UNIVERSITY OF SWAZILAND
FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL SCIENCE

SUPPLEMENTARY EXAMINATION 2007/08

TITTLE 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

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COMPULSORY QUESTION

QUESTION 1

a. With the aid of a diagram and an equation, show what you understand by the cross product of two vectors? **(4 marks)**

b. You are able to walk on the ground without sinking yet you are acted upon by the gravitational force. Explain using equations and one of Newton's laws why you do not sink into the ground. **(4 marks)**

c. Define: Power and give the unit of power according to physics **(3 marks)**

d. Why is it easy to make a hole in a material with a sharp object compared to trying to make a hole in the material with a blunt object? **(4 marks)**

e. State Ohms Law and explain what happens to the current when resistors are connected in series and in parallel. **(5 marks)**

CHOOSE ANY FOUR QUESTIONS

QUESTION 2.

a. A body is shot vertically with a velocity of $\Lambda_0 = 10$ m/s.

i. Find its velocity at $t = 10$ s. **(1 mark)**

ii. Find its velocity at $t = 15$ s. **(1 mark)**

iii. What are the directions of the velocities in i and ii. Justify your answer. **(3 marks)**

iv. From the results in i and ii explain whether velocity is a vector or scalar? **(2 marks)**

b. A body starting at the origin moves according to the velocity-time graph shown in Figure 1.

i. Find the accelerations $a_{0,4}$ for 0 - 4 s, $a_{4,8}$ for 4 - 8 s and $a_{8,14}$ for 8 - 14 s. **(3 marks)**

ii. Sketch the acceleration-time graph. **(3 marks)**

iii. Calculate the distance traveled at t = 4 s, t = 8 s and t = 14 s. **(3 marks)**

iv. Sketch a clear distance-time graph for this motion. **(4 marks)**

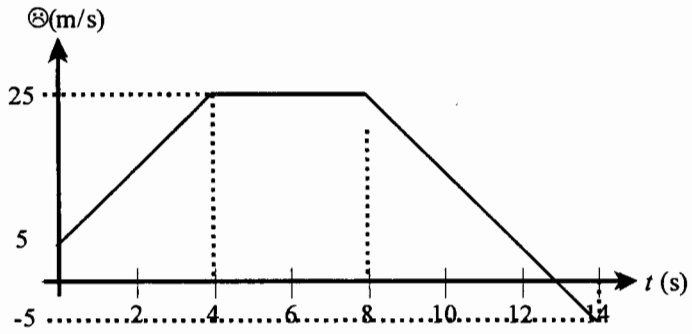

Figure 1.

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QUESTION 3

c. The systems shown in Figure 2 supports a mass of $m = 50$ kg in equilibrium. Find the tension in each cord, T_1, T_2, and T_3. in the cord and the required mass m. Assume that both pulleys are frictionless. **(9 marks)**

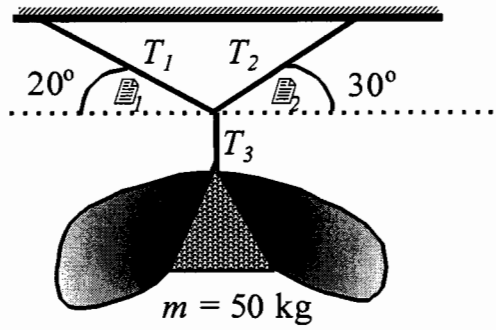

Figure 2.

d. The beam shown in Figure 3 is uniform, 12 m long, weighs 2000 N and is in equilibrium. The cable is attached to the beam a distance of 5 m from the wall.

i. Find the tension in the cable. **(8 marks)**

ii. Find the x- and y-components of the reaction force by the wall. **(3 marks)**

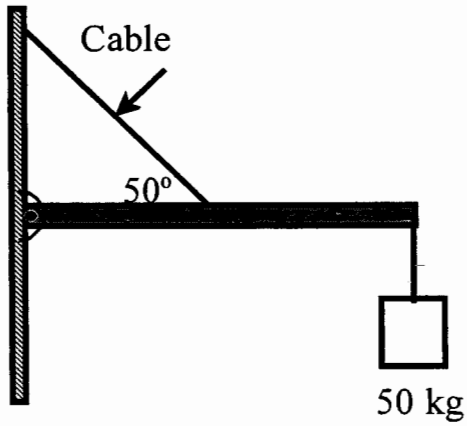

Figure 3.

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QUESTION 4

a. A worker pushes a trolley horizontally with a force of 100 N for distance of 10 m.

i. What is the work done by the worker in joules? **(2 marks)**

ii. What is the work done by the worker in calories? **(1 mark)**

iii. What is the work done by the worker in food calories? **(1 mark)**

iv. If the worker pushes the cart for 3 minutes, what is the power used? **(1 mark)**

b. A bullet of mass m = 100 g moving with an initial speed Λ_0 = 300 m/s strikes a stationary block of mass M = 8 kg. The bullet gets imbedded in the block and move with the block after the collision. What is the final velocity of the block and bullet? **(5 marks)**

c. A flywheel of moment of inertia I = 125 kg m^2 is accelerated from T_0 = 1000 rpm to T = 5000 rpm in 5 s. under a torque of ϑ = 10 Nm.

i. What are T_0 and T in rad/s? **(3 mark)**

ii. What is the angular acceleration of the wheel? **(1 mark)**

iii. What is the torque on the wheel? **(1 mark)**

iv. What angle in radians and in degrees does it turn through in the first 5 s? **(3 marks)**

v. What is the kinetic energy of the wheel at t = 5 s? **(1 mark)**

vi. If the radius of the wheel is 1.2 m, what is the centripetal force required to hold a 250 g object at the circumference of the wheel? **(1 mark)**

QUESTION 5

a. A circular steel wire of length 1.8 m and a cross-sectional area of 7.85×10^{-7} m^2 supports a load of 20 kg within the proportional region. The wire stretches by 4.5 mm.

i. What is the force on the wire? **(1 mark)**

ii. What is the stress on the wire? **(1 mark)**

iii. What is the strain on the wire? **(1 mark)**

iv. What is the Young's modulus for the wire? **(1 mark)**

b. State Pascal's law and give an example of its application in everyday life. **(5 marks)**

c. A body of mass 2 kg floats on water. Find the volume of water it displaces? **(3 marks)**

d. A ball copper (c_{copper} = 387 J/(kg.°C)) ball of mass m_b = 1.5 kg at a temperature of T_c = 130°C is immersed in a perfectly insulating container with water of mass m_w = 3 kg at a temperature T_w = 20°C. Determine the final equilibrium temperature T_f reached by the system. **(8 marks)**

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QUESTION 6

a. A medical machine produces a sound at an average power of P_{av} = 100 W. At what distance r from the source is the sound level at 80 dB? **(4 marks)**

b. Show with the aid of a fully labeled diagram how a real image can be formed by a converging lens. **(4 marks)**

c. The far point of a person is 20 m. What must be the focal length of the spectacle lenses for the person to see up to 5 km in order to drive a car. **(3 marks)**

d. Consider the circuit shown in Figure 4.

i. What is the current through each resistor, I_1, I_2 and I_3, respectively? **(3 marks)**

ii. What is the total current through the network? **(1 mark)**

iii. What is the effective resistance of the network? **(1 mark)**

iv. What would be the effective resistance of the network if the three resistors were connected in series? **(1 mark)**

v. What would be the total current through the network if the resistors were connected in series.? **(1 mark)**

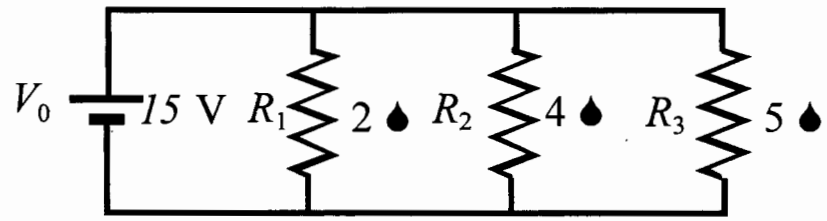

Figure 4.

e. A step-down transformer is used for powering a medical piece of equipment purchased from North America that operates at 110 V *rms*. Find the turns ration $N_{secondary}/N_{primary}$ of the transformer needed if it has to pe plugged to an outlet of 440 V *rms*.? **(2 marks)**

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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