UNIVERSITY OF SWAZILAND
FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL SCIENCE

MAIN EXAMINATION 2007/08

TITTLE OF PAPER: PHYSICS FOR HEALTH SCIENCES

COURSE NUMBER: HSC107

TIME ALLOWED: TWO HOURS

INSTRUCTIONS:

1. ANSWER QUESTION 1
2. ANSWER ANY THREE QUESTIONS FROM QUESTION 2 TO 6
3. EACH QUESTION CARRIES 25 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

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COMPULSORY QUESTION

QUESTION 1

(a) With the aid of a diagram and an equation, show what you understand by the dot product of two vectors? Also give an example where the dot product is applicable. **(4 marks)**

(b) Suppose you are sitting at the front seat of a fast moving vehicle without any restraint such as a seatbelt, and the vehicle gets involved in an accident and stops suddenly. Describe your motion at the instant of the accident and state how it can be explained by one of Newton's laws of motion. **(5 marks)**

(c) Define

(i) work **(2 marks)**

(ii) and energy according to physics. **(2 marks)**

(d) In order to deform an object explain what is more important between the applied force and applied stress. **(5 marks)**

(e) Define the near point of a human eye? **(2 marks)**

(d) Why is it possible for a bird to sit on a high voltage wire without being electrocuted?

(i) Make a circuit diagram to illustrate the situation. **(1 mark)**

(ii) Explain your answer in terms of the voltage across the bird. **(2 marks)**

(iii) Also explain your answer in terms of the current trough the bird. **(2 marks)**

CHOOSE ANY THREE QUESTIONS FROM QUESTION 2 TO 6

QUESTION 2.

(a) Given two vectors

and, $\vec{A} = 3\hat{i} - 3\hat{j} + 3\hat{k}$

find $B = 2\hat{i} - 4\hat{j} + 5\hat{k}$,

(i) the dot product of the two vectors and **(3 marks)**

(ii) the cross product $\vec{A} \times \vec{B}$. **(4 marks)**

(b) A body with an initial velocity of 4 m/s is accelerated at 6 m/s^2 for 4 s. It then moves at constant velocity for 5 s, after which it is accelerated at -4 m/s^2 for 5 s. Sketch

(i) the acceleration-time graph, **(5 marks)**

(ii) the velocity-time graph, and **(6 marks)**

(iii) the distance-time graph for this motion. **(7 marks)**

QUESTION 3

(a) The systems shown in Figure 1 is to maintain a fractured leg in equilibrium. The required horizontal tension on the leg is TN = 40 N. Find the tension T in the cord and the required mass m. Assume that both pulleys are frictionless. **(8 marks)**

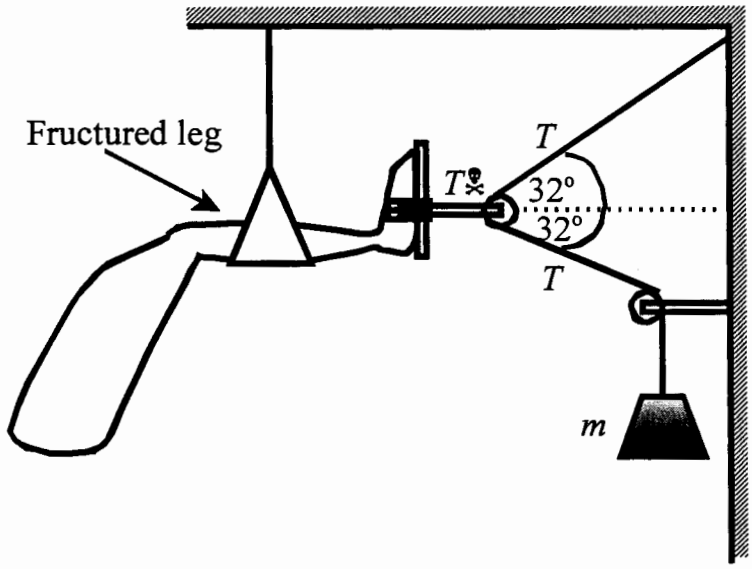

Figure 1.

(b) The platform shown in Figure 2 is uniform, 3 m long, weighs 500 N and is used to store medical supplies. The stock that is left has a mass of 40 kg and is centered at 2.2 m from the wall. The stock clerk checking the medical supplies left stands 0.9 m from the wall and has a mass of 80 kg.

(i) Find the tension in the cable. **(9 marks)**
(ii) Find the x- and y-components of the reaction force by the wall. **(5 marks)**
(iii) What angle does the reaction force make with the wall? **(3 marks)**

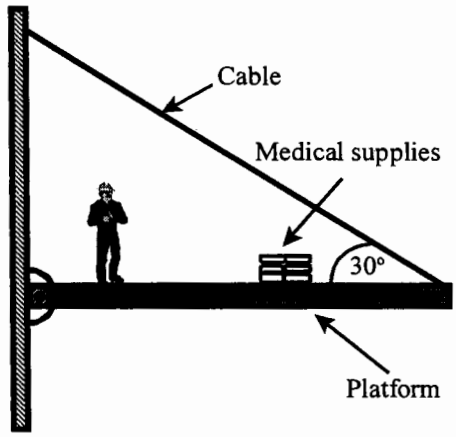

Figure 2.

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QUESTION 4

(a) A Faculty of Health student eats a breakfast rated at 2000 food Calories. She wishes to do an equivalent amount of work by lifting a 40 kg mass up a distance of 1.5 m to avoid gaining weight.

(i) How many times must he lift the mass to loose the energy consumed? Neglect the energy required or gained in lowering the mass each time. **(5 marks)**

(ii) Explain whether it can be realistic to loose weight this way? **(1 mark)**

(iii) How else does the body lose energy consumed? **(2 marks)**

(b) A pump has to lift 1.5 litres of water per minute from a bore hole 45 m deep into a tank with an inlet 2.5 m high from the ground. The water is discharged at a velocity of 0.5 m/s. Determine what power pump is required. **(6 marks)**

(c) A bullet of mass m = 200 g moving with an initial speed Λ_0 = 340 m/s strikes a stationary block of mass M = 5 kg. The block acquires a velocity of 2 m/s after the impact. What is the final velocity of the bullet Λ_f? **(6 marks)**

(d) A boy of mass m = 40 kg holds on to merry-go-round platform that rotates at angular velocity T = 23 rpm at a radius of r = 3 m. With how much force must he hold on so that he does not get thrown off? **(5 marks)**

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QUESTION 5

(a) A construction worker of mass 80 kg falls feet first from a height of $h = 10$ m. His collision time with the ground takes a time $t = 0.08$ s. The area of impact at each ankle is $A = 5$ cm^2, and the compressive strength of the human bone $S = 2.05 \times 10^6$ Pa.

(i) What is the force of impact of his feet with the ground? **(5 marks)**

(ii) Determine whether fracture of the ankles is likely? **(5 marks)**

(b) State Archimedes principle, and discuss with the aid of equations why ships can be built from steel which has a higher density than water. **(6 marks)**

(c) Ice of mass $m_i = 50$ g at $T_i = -4^\circ$C is mixed with water of mas $m_w = 5$ kg at a temperature $T_w = 50^\circ$C in a perfectly insulating container. All the ice melts. Determine the the final temperature reached? **(9 marks)**

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QUESTION 6

(a) An industrial machine produces a sound at an average power of $P_{av} = 400$ W. At what distance r from the source is the sound level at the threshold of pain? **(5 marks)**

(b) Show with the aid of fully labeled diagrams how a virtual image can be formed by a converging lens. **(5 marks)**

(c) The near point of a person is 5 m. What must be the focal length of the spectacle lenses for the person to read a newspaper at a distance of 25 cm? **(4 marks)**

(d) On a cold day a Faculty of Health student under the pressure of examinations decides to connect a power strip to a voltage source $V = 220$V rms, 15 A wall socket in order to power a number of appliances. She then connects a 1200 W electric kettle (resistance R_1), a 1500 W heater (resistance (R_2), a 500 W microwave oven (resistance R_3), and a 1100 W electric iron (resistance R_4) and tries to use all these appliances simultaneously.

(i) Make a fully labeled circuit diagram for this network. **(4 marks)**

(ii) Find the required current through each appliance. **(4 marks)**

(iii) Is it possible to simultaneously use all these appliances. **(3 marks)**

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HSC107 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/s^2
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2/kg^2
Density of mercury = 1.36×10^4 kg/m^3
Density of water = 1000 kg/m^3
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}
$I_0 = 10^{-12}$ W/m^2
1 calorie = 1 c = 4.186 J
1 food calorie = 1 Calorie = 1C = 10^3 calories = 4.186×10^3 J

c(*water*) = 4186 J/(kg K) c(*ice*) = 2090 J/(kg K) c(*steam*) = 2079 J/(kg K)
L_f(*ice*) = 3.33×10^5 J/kg L_v(*water*) = 2.260×10^6 J/kg

$$k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9 \quad \text{Nm}^2/\text{C}^2$$

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