**UNIVERSITY OF SWAZILAND**

**FACULTY OF HEALTH SCIENCES**

**DEPARTMENT OF ENVIRONMENTAL HEALTH**

**MAIN EXAMINATION 2011/2012**

| | |
|---|---|
| **TITLE O F PAPER:** | PHYSICS FOR HEALTH SCIENCES |
| **COURSE NUMBER:** | HSC107 |
| **TIME ALLOWED:** | THREE HOURS |
| **INSTRUCTIONS:** | ANSWER ANY FOUR OUT OF FIVE QUESTIONS |
| | EACH QUESTION CARRIES 25 MARKS |
| | MARKS FOR EACH SECTION ARE IN THE RIGHT HAND MARGIN |
| | 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 SEVEN 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

**QUESTION 1**

(a) Given the vectors $\vec{A} = 4\hat{\imath} + 2\hat{\jmath} - 3\hat{k}$ and $\vec{B} = 2\hat{\imath} + 4\hat{\jmath} - 2\hat{k}$, find

(i) the magnitude of each vector, **(2 marks)**

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

(iii) the angle between the two vectors **(2 marks)**

(b) A body starts at the origin with a velocity of 3 m/s and accelerates to 21 m/s in 6 s, and then moves at constant velocity for 3 s, after which it is accelerated to -3 m/s (minus 3 m/s) in 6 s. Sketch

(i) the velocity-time, **(5 marks)**

(ii) the acceleration-time, and **(6 marks)**

(iii) the displacement-time graphs for this motion. **(7 marks)**

**QUESTION 2**

(a) Figure 1 illustrates a traction system in equilibrium used to align a broken leg. The pulley is frictionless. Find the mass $m$ required to make the tension $T_1$ to be 50 N. **(14 marks)**

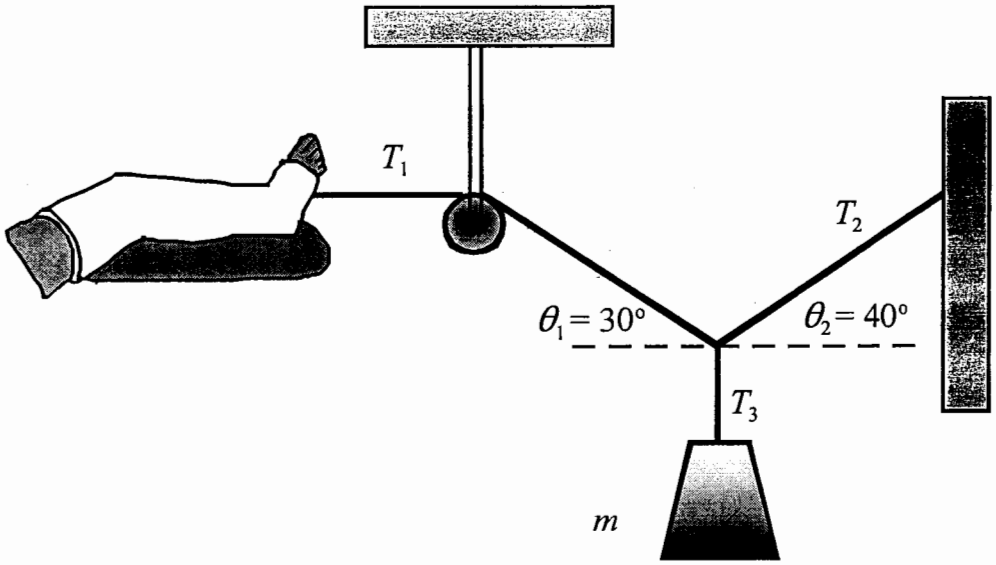


**Figure 1.**

(b) How do seatbelts in vehicles help in reducing the force of impact during collisions? State how this relates to one of Newton's laws, and state that law. **(6 marks)**

(c) You can observe your pen falling towards the earth. Why can't you observe the earth rising towards the pen, considering that the gravitational force on the pen by the earth is equal to the gravitational force on the earth by the pen? Use equations. **(5 marks)**

**QUESTION 3**

(a) From your knowledge of work and energy, explain why you consider light to be a form of energy. **(6 marks)**

(b) A 50 kg student who has taken HSC107 has a 40 g slice of white bread toast, one large egg and a 350 ml glass of milk for breakfast. After this breakfast he starts to climb a high mountain. How far will he climb vertically up the mountain before getting hungry again? (Neglect energy used in horizontal movement). The calorific values are $2.65 \times 10^3$ calories per gram of white bread toast, $149 \times 10^3$ calories per large egg and $2.4 \times 10^6$ joule per litre, where the calories are the scientific calories (4.186 J). **(10 marks)**

(c) A student forgets his keys in an upstairs room. He calls his roommate who is still in the room and asks him to drop him his keys. The roommate drops his keys of mass 150 g from a height of 10 m. The collision time between the keys and the hand is 0.02 s.

(i) What is the force of impact on the hand due to the dropping keys? **(5 marks)**

(ii) Explain with the aid of equations what would happen to the force of impact if the student lowers his hand when contact with the keys is made? **(4 marks)**

**QUESTION 4**

(a) The small piston of a hydraulic jack has a radius of 1 cm, and its large piston has a radius of 3 cm. State the law according which the solution is obtained.

(i) Make a sketch of a hydraulic jack to show its function. **(3 marks)**

(ii) What force must be applied to the smaller piston to get a force of 250 N to lift the wheel of the car during flat tyre change? **(5 marks)**

(b) Arteriosclerotic plaques forming on the inner walls of arteries can decrease the effective cross-sectional area of an artery. Even small changes in the effective area of an artery can lead to very large changes in the blood pressure in the artery and possibly to the collapse of the blood vessel. Consider an artery with blood flow velocity of 0.14 m/s, a systolic blood pressure of 120 mm Hg, and density of 1050 kg/m$^3$. Find the pressure in the constricted part of the artery where the cross sectional area is reduced to 20 % of normal. Figure 2 illustrates this proble. **(12 marks)**

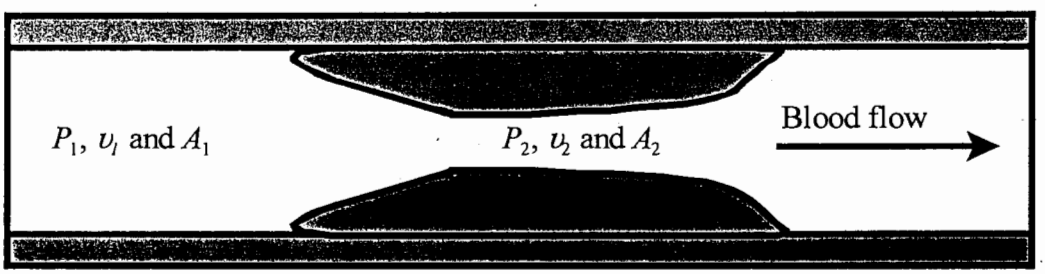


**Figure 2.**

(c) Suppose you are burnt by 0.75 kg of steam at a temperature of 110°C. How much heat energy will be transferred to your body as the steam cools to water at 37°C.

**(5 marks)**

**QUESTION 5**

(a) An industrial machine produces 2 W of acoustic power isotropically. At what distance is the sound level 80 dB? **(9 marks)**

(b) The far point of a forest protection officer is 100 m. What should be the focal length of his spectacle lenses to enable him to see up to 10 km into the forest? **(4 marks)**

(c) A person standing on the ground has a total resistance of 500 Ω including his footwear. He accidentally touches a 220 V line. Find the current that flows through the person, and state whether this current is safe to the person. **(6 marks)**

(d) Why doesn't a bird get electrocuted when perched on a high voltage power line? Use diagrams and equations in your explanation. **(6 marks)**

## GENERAL DATA SHEET

Avogadro's number $N_A = 6.022 \times 10^{23}$ mol$^{-1}$
1 calorie = 1 c = 4.186 J
1 food calorie = 1 Calorie = 1C = $10^3$ calories = $4.186 \times 10^3$ J
Density of mercury (Hg) = $1.36 \times 10^4$ kg/m$^3$
Density of water = 1000 kg/m$^3$
Gas constant $R$ = 8.314 J/(K mol)
Gravitational acceleration = 9.80 m/s$^2$
Speed of light in vacuum $c = 2.9978 \times 10^8$ m/s
Speed of sound in air = 343 m/s
Standard atmospheric pressure = $1.013 \times 10^5$ Pa
Threshold of hearing $I_0 = 10^{-12}$ W/m$^2$
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m$^2$/kg$^2$

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

Charge of an electron = $-1.6 \times 10^{-19}$ C
Charge of a proton = $+1.6 \times 10^{-19}$ C
1 atomic mass unit = 1 amu = 1 u = $1.66 \times 10^{-27}$ 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