JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION

1ST YEAR 1ST SEMESTER 2018/2019

MAIN REGULAR

COURSE CODE: SPH 101

COURSE TITLE: MECHANICS

EXAM VENUE: **STREAM: (B.Ed Sc)**

DATE: **EXAM SESSION:**

TIME: 2:00 HRS

INSTRUCTIONS:

1. **Attempt question 1 (compulsory) and ANY other two questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Useful constants

Acceleration due to gravity , $g, = 9.8$ m s^{-2}.
Universal gravitational constant, $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
Radius of the earth $= 6.37 \times 10^6$ m
Mass of the earth $= 5.98 \times 10^{24}$ kg

Question 1

(a) State Newton's laws of motion.

(3 Marks)

(b) Find the dimensions of the constants a and b in the gas equation

$$\left(p + \frac{a}{V^2}\right)(V - b) = RT$$

where p is the pressure and V is the volume.

(4 Marks)

(c) A block of wood of mass 6 kg lies on a horizontal surface for which the coefficient of static friction $\mu_s = 0.15$ and the coefficient of kinetic friction $\mu_k = 0.10$. It is pulled by a 12 N force directed at 47° above the horizontal. Find the force of friction on the block if it is at rest.

(6 Marks)

(d) A girl delivering newspapers covers her route by traveling 30.0 m west, 40.0 m north, and then 60.0 m east.

(i) What is her resultant displacement?

(ii) What is the total distance she travels?

(3,2 Marks)

(e) A proposed communciation satellite would revolve round the earth in a circular orbit in the equatorial plane, at a height of 35880 km above the earth's surface. Find the period of revolution of the satellite in hours, and comment on the results.

(3 Marks)

(f) A student stands at the edge of a cliff and throws a stone horizontally over the edge with a speed of 18.0 m/s. The cliff is 50.0 m above a flat, horizontal beach. How far from the foot of the cliff does the stone land on the beach?

(5 Marks)

(g) A vehicle of mass 2000 kg travelling at 10 m/s on a horizontal surface is brought to rest in a distance of 12.5 m by the action of its brakes. Calculate the average retarding force.

(4 Marks)

Question 2

(a) The graph of the vertical motion of an object is shown in Fig. 1. Describe its motion qualitatively, and find its instantaneous velocity at points A, B, and C.

(8 Marks)

(b) Given the first equation of linear motion, derive the second and third equations.

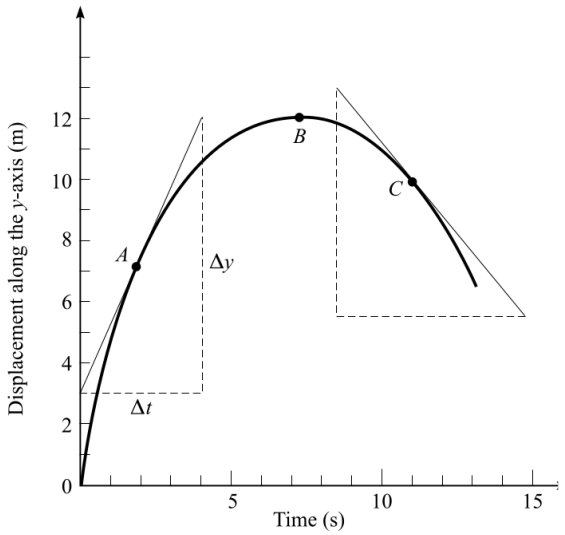

Figure 1:

(7 Marks)

(c) A car and a truck are both travelling with a constant speed of 20 m/s. The car is 10 m behind the truck. The truck driver suddenly applies his brakes, causing the truck to decelerate at the constant rate of 2 m/s^2 . Two seconds later the driver of the car applies his brakes and just manages to avoid a rear-end collision. Determine the constant rate at which the car decelerated.

(5 Marks)

Question 3

(a) Derive the work-energy theorem.

(4 Marks)

(b) (i) State the laws of friction.

(ii) A body slides down a rough plane inclined to the horizontal at 30°. If 70% of the initial potential energy is dissipated during the descent, find the coefficient of sliding friction.

(3,5 Marks)

(c) A spring of spring constant k is stretched from an original length x_1 to a final length x_2. Find the work done in the process.

(4 Marks)

(d) A 250 g ball is thrown at 40 m/s. It is struck by a bat which gives ita velocity of 50 m/s in the opposite direction. If the time of contact is 2×10^{-2}, find the average force exerted on the ball, and state any assumption made.

(4 Marks)

Question 4

(a) A projectile is fired from the ground with an initial velocity u at an angle θ to the horizontal. It returns to the same horizontal level. Find the time of flight.

(5 Marks)

(b) A projectile is fired with an initial velocity of 30 m/s from ground level at a target that is on the ground, at distance $R = 20$ m. Find the

(i) least and

(ii) greatest launch angles that will allow the projectile to hit the target.

(4,3 Marks)

(c) A ball is dropped into a lake from a diving board 4.9 m above the water. It hits the water with velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 5.0 s after it is dropped. Find

(i) the value of v.

(ii) the average velocity of the ball.

(iii) the depth of the lake.

(3,3,2 Marks)

Question 5

(a) In an Atwood machine shown in Figure 2, the mass m_2 is greater than the mass m_1. Express, in terms of m_1, m_2 and the gravitational acceleration g,

(i) the acceleration of the system.

(ii) the tension in the string.

(iii) Given that $m_1 = 1.6$ kg and $m_2 = 1.9$ kg, find the acceleration of the system and the tension in the string.

(4,3,2 Marks)

(b)(i) State the Kepler's laws of planetary motion.

(3 Marks)

(ii) A satellite orbits the earth at a considerable distance R from the center of the earth in the plane of the equator and in the same direction of rotation as the earth. Show that the period of the satellite T is given by

$$T^2 = \frac{4\pi^2 R^3}{gr^2}$$

where g is the gravitational acceleration and r is the radius of the earth.

(8 Marks)

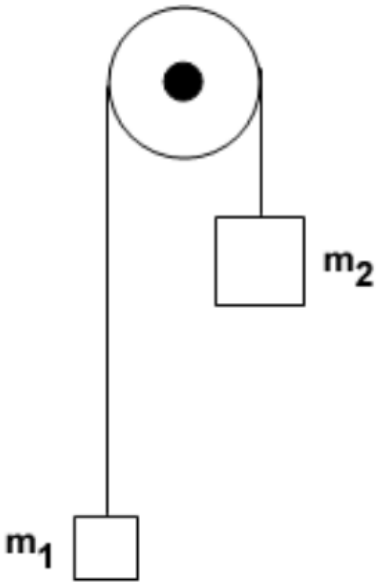

Figure 2: