



**UNIVERSITY OF SWAZILAND  
MAIN EXAMINATION PAPER**

**PROGRAMMES:**

BSc. ABE 1, BSc. Agric. Econ and AgBMgt 1, BSc. Ag.Ed 1, BSc. Agron 1, BSc. An. Sc 1, BSc. An. Sc 1 (Dairy Option), BSc. COS 1, BSc. COSE 1, BSc. FSNT 1, BSc. Hort 1, BSc. TADM 1

**COURSE CODE:** ABE 101

**TITLE OF PAPER:** PHYSICS

**TIME ALLOWED:** TWO (2) HOURS

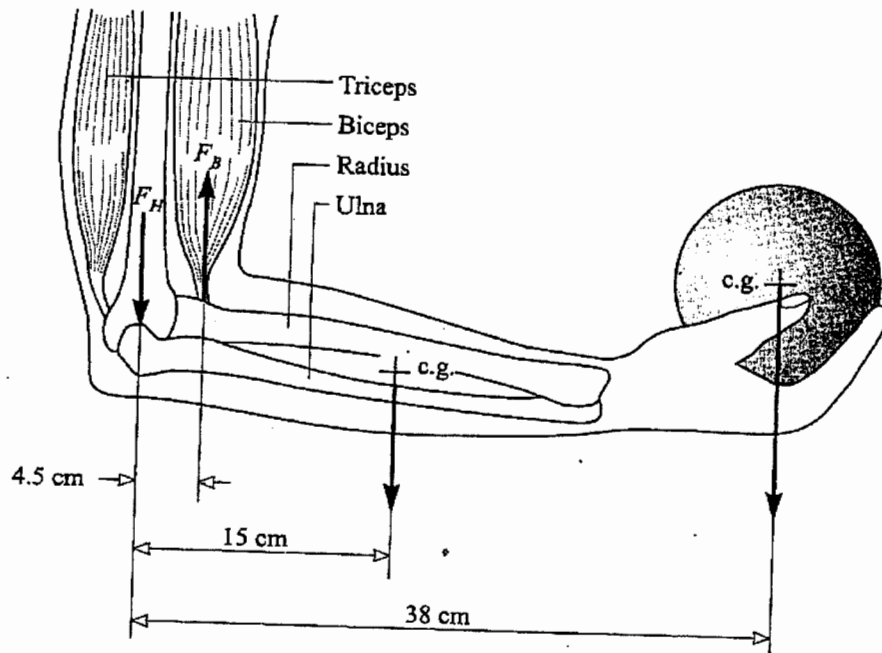
**SPECIAL MATERIAL REQUIRED:** NONE

**INSTRUCTIONS:** ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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THE CHIEF INVIGILATOR**

**QUESTION 1**

a. The arm shown in the figure below supports a  $4.0 \text{ kg}$  sphere. The mass of the hand and forearm together is  $3.0 \text{ kg}$  and its weight acts at a point  $15 \text{ cm}$  from the elbow. Determine the force exerted by the biceps muscle.

**[10 marks]**

b. A  $700.0 \text{ kg}$  truck traveling at  $5.0 \text{ m/s}$  east collide with a  $1500.0 \text{ kg}$  car moving at  $20 \text{ m/s}$  in a direction  $30^\circ$  south of west. After collision, the two vehicles remain tangled together.

(i) With what speed does the wreckage begin to move?

**[15 marks]**

(ii) In what direction does the wreckage begin to move?

**[5 marks]**

c. A piece of pure gold ( $\rho = 19.3 \text{ g/cm}^3$ ) is suspected to have a hollow centre. It has a mass of  $38.25 \text{ g}$  when measured in air and  $36.22 \text{ g}$  in water. What is the volume of the central hole in the gold?

**[10 marks]**

**QUESTION 2**

a. A  $2.0\text{ cm}$  cube of metal is suspended by a thread attached to a scale. The cube appears to have a mass of  $47.3\text{ g}$  when measured submerged in water. What will its mass appear to be when submerged in glycerin (specific gravity =  $1.26$ )? [10 marks]

b. A  $3.0\text{ g}$  bullet ( $c = 128\text{ J/kg}^\circ\text{C}$ ) moving at  $180\text{ m/s}$  enters a bag of sand and stops. By what amount does the temperature of the bullet change if all its kinetic energy becomes thermal energy that is added to the bullet? [10 marks]

c. State the principle of conservation of energy and explain how this principle is applied when a ball is thrown vertically upwards. [10 marks]

**QUESTION 3**

a. An electric motor, which has 95% efficiency, uses  $20\text{ A}$  at  $110\text{ V}$ .

(i) What is the power output of the motor? [5 marks]

(ii) How many Watts are lost in thermal energy? [5 marks]

(i) How many calories of thermal energy are developed per second? [5 marks]

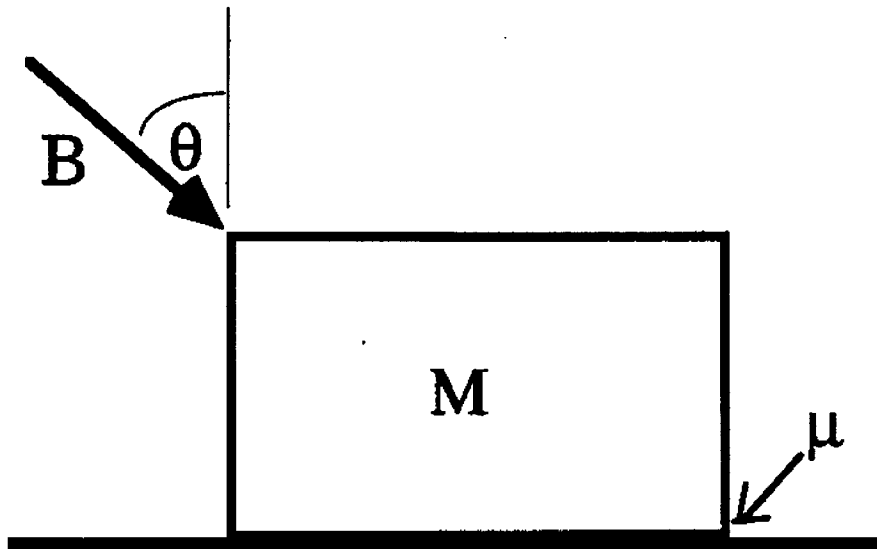
(ii) If the motor operates for 3.0 hours, what energy, in  $\text{MJ}$  and in  $\text{KW.h}$ , is dissipated? [5 marks]

b. State the Bernoulli's theorem. [5 marks]

c. State the Archimedes principle. [5 marks]

**QUESTION 4**

An astronaut is pushing a block of mass  $M$  that is sitting on a surface as shown. The magnitude of force exerted by an astronaut is given by  $B$  and the direction is shown below by the angle  $\theta$  in the drawing. This experiment is done in the outer space where gravity can be neglected. The coefficients of static and kinetic friction between the block and the surface are both equal to  $\mu$ .



- (iii) Assume initially that the block does not move. Draw a clear diagram showing all the forces acting on the block. **[10 marks]**
- (iv) Still assuming that the block does not move, find the magnitude of all the forces acting on the block (other than the astronaut's hand) in terms of the given quantities. **[10 marks]**
- (v) Now assume that the astronaut wants the block to start moving. She will accomplish this by pushing harder (changing  $B$ ) or by pushing at a different angle (changing  $\theta$ ) or by changing both angle and magnitude. Find the requirements for  $B$  and  $\theta$  in order for the block to just barely start to move. If there are no restrictions on the value of either  $B$  or  $\theta$ , or both, clearly explain why that is the case. **[10 marks]**