

**UNIVERSITY OF SWAZILAND
FACULTY OF HEALTH SCIENCES**

DEPARTMENT OF ENVIRONMENTAL SCIENCE

SUPPLEMENTARY EXAMINATION 2009/10

TITLE OF PAPER: PHYSICS FOR HEALTH SCIENCES

COURSE NUMBER: HSC107

TIME ALLOWED: THREE HOURS

- INSTRUCTIONS:**
1. ANSWER QUESTION 1
 2. ANSWER ANY FOUR QUESTIONS FROM 2 TO 6
 3. EACH QUESTION CARRIES 20 MARKS
 4. MARKS FOR EACH SECTION ARE IN THE RIGHT HAND MARGIN
 5. GIVE CLEAR EXPLANATIONS AND USE CLEAR DIAGRAMS IN YOUR SOLUTIONS. MARKS WILL BE LOST WHERE IT IS NOT CLEAR HOW THE EQUATIONS USED WERE OBTAINED

THIS PAPER HAS EIGHT PAGES INCLUDING THE COVER PAGE

THE LAST PAGE CONTAINS DATA THAT MAY BE USEFUL IN SOME QUESTIONS

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GIVEN BY THE CHIEF INVIGILATOR

COMPULSORY QUESTION

QUESTION 1

- (a) A body initially at rest free falls over a height $h = 20$ m. What is its velocity when it hits the ground? Show how you obtain the final equation used. **(4 marks)**
- (b) Newton's First Law states that a body will remain at rest or continue in straight line motion unless acted upon by a force? Why is this not easily observed in everyday life? **(2 marks)**
- (c) How is the dot product used in finding the work done by a given force \vec{F} that causes a displacement \vec{r} ? **(3 marks)**
- (d) Use your knowledge of momentum to explain how air bags reduce injury during vehicle crashes. **(4 marks)**
- (e) What do you understand by the threshold of pain of the human ear? **(3 marks)**
- (f) List two dangers of electricity to humans? **(4 marks)**

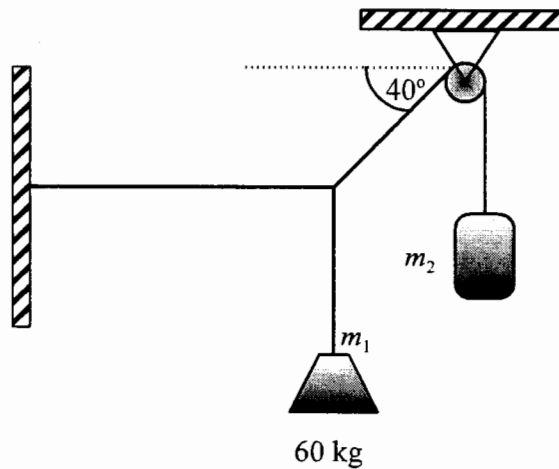
CHOOSE ANY FOUR QUESTIONS FROM QUESTION 2 TO 6

QUESTION 2

(a) Given two vectors $\vec{A} = 2\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{B} = -\hat{i} + 2\hat{j} + 2\hat{k}$, find the dot product of the two vectors and the angle between the two vectors. **(4 marks)**

(b) A body is projected upward with a velocity of 40 m/s. Determine its maximum height. **(4 marks)**

(c) The systems shown in Figure 1 is in equilibrium. Find the tension in each cord, and the mass m_2 . **(12 marks)**



QUESTION 3

(a) A worker lifts a bag of mass 50 kg on to a flat-bed truck. The height of the truck from the ground is 1.5 m. How much energy in food calories does he spend loading the bag? **(4 marks)**

(b) A bullet of mass $m = 200$ g moving with an initial speed $v_0 = 320$ m/s strikes a stationary block of mass $M = 10$ kg. After the collision the block acquire a velocity $V_f = 5$ m/s. What is the final velocity of the bullet after the collision? **(8 marks)**

(c) A flywheel of moment of inertia $I = 125$ kg m² is accelerated from 50 rpm to 500 rpm in 2 s.

(i) What is the angular acceleration of the wheel? **(4 marks)**

(ii) What is the torque on the wheel? **(2 marks)**

(iii) What is the kinetic energy of the wheel at $t = 2$ s? **(2 marks)**

QUESTION 4

(a) A circular steel wire of length 1.8 m and a cross-sectional area of $7.85 \times 10^{-7} \text{ m}^2$ supports a load of 80 kg within the proportional region. The wire extends by 0.45 mm under the load.

- (i) What is the stress on the wire? **(3 marks)**
- (ii) What is the strain on the wire? **(2 marks)**
- (iii) What is the Young's modulus for the wire? **(2 marks)**

(b) In a certain day the height h of the mercury column in the barometer is 76.1 cm. What is the atmospheric pressure on such a day? Clearly show how you arrive at the final equation used. **(8 marks)**

(c) Steam of mass 5 kg at 110°C is converted to water at 60°C . How much energy has to be lost in this process? **(5 marks)**

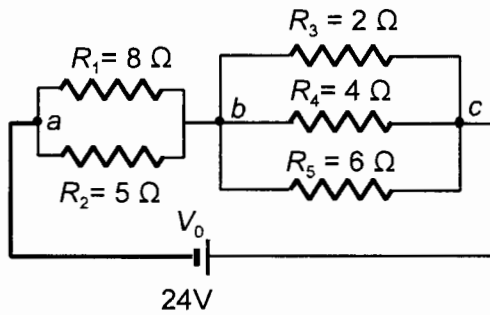
QUESTION 5

- (a) An industrial machine produces a sound at an average power of 50 W.
- (i) At what distance r from the source is the sound level at the threshold of pain? **(5 marks)**
 - (ii) What is the sound level at a distance $r = 10$ m? **(5 marks)**
- (b) Show with the aid of fully labeled diagram how a virtual image can be formed by a converging lens. **(4 marks)**
- (c) The near point of a person is 10 m. What must be the focal length of the spectacle lenses for the person to read a newspaper at a distance of 25 cm? **(6 marks)**

QUESTION 6

(a) Consider the network shown in Figure 2.

- (i) What is the effective resistance of the network? **(6 marks)**
- (ii) What is the total current through network? **(2 marks)**
- (iii) What is the voltage drop between junctions a and b and b and c ? **(4 marks)**



(b) An electric heater is rated at 1500 W at 230 V(rms).

- (i) How much current is drawn by the heater? **(2 marks)**
- (ii) What is the resistance of the filament? **(2 marks)**
- (iii) If the heater is kept on for 4 hours what is the cost of the electricity consumed assuming that electrical energy cost 64 cents per kilowatt-hour. **(4 marks)**

GENERAL DATA SHEET

Speed of light in vacuum $c = 2.9978 \times 10^8$ m/s

Speed of sound in air = 343 m/s

Gravitational acceleration = 9.80 m/s²

Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m²/kg²

Density of mercury (Hg) = 1.36×10^4 kg/m³

Density of water = 1000 kg/m³

Standard atmospheric pressure = 1.013×10^5 Pa

Gas constant $R = 8.314$ J/(K mol)

Avogadro's number $N_A = 6.022 \times 10^{23}$ mol⁻¹

Threshold of hearing $I_0 = 10^{-12}$ W/m²

1 calorie = 1 c = 4.186 J

1 food calorie = 1 Calorie = 1C = 10^3 calories = 4.186×10^3 J

$c(\text{water}) = 4186$ J/(kg K)

$c(\text{ice}) = 2090$ J/(kg K)

$c(\text{steam}) = 2079$ J/(kg K)

$L_f(\text{ice}) = 3.33 \times 10^5$ J/kg

$L_v(\text{water}) = 2.260 \times 10^6$ J/kg

$$k_e = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$$

Charge of an electron = -1.6×10^{-19} C

Charge of a proton = $+1.6 \times 10^{-19}$ C

1 atomic mass unit = 1 amu = 1 u = 1.66×10^{-27} kg

Electron mass, $m_e = 9.109 \times 10^{-31}$ kg

Proton mass, $m_p = 1.673 \times 10^{-27}$ kg

Neutron mass $m_n = 1.675 \times 10^{-27}$ kg