

Mid-Semester Test (30% CA)

Name : _____

Adm. No. : _____

Class : _____

Class S/N : _____

Date : _____

Time allowed : 1 hour

Maximum mark : 100

Instructions

Answer all 4 questions. Take $g = 9.80 \text{ m/s}^2$.

This question paper consists of 3 printed pages including 1 page of formulae.

You are reminded that cheating during this test is a serious offence.

All working in support of your answer must be shown. Answers must be to appropriate significant figures.

1. a) From an experiment, a formula $t = k\sqrt{\frac{ml^3}{a}}$ is established where t , m , l and a are time, mass, distance and acceleration respectively. Find the dimension of the quantity k . What is the SI unit of k ?
- b) Find the cross product of $\mathbf{A} = (2\mathbf{i} + 3\mathbf{j} + 4\mathbf{k})$ and $\mathbf{B} = (4\mathbf{i} + 6\mathbf{j})$.
- c) Find the angle between the two vectors \mathbf{A} and \mathbf{B} in 1 (b).

(25 marks)

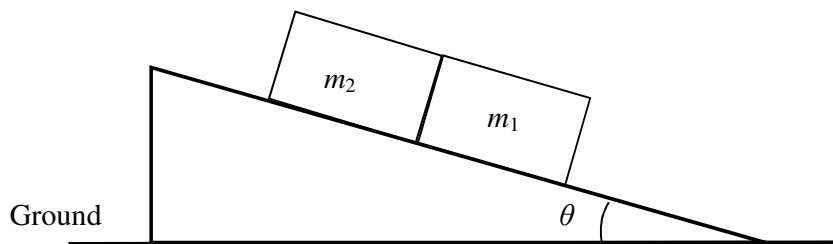
2. A rocket is accelerated from rest at 5 m/s^2 vertically for 5 seconds before it accelerates at 2 m/s^2 for another 5 seconds.
- a) What is the total vertical distance travelled in 10 seconds?
- b) Sketch the velocity-time graph of the rocket for the first 10 seconds.
- c) If at the end of the second acceleration, the engine is turned off, how long will it take for the rocket to return to the launch pad, i.e. count from the time the engine is turned off?

(25 marks)

3. An object moves at 10 m/s in a direction 60° north of west.
- Draw the velocity vector, clearly labelling the directions N, S, E and W.
 - Calculate the velocities in the direction of north and west respectively?
 - How long does it take to go 1000 m west?
 - By the time it is 1000 m west, what is the total distance it has travelled?

(25 marks)

4. There are two objects of masses m_1 and m_2 that are touching each other on an inclined plane as shown in the figure. The coefficient of friction between m_1 and the inclined plane is μ_1 while there is no friction between m_2 and the inclined plane.
- Draw the free body diagram of the objects.
 - Find the interaction force between the two objects.
 - Find the minimum angle at which the objects start sliding.
 - If there is a friction between m_2 and the inclined plane, how would it affect the interaction force and the acceleration of the objects? Explain without giving numerical answer to this question.



(25 marks)

***** End of Paper *****

Formula sheet

Name: _____ Admin. No.: _____ Seat No.: _____

<p><u>Kinematics</u></p> $v_x = v_{0x} + a_x t$ $v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$ $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$ $\vec{v} = \frac{d\vec{r}}{dt}, \quad \vec{a} = \frac{d\vec{v}}{dt}$ $y = (\tan \theta)x - \left(\frac{g}{2v^2 \cos^2 \theta}\right)x^2$ $R = \frac{v^2 \sin 2\theta}{g}$ <p><u>Dynamics</u></p> $\vec{F} = m \frac{d\vec{v}}{dt} = m\vec{a}, F = \mu N$ $a = \frac{dv}{dt}, a = \frac{v^2}{r}, F = m \frac{v^2}{r}$ $\vec{J} = \int \vec{F} dt = \Delta \vec{p}$ $W = \int \vec{F} \cdot d\vec{r}, W_{net} = K_f - K_i$ $KE = \frac{1}{2}mv^2, PE = mgh$ $P = \frac{W}{t}, P = \frac{dW}{dt}$ <p><u>Linear momentum</u></p> $m_1 \vec{u}_1 + m_2 \vec{u}_2 = m_1 \vec{v}_1 + m_2 \vec{v}_2$ <p><u>Static electricity</u></p> $F = k \frac{q_1 q_2}{r^2}, k = \frac{1}{4\pi\epsilon_0}$ $F = qE$ $V = k \frac{q}{r}, U = qV$ $\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0}$ $V = Ed, W = qV, E = \frac{kq}{r^2}$	<p><u>Current electricity</u></p> $Q = It \quad V = IR$ $P = VI = I^2 R = \frac{V^2}{R}$ <p><u>Magnetism & electromagnetism</u></p> $\vec{F} = q\vec{v} \times \vec{B} \quad \vec{F} = i\vec{L} \times \vec{B}$ $e.m.f. = -N \frac{d\Phi_B}{dt} \quad \Phi_B = BA$ <p><u>Thermodynamics</u></p> $\Delta U = Q - W$ $W = \int p dV$ $Q_V = nC_V \Delta T \quad \text{const vol}$ $Q_p = nC_p \Delta T \quad \text{const pressure}$ $Q = mC \Delta T$ $Q = mL$ <p><u>Ideal Gas</u></p> $pV = nRT$ $pV^\gamma = c \text{ (adiabatic)}$ $\gamma = \frac{C_p}{C_v}, C_p - C_v = R$ $W = pV \ln \frac{V_2}{V_1} = nRT \ln \frac{V_2}{V_1}$ $W = \frac{1}{\gamma - 1} (p_1 V_1 - p_2 V_2)$ <p><u>Rotational Motion</u></p> $\omega = \frac{d\theta}{dt}, \quad \alpha = \frac{d\omega}{dt}$ $\omega = \omega_0 + \alpha t$ $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ $I = \sum_i m_i r_i^2, I = \int r^2 dm, K = \frac{1}{2} I \omega^2$	<p><u>SHM & waves</u></p> $T = \frac{1}{f} \quad v = f\lambda \quad \omega = 2\pi f$ $\omega = \frac{2\pi}{T} \quad k = \frac{2\pi}{\lambda}$ $\omega = \sqrt{k/m} \quad \omega = \sqrt{g/L}$ $x = A \cos(\omega t + \phi)$ $x = A \sin(\omega t + \phi)$ $y(x, t) = A \cos(\omega t \pm kx)$ $y(x, t) = A \sin(\omega t \pm kx)$ $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}$ <p><u>Circuits</u></p> $R = R_1 + R_2 + R_3 + \dots \quad \text{series}$ $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \quad \text{parallel}$ $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots \quad \text{series}$ $C = C_1 + C_2 + C_3 + \dots \quad \text{parallel}$ $Q = CV \quad U = \frac{1}{2} CV^2$ <p><u>Constants</u></p> <p>Charge on electron</p> $e = -1.60 \times 10^{-19} \text{ C}$ <p>Coulomb's constant</p> $k = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$ <p>Ideal gas constant</p> $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ <p>Mass of proton</p> $m_p = 1.67 \times 10^{-27} \text{ kg}$ <p>Mass of electron</p> $m_e = 9.11 \times 10^{-31} \text{ kg}$ <p>Permeability of free space</p> $\mu_0 = 4\pi \times 10^{-7} \text{ N A}^{-2}$ <p>Permittivity of free space</p> $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$ <p>Speed of light in vacuum</p> $c = 3.00 \times 10^8 \text{ m s}^{-1}$
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