UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

RESIT EXAMINATION 2017/2018

TITLE O F PAPER:	PHYSICS FOR HEALTH SCIENCES
COURSE NUMBER:	EHS103
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 $\vec{A} = 4\hat{\imath} + 3\hat{\jmath} - 6\hat{k}$ and $\vec{B} = 5\hat{\imath} + 4\hat{\jmath} + 2\hat{k}$, find

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

(ii) the dot product of the two vectors, $\vec{A} \cdot \vec{B}$, and **(3 marks)**

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

(b) A body starts at the origin with a velocity of 5 m/s and accelerates to 20 m/s in 3 s, and then moves at constant velocity for 4 s after which it accelerates to - 4 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 forearm. The pulley is frictionless. Find the tension T applied to the arm by the traction. **(9 marks)**

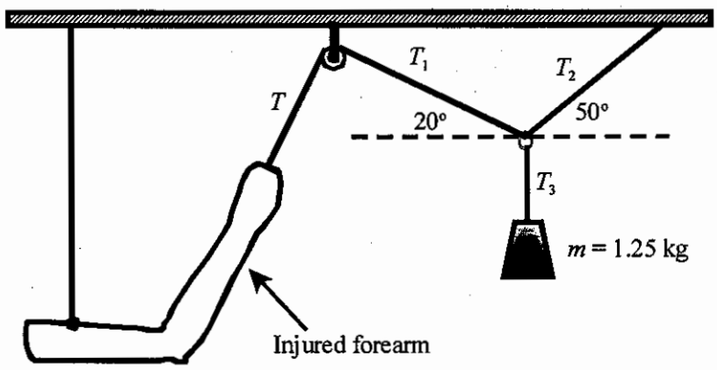

Figure 1.

(b) Define

i. work, **(3 marks)**

ii. energy, and **(3 marks)**

iii. discuss one case where work was done in your life today (or where you observed work being done) and give the energy source used. **(3 marks)**

(c) A construction worker of mass 80.0 kg falls over a height of 20.0 m. The collision with the ground takes 0.0500 s.

i. Define force in terms of momentum. **(2 marks)**

ii. Determine the force of impact with the ground. **(5 marks)**

QUESTION 3

(a) A human muscle of length $l_0 = 15.0$ cm with a cross-sectional area $A = 1.57 \times 10^{-4}$ m^2 is under a tension of 125 N. The muscle stretches by $\Delta l = 0.450$ mm under this load. Determine the Young's Y modulus for this muscle. **(5 marks)**

(b) With the aid of an equation, explain why it is much easier to cause damage with sharper objects than blunt objects? Give an example that supports your answer. **(6 marks)**

(c) State Pascal's law and give an example of its application in everyday life. Use equations in your explanation. **(6 marks)**

(d) A HSC107 student of mass $m = 65.0$ kg relaxes on a uniform Styrofoam slab of vertical thickness $h = 10.0$ cm and density 800 kg/m^3 floating on fresh water. The slab is floating such that its top surface coincides with the water level. First state Archimedes Principle and use this principle to find the thickness of the slab so that its top coincides with the level of the water. **(8 marks)**

QUESTION 4

(a) A solar water heater is used to heat 100 kg of water from 20.0°C to 60.0°C. Calculate the energy needed to heat water. **(4 marks)**

(b) On a day when the temperature is 25.3°C, what is the temperature in the Kelvin and Fahrenheit scales? **(4 marks)**

(c) The sound level from a medical machine is 90.0 dB at a distance of 5.00 m. Assuming that the sound source is isotropic, what is the power generated by the source? **(8 marks)**

(d) Briefly explain total internal reflection. **(4 marks)**

(e) The near point of a person is 3 m. What should be the focal length of the spectacle lenses for the person to read a newspaper at 25 cm? **(5 marks)**

QUESTION 5

(a) Three resistors $R_1 = 3.00\ \Omega$, $R_2 = 6.00\ \Omega$ and $R_3 = 9.00\ \Omega$ are connected in parallel across an 18.0 V source.

i. Find the current through each resistor. **(3 marks)**

ii. Calculate the power delivered to each resistor. **(3 marks)**

iii. What is the effective resistance of the network? **(3 marks)**

(b) List two effects of electricity in the human body and give the associated currents. **(4 marks)**

(c) A Faculty of Health Sciences student owns an electric space heater rated at 1500 W and 220 V rms. She turns on the heater at 6:00 p.m. and switches it off at 11:00 p.m.

i. How much current is drawn by the heater? **(2 marks)**

ii. What is the resistance of the heater filament? **(2 marks)**

iii. How much energy in kilowatt-hours is consumed by the heater during the time it is on? **(2 marks)**

iv. If electrical energy cost 178 cents per kilowatt-hour, what is the cost of the electricity consumed? **(2 marks)**

(d) A step down transformer is to be used to reduce the voltage from the 230 V rms wall socket voltage to 15.0 V rms in order to operate a music system. The transformer draws 500 mA from the wall socket.

i. What is the turns-ratio of secondary to primary in the transformer? **(2 marks)**

ii. What is the secondary current? **(2 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