

**Mid-Semester Test (30% CA)**

Name : \_\_\_\_\_

Adm No : \_\_\_\_\_

Class : \_\_\_\_\_

Class S/N : \_\_\_\_\_

Date : \_\_\_\_\_

Time allowed : 1.5 hour

Maximum Marks :100

**Instructions**

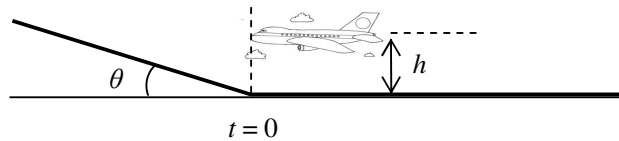
Answer all 7 questions. Take  $g = 9.80 \text{ m/s}^2$ .

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

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

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

1. a) Calculate  $56 + (32.00) / [1.2465 + 3.45]$  to the appropriate significant figures.
- b) The force  $F$  acting on an object of mass  $m$  moving in a circle with velocity  $v$  and at a distance  $r$  from the centre of the circle is given by  $F = m^x v^y r^z$ . Using dimensional analysis show that  $x = 1$ ,  $y = 2$  and  $z = -1$  and hence the formula for  $F$ .  
(15 marks)
2. An airplane flies horizontally at 1500 km/h, at height  $h = 35 \text{ m}$  above the ground. At time  $t = 0$ , the pilot approaches an inclined ground (see figure) that is sloping upward at angle  $\theta = 4.3^\circ$ . If the pilot does not change the airplane's direction, at what time will the plane crash?

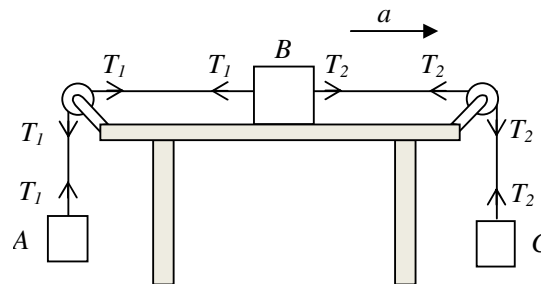


(15 marks)

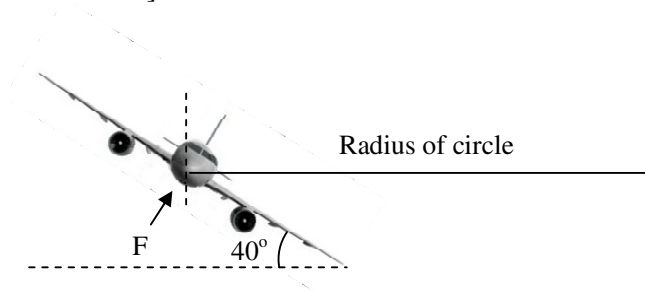
3. Two particles A and B move along the  $x$  axis. The position of particle A (in m) is given by  $x = 6.00t^2 + 3.00t + 2.00$ . The acceleration of particle B (in  $\text{m/s}^2$ ) is given by  $a = -8.00t$ . At  $t = 0$ , the velocity of particle B is 15 m/s. When will the velocity of the two particles be equal?

(15 marks)

4. Three forces act on a particle that moves with unchanging velocity (in m/s)  
 $\mathbf{v} = 2\mathbf{i} - 7\mathbf{j}$ . Two of the forces (in N) are  $\mathbf{F}_1 = 2\mathbf{i} + 3\mathbf{j} - 2\mathbf{k}$  and  $\mathbf{F}_2 = -5\mathbf{i} + 8\mathbf{j} - 2\mathbf{k}$ .  
 What is the third force that acts on the particle?  
 (10 marks)
5. The diagram below shows three blocks A, B and C attached by chords that loop over frictionless pulleys. Block B lies on a frictionless table. The masses are  $m_A = 6.00$  kg,  $m_B = 8.00$  kg and  $m_C = 10.00$  kg. The tension in the chord connecting A and B is  $T_1$  while the tension in the chord connecting B and C is  $T_2$ . When the blocks are released, what is the tension  $T_2$  in the chord on the right in terms of the acceleration due to gravity “g”? [Hint : Assume the system of blocks to accelerate at “a” as shown].



- (15 marks)
6. A man playing basket ball stands 2.50 m in front of the ring. He jumps up so that his hands are level with the ring and launches the ball at 5.00 m/s at an angle of  $75^\circ$  above the horizontal. Will he be able to put the ball into the ring? Explain with calculation.  
 (15 marks)
7. The figure shows an aeroplane flying in a horizontal circle at a speed of 600 km/h. If its wings are tilted at an angle  $\theta = 40^\circ$  to the horizontal, what is the radius of the circle in which the plane is flying? Assume that the required force is provided entirely by an “aerodynamic lift” that is perpendicular to the wing surface. [Hint : Resolve F in the vertical and horizontal direction].



(15 marks)

\*\*\*\*\*END of Paper\*\*\*\*\*

**Formula sheet for MS811M**

Name: \_\_\_\_\_ Admin. No.: \_\_\_\_\_ Seat No.: \_\_\_\_\_

<p><b><u>Kinematics</u></b></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><b><u>Dynamics</u></b></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><b><u>Linear momentum</u></b></p> $m_1 \vec{u}_1 + m_2 \vec{u}_2 = m_1 \vec{v}_1 + m_2 \vec{v}_2$ <p><b><u>Static electricity</u></b></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><b><u>Current electricity</u></b></p> $Q = It \quad V = IR$ $P = VI = I^2 R = \frac{V^2}{R}$ <p><b><u>Magnetism &amp; electromagnetism</u></b></p> $\vec{F} = q\vec{v} \times \vec{B} \quad \vec{F} = i\vec{L} \times \vec{B}$ $e.m.f. = -N \frac{d\Phi_B}{dt}$ $\Phi_B = BA$ <p><b><u>Thermodynamics</u></b></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><b><u>Ideal Gas</u></b></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><b><u>Rotational Motion</u></b></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><b><u>SHM &amp; waves</u></b></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><b><u>Circuits</u></b></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><b><u>Constants</u></b></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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