UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

MAIN EXAMINATION 2012/2013

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 two vectors $\vec{A} = 4\hat{\imath} - 3\hat{\jmath} + 5\hat{k}$ and $\vec{B} = -2\hat{\imath} + 4\hat{\jmath} - 3\hat{k}$, find the angle between the two vectors. **(7 marks)**

(b) A body starts at the origin with a velocity of 3 m/s and accelerates to 15 m/s in 4 s, and then moves at constant velocity for 3 s after which it accelerates to - 3 m/s in 6 s. Sketch

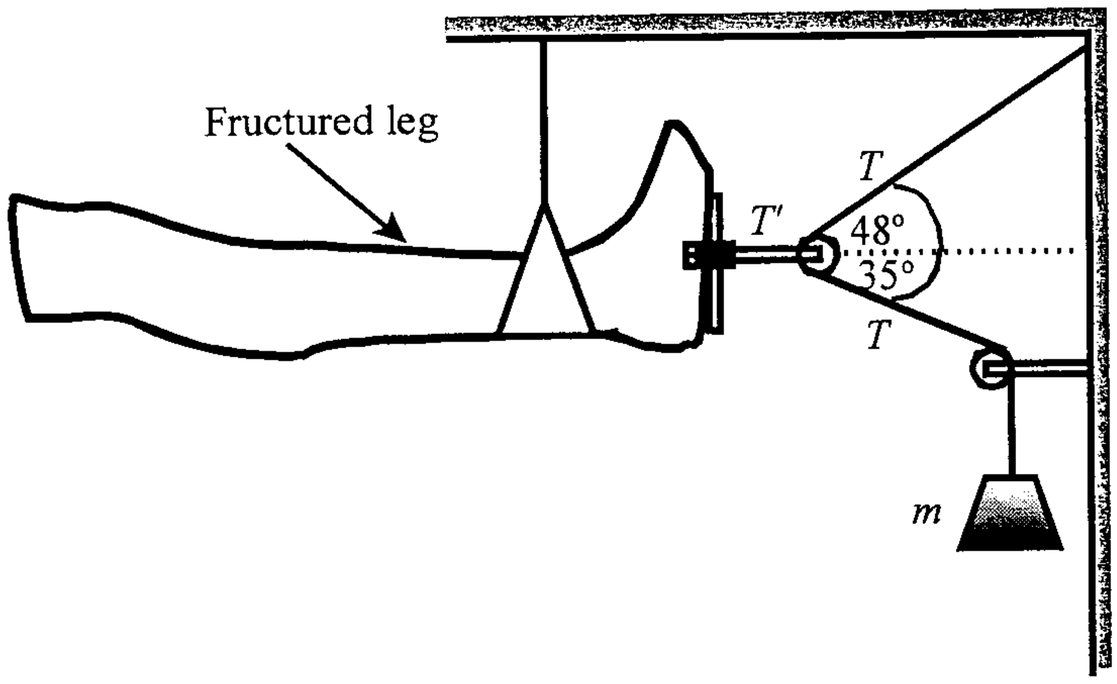
(i) the velocity-time, **(5 marks)**

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

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

QUESTION 2

(a) The system shown in Figure 1 is to maintain a fractured leg in equilibrium. The required horizontal tension on the leg is $T' = 50$ N. Find the tension T in the cord and the mass m required. Neglect the masses and the friction of the pulleys. **(13 marks)**



(b) From your understanding of work, explain why you consider firewood to possess some energy. **(6 marks)**

(c) A glass vessel of mass $m = 300$ g falls from a cupboard shelf a height $h = 2$ m from the ground and the impact with ground lasts for 0.02 s. Find the force on of impact the glass and compare it with the weight of the glass. **(6 marks)**

QUESTION 3

(a) A student has biceps muscles of area A = 50 cm^2 and a length of 22 cm. They require a force of 25.3 N for an elongation of 3.2 cm. What is the Young's modulus for the student's biceps muscles? **(7 marks)**

(b) The small piston of a hydraulic jack has a radius $r = 1$ cm, and its large piston has a radius of $R = 2$ cm. Determine the force applied on the smaller piston if the force on the larger piston is $F = 3000$ N. First state the in full the law used to solve this problem.**(9 marks)**

(c) The blood pressure of a patient is 130 mm Hg. What is the pressure in Pascal? **(4 marks)**

(d) A piece of cork of mass $m_c = 2$ kg and density of 215 kg/m^3 floats on fresh water. Determine the volume of the water it displaces. **(5 marks)**

QUESTION 4

(a) On a day when the temperature is 95°F, what is the temperature in the Celsius and Kelvin scales? **(4 marks)**

(b) Give any example where thermal expansion is a concern in everyday life. **(2 marks)**

(c) State three ways and the required media in each case for enabling heat transfer. **(6 marks)**

(d) How much heat is required to heat 3 kg of ice at -10°C to water at 100°C **(8 marks)**

(e) A very strong tank contains a gas at a pressure $P = 3$ atmospheres at a temperature of 30°C. The tank is heated to a temperature of 350°C. What is the pressure in Pascal reached by the gas in the tank? **(5 marks)**

QUESTION 5

(a) A machine in a clinic produces some noise isotropically. At a distance of $r = 25$ m, the sound level is measured to be $\beta = 89$ dB. What is the power of the sound source? **(8 marks)**

(b) The near point of a person is 10 m. What should be the focal length of the spectacle lenses for the person to read a newspaper at 25 cm? **(4 marks)**

(c) Four resistors $R_1 = 2\ \Omega$, $R_2 = 4\ \Omega$, $R_3 = 5\ \Omega$ and $R_4 = 8\ \Omega$ are connected in parallel.

(i) What is their effective resistance of these resistors? **(3 marks)**

(ii) Explain with the aid of an equation which of the four resistors dissipates the highest amount of energy. **(3 marks)**

(d) Under the pressure of examinations, a student uses a power-strip to try to power a 120 W electric iron, a 1500 W electric kettle, a 1000 W microwave oven and a 1800 W hot plate at once. The circuits breaker is rated at 15 A.

(i) Find the current consumed by each of the four devices. **(4 marks)**

(ii) Explain whether or not these devices can run simultaneously. **(3 marks)**

DATA SHEET

General Data

Avogadro's number $N_A = 6.022 \times 10^{23}$ mol^{-1}
Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J/K
Density of mercury = 1.36×10^4 kg/m^3
Gas constant $R = 8.314$ J/(mol·K)
Gravitational acceleration $g = 9.80$ m/s^2
Refractive index of air $n_{air} = 1$
Standard atmospheric pressure = 1.013×10^5 Pa
Speed of light in vacuum $c = 2.997\ 8 \times 10^8$ m/s
Speed of sound in air $\upsilon_s = 343$ m/s
Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W/(m^2·K^4)
Threshold of hearing $I_0 = 10^{-12}$ W/m^2
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N·m^2/kg^2
1 calorie = 1 c = 4.186 J
1 food calorie = 1 Calorie = 1C = 10^3 calories = 4.186×10^3 J

Water data

$c(water) = 4186$ 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
ρ (water) = 1000 kg/m^3 refractive index $n_w = 1.333$

Electricity and nuclear data

Alpha particle mass = $6.644\ 657 \times 10^{-27}$ kg
Charge of an electron = -1.6×10^{-19} C
Charge of a proton = $+1.6 \times 10^{-19}$ C
Coulomb's constant $k_e = 8.987\ 5 \times 10^9$ Nm^2/C^2
Deuteron mass = $3.343\ 583 \times 10^{-27}$ kg
Electron mass, $m_e = 9.109 \times 10^{-31}$ kg
Neutron mass $m_n = 1.675 \times 10^{-27}$ kg
Proton mass, $m_p = 1.673 \times 10^{-27}$ kg
1 atomic mass unit = 1 amu = 1 u = 1.66×10^{-27} kg
$\epsilon_0 = 8.85 \times 10^{-12}$ C^2 (N·m^2)
1 Ci = 3.7×10^{10} decays/s
1Bq = 1 decay/s