

OLABISI ONABANJO UNIVERSITY, AGO – IWOYE
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS
2017/2018 HARMATTAN SEMESTER EXAMINATION
PHY 201: ANALYTICAL MECHANICS I

ANSWER ANY FOUR QUESTIONS

TIME: 2Hours

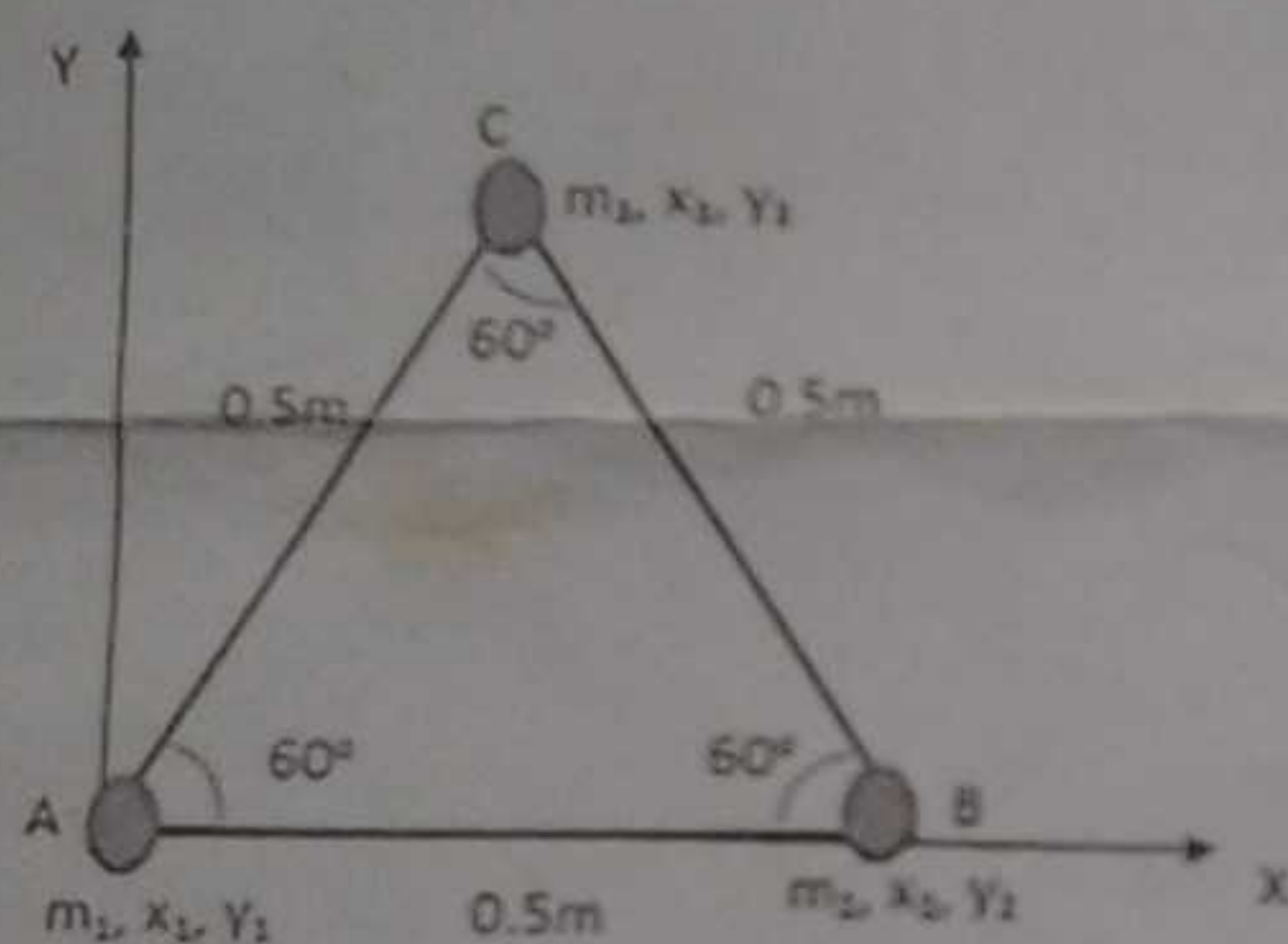
Question 1 ✓

- 1 A. State Kepler's Laws of Planetary motion; hence or otherwise show the relation between the Force F and the radius apart R .
- B. The gravitational force acting on a rocket at a height from the Earth surface is $1/3^{\text{rd}}$ (one-third) of the force acting on a body at sea level. Derive the relation between the height h and radius of the Earth R_e

Question 2 ✓

- 2 A. Determine the torque experienced by a force of 20N acting at 30degrees to the horizontal, and radius of 50cm, which is 60 degrees to the horizontal.
- 3 B. Consider the forces $F_1 = (6,0,0)$; $F_2 = (6,-7,4)$; $F_3 = (5,0,-3)$; $r = 45m$ at 45 degrees to the \vec{x} -axis
4 in the x-y plane. Verify that $\tau = r \wedge F$; $\tau = \tau_1 + \tau_2 + \tau_3$ where $R = F_1 + F_2 + F_3$

Question 3



- A. Locate the Centre of mass of a system of particle of masses $m_1 = 2kg$; $m_2 = 4kg$; $m_3 = 6kg$ situated at edges of an equilateral triangle of side 0.5m as shown above.
- B. Two particles of mass 6g and 3g having position vectors $(2i + 2j + 2k)$ and $(-4i - 4j - 4k)$ are moving with velocity of $(-i - j)$ and $(4i + 4j)$ respectively. Find the linear momentum of mass of the system of these particles.

Question 4

- A. Given that the motion of two particles (A and B) is described by the position vectors

$$r_A = [(3t)i + 9t(2-t)j]m$$

$$r_B = [3(t^2 - 2t + 2)i + 3(t-2)j]m$$

Find the point at which the particles collide and their speeds just before collision.

- B. A disc of radius 0.1m is rotating about its horizontal axis. A cord is wrapped around the outer circumference of the disc and a body A attached to the cord falls under gravity as $t = 0$ the velocity of A is $0.04ms^{-1}$. Two seconds later, A has fallen 0.2m. Find the tangential acceleration, a_t , and normal acceleration, a_n , at any other instance of point on the rim of the disc.

Question 5

- 5 A. The position coordinate of a particle which is confined to move along straight line is given by $x = 2t^3 - 24t + 6$, where x is measured in meters from a convenient origin and t in seconds. Determine
- 6 i. the time required for the particle to reach a velocity of 72 ms^{-1} from its initial condition at $t = 0$
- 7 ii. the acceleration of the particle when $v = 30 \text{ ms}^{-1}$, and
- 8 iii. the net displacement of the particle during the interval from $t = 1 \text{ s}$ to $t = 4 \text{ s}$
- 7 B. A ball was thrown with 20 ms^{-1} at 30° with the ground, find its velocity and position after 3 s . Find also the range and time required for the ball to return to the ground.

Question 6

- A. In a tabular form, write out the translatory and rotatory equivalent of the following parameters; Momentum, Force, Kinetic Energy, Work, Impulse, Displacement.
- B. Express the angular momentum L in terms of Kinetic and Potential Energy of a satellite of mass m in circular orbit of radius r

$$\left\{ \text{Hints: } E_k = \frac{1}{2}mv^2; V = -\frac{GMm}{r} \right\}$$

- 10 C. If the helicopter's rotor's speed changes from 200 rev/min to 300 rev/min in two minutes, how long will it take the rotor to have its angular velocity doubled (over its initial speed) assuming a constant angular acceleration.