



# MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR ..... SEMESTER EXAMINATION FOR

CERTIFICATE .....

BCE BT 111 PHYSICS

DATE: \_\_\_\_\_

TIME: \_\_\_\_\_

## INSTRUCTIONS TO CANDIDATES

Answer question ONE and any TWO questions.

Question one carries 30 marks, all other questions carry 20 marks each

## SOME USEFUL CONSTANTS

Acceleration due to gravity,  $g=9.81 \text{ m/s}^2$

Specific heat capacity of water =  $4.2 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$ ,

Specific latent heat of fusion of ice =  $3.3 \times 10^5 \text{ J kg}^{-1}$

Take specific heat capacity of water  $4200 \text{ J kg}^{-1} \text{ K}^{-1}$ .

Heat capacity of the kettle =  $450 \text{ J K}^{-1}$ ,

Specific latent heat of vaporization of water =  $2.3 \text{ MJ kg}^{-1}$

The speed of light in a vacuum,  $c= 2.998 \times 10^8 \text{ m/s}$ .

### QUESTION ONE (COMPULSORY) (30 MARKS)

- (a) Distinguish between fundamental and derived quantities. For each, give 2 examples with their S.I units. (4 marks)
- (b) Distinguish between mass and weight. (4 marks)
- (c) If a man weighs 900N on the Earth, what would he weigh on Jupiter, where the free-fall acceleration is  $25.9\text{m/s}^2$ ? (3 marks)
- (d) A large man and a small boy stand facing each other on frictionless ice. They put their hands together and push against each other so that they move apart.
- (i) Who moves away with the higher speed? (3 marks)
- (ii) Who moves farther while their hands are in contact? (2 marks)
- (e) Can a body be in equilibrium when only one force acts on it? Explain? (2 marks)
- (f) Write down the mathematical forms of the three Newton's law of motion. (3 marks)
- (g) A car with mass of 1400kg has a net forward force of 4500N applied to it. The car starts from rest and travels down a horizontal highway. Determine its kinetic energy and speed after it has traveled 100 m? (Ignore both friction and air resistance). (3 marks)
- (h) A machine part rotates at an angular velocity of **0.6 rad/s**; its value is then increased to **2.2 rad/s** at an angular acceleration of **0.7 rad/s<sup>2</sup>**. Find the angle through which the part rotates before reaching the final velocity. (3 marks)
- (i) A 77-kg diver drops from a board 10 m above the water surface. Use conservation of mechanical energy to find his speed 5 m above the water surface. (3 marks)

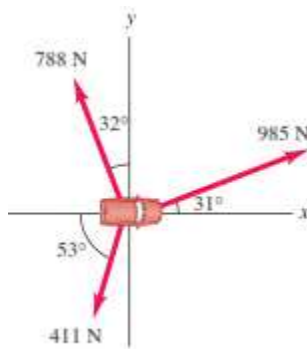
### QUESTION TWO (20 MARKS)

- (a) Distinguish between a scalar and a vector quantity giving an example of each. (3 marks)
- (b) Given the two displacements;  $\vec{D} = (6.0\hat{i} + 3.0\hat{j} - 1.0\hat{k})\text{ m}$ ; and  $\vec{E} = (4.0\hat{i} - 5.0\hat{j} + 8.0\hat{k})\text{ m}$ ,
- (i) Find the magnitude of the displacement  $2\vec{D} - \vec{E}$ . (4 marks)
- (ii) Find the angle between the vectors. (3 marks)
- (c) Define the following terms: position, Average velocity and Average acceleration. (3 marks)
- (d) A jet lands on an aircraft carrier at a speed of 63m/s.
- (i) What is its acceleration (assumed constant) if it stops in 2.0 s due to an arresting cable that snags the jet and brings it to a stop? (2 marks)

- (ii) If the jet touches down at position  $x_i = 0$ , what is its final position? (2 marks)
- (e) Estimate the force exerted on your eardrum due to the water when you are swimming at the bottom of a pool that is 5.0 m deep. (3 marks)

### QUESTION THREE (20 MARKS)

- (a) State the principle of conservation of momentum. (2 marks)
- (b) Passengers on a carnival ride move at constant speed in a horizontal circle of radius 5.0 m, making a complete circle in 4.0 s. What is their acceleration? (4 marks)
- (c) Workmen are trying to free a car stuck in the mud. To extricate the vehicle, they use three horizontal ropes, producing the force vectors shown in figure below.



- (i) Find the x- and y-components of each of the three pulls. (4 marks)
- (ii) Use the components to find the magnitude and direction of the resultant of the three pulls. (4 marks)
- (d) Define center of mass. Write down the three coordinates used in identification of center of mass. (4 marks)
- (e) Define impulse of a force. Write the mathematical expression. (2 marks)

### QUESTION FOUR (20 MARKS)

- (a) Distinguish between conservative and non-conservative forces. Give an example of each. (2 marks)
- (b) State the two properties of conservative forces. (2 marks)
- (c) Distinguish between an elastic collision and inelastic collision. (2 marks)
- (d) Two blocks as shown in figure below slide without friction. (i) What is the velocity of the 1.6 kg block after the collision? (ii) is the collision elastic? (3 marks)



- (e) Define pressure and give its S.I unit. (2 marks)
- (f) Water stands 12.0 m deep in a storage tank whose top is open to the atmosphere. What are the absolute and gauge pressures at the bottom of the tank? ( $\rho_0 = 1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$ ). (4 marks)
- (g) A robotic lander with an earth weight of 3430 N is sent to Mars which has radius  $R_m = 3.40 \times 10^6 \text{ m}$  and mass  $m_M = 6.42 \times 10^{23} \text{ kg}$ . Find the weight  $F_g$  of the lander on the Martian surface and the acceleration there due to gravity,  $g_M$ . (5 marks)

#### QUESTION FIVE (20 MARKS)

- (a) Define a thermometer and state any two physical properties that change with temperature. (3 marks)
- (b) On a day when the temperature reaches  $50^\circ\text{F}$ , what is the temperature in degrees Celsius and in kelvins? (2 marks)
- (c) State the zeroth law of thermodynamics. (1 marks)
- (d) An 80-kg man ran a fever of  $39^\circ\text{C}$  instead of the normal body temperature of  $37^\circ\text{C}$ . Assuming that the human body is mostly water, how much heat is required to raise his temperature by that amount. ( $c_w = 4190 \text{ J / Kg.K}$ ). (3 marks)
- (e) A car accelerates from rest to a speed of 10m/s in 8s. What is the acceleration and how far has it gone? (3 marks)
- (i) An object of mass 0.5 Kg on the end of a string is whirled round in a horizontal circle of radius 2 m with a constant speed of 10 m/s. Find its angular velocity and the tension in the string. (2 marks)
- (ii) If the same object is whirled in a vertical circle of the same radius with the same speed, determine the maximum and minimum tensions in the string. (2 marks)
- (f) A particle displaying SHM moves in a straight line between extreme positions A & B and passes through a mid-position O. If the distance AB=10 m and the maximum speed of the particle is 15 m/s find the period of the motion to 1 decimal place. (4 marks)