
Long, thin rod with rotation axis through center

$I_{CM} = \frac{1}{12}ML^2$



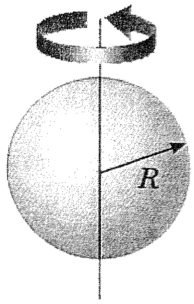
Long, thin rod with rotation axis through end

$I = \frac{1}{3}ML^2$



Solid sphere

$I_{CM} = \frac{2}{5}MR^2$



Thin spherical shell

$I_{CM} = \frac{2}{3}MR^2$