



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

BACHELOR OF SCIENCE (MATHEMATICS)

BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF SCIENCE (TELECOMMUNICATION)

SPH 100: MECHANICS 1

DATE: 24/9/2019

TIME: 2:00 – 4:00 PM

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

The mass of the sun is 1.99×10^{30} kg

SECTION A

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Two blocks $m_1 = 5000$ g and $m_2 = 10$ kg on a frictionless surface are connected together with a light string. A force F , acts on m_2 as shown in figure 1, so that the blocks move with an acceleration of 3.0 m/s² towards the right-hand side. Calculate

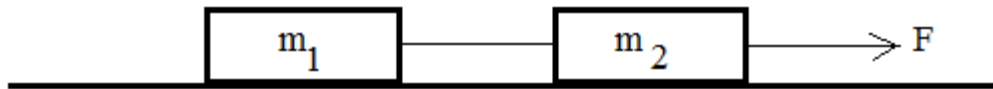


Figure 1

- i) The value of force F 3 marks
- ii) Tension (T) between them 3 marks
- a) Children riding a merry go round rotate at a constant speed of 2 revolutions per minute. Calculate the merry go round
 - i) Frequency
 - ii) Period of revolution 4 marks
- a) An airplane flying with an initial velocity of 30 m/s eastwards (starting at $t_0 = 0$) is accelerated at 4 m/s^2 in northward direction. What is
 - i) Its position 3 hours after t_0 ? 4 marks
 - ii) Its velocity at that time? 4 marks
- b) A merry go round makes 36 revolutions in 4 minutes ride. Calculate its average speed in rad/sec? 4 marks
- c) A 100 kg steel file cabinet is in the back of a truck. The truck's bed, also made of steel, is slowly tilted.
 - i) What is the magnitude of the static friction force on the cabinet when the bed is tilted 19° ? 4 marks
 - ii) At what angle will the file cabinet begin to slide? 4 marks

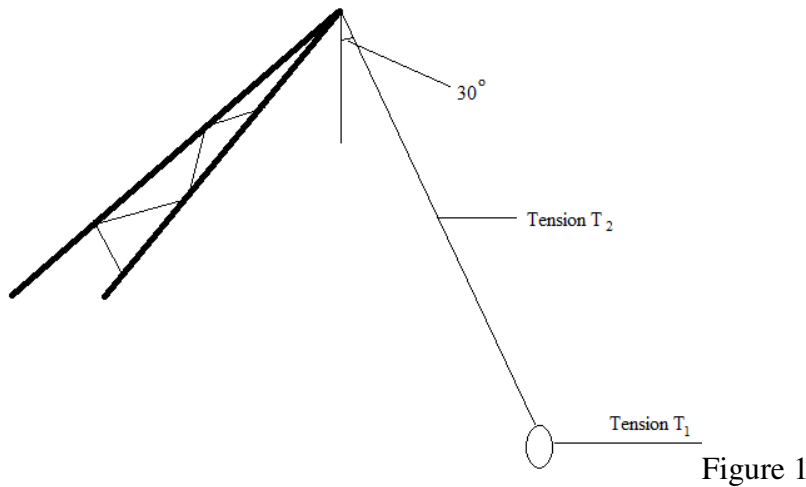
SECTION: ANSWER ANY OTHER TWO QUESTIONS

QUESTION TWO (20 MARKS)

- a) A block of mass 2 kg is travelling with a speed of 3 m/s along y-axis on a flat frictionless surface. On passing through origin it experiences a constant force at an angle 45° relative to y- axis towards the left-hand side for 3 s. What is the velocity of the block? 8 marks
- b) Derive the expression for centripetal acceleration $a = \frac{v^2}{r}$ 6 marks
- c) An engineer measures the inside diameter of a pipe as 0.25 cm using a vernier caliper. And its length as 50.2 m using a tape measure. Compute
 - i) Volume of the hollow region of the pipe (3 marks)
 - ii) Error in volume (3 marks)

QUESTION THREE (20 MARKS)

- b) Show that $F = ma$ 3 marks
- c) A motor boat cruising with a velocity of 30 m/s accelerates in a straight line for 3 minutes covering a distance of 600 m/s. Calculate acceleration of the boat, justifying that the units are dimensionally correct. 7 marks
- d) A wrecking ball weighing 1000 kg hangs from a cable. Prior to swinging, it is pulled front to 30° by a second horizontal cable as shown in figure 1. What is the tension in the horizontal cable? 10 marks



QUESTION FOUR (20 MARKS)

- a) An airplane travels with a velocity of 300 km/hr at an angle of 30° relative to x –axis for 30 min. Find
- i) x and y components of velocity
 - ii) Component distances
 - ii) Distance covered. 6 marks
- b) A moving walkway in an airport is 120 m long and moves at a speed of 0.4 m/s. A passenger, after travelling 50 m while standing on the walkway, starts to walk at a speed of 0.7 m/s relative to the surface of the walkway. How long does it take her to travel the total distance of the walkway? 6 marks

- d) The orbital speed of the earth around the sun is 29 km/s. Find the radius of the Earth's orbit around the sun and derive its SI units using dimensional analysis? 8 marks

QUESTION FIVE (20 MARKS)

- a) Derive an equation for orbital speed v , of a planet of mass m , orbiting the sun of mass M at a distance d . 3 marks
- b) A skier slides down a steep slope of angle θ with horizontal, on an ideal frictionless snow. If her mass is “ m ” and g is the gravitational acceleration,
- i) show that his acceleration will be given by $a = g \sin \theta$ 4 marks
- ii) Suppose the magnitude of his acceleration is 8 m/s^2 find θ 4 marks
- c) A geophysist sends a signal down the earth crust at point A, the signal is reflected by a big rock buried underground, and it is received by a detector erected at point B, 5.4 m away as shown in figure 2

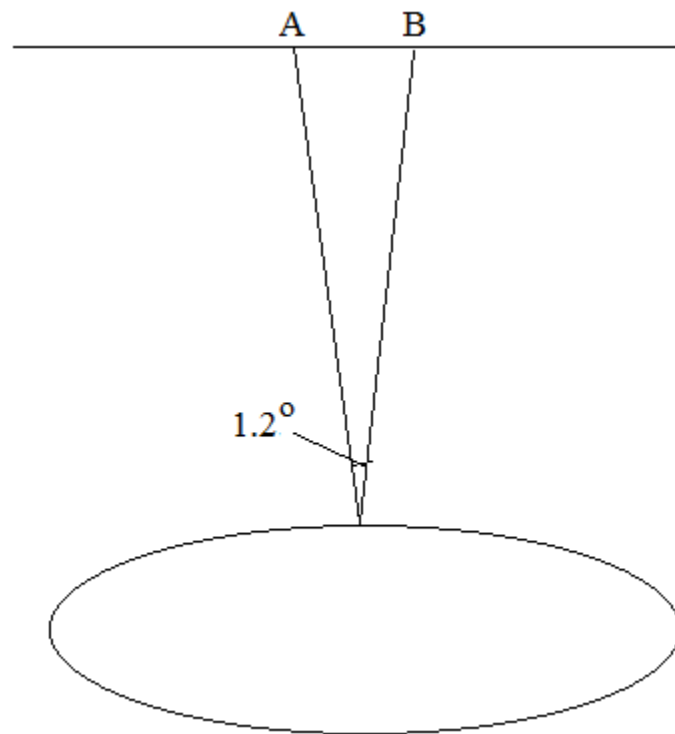


Figure 2
3 marks

Calculate how deep the rock is.

- d) Consider a viscous liquid undergoing steady flow through a pipe of circular cross section. It can reasonably be supposed that, the rate of volume flow Q (m^3/s) depends on coefficient of viscosity η ($\text{kg}/\text{m}\cdot\text{s}$), radius of the pipe r (metres m) and pressure gradient ΔP ($\text{kg}/\text{m}^2\text{s}^2$). Using dimensional analysis, derive a formula for rate of volume flow Q . 6 marks