UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

MAIN EXAMINATION 2016/2017

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 (7) 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 $\vec{A} = 5\hat{\imath} - 2\hat{\jmath} + 2\hat{k}$ and $\vec{B} = 2\hat{\imath} - 3\hat{\jmath} - 3\hat{k}$, find the angle between the two vectors. **(6 marks)**

(b) A body starts at the origin with an initial velocity of 2 m/s is accelerated at 3 m/s^2 for 4 s. It then moves at constant velocity for 4 s, after which it is accelerated at -4 m/s^2 for 6 s. Sketch the

i. acceleration-time, **(4 marks)**
ii. velocity-time, and **(5 marks)**
iii. displacement-time graphs for this motion. **(6 marks)**

(c) A body is projected upward with a velocity of 30.0 m/s. Find the height where the velocity is ± 2.00 m/s **(4 marks)**

QUESTION 2

(a) Figure 1 illustrates a traction system in equilibrium used to align a broken leg. The pulleys are frictionless. Find the x and y-components of the force F applied to the leg by the traction. **(12 marks)**

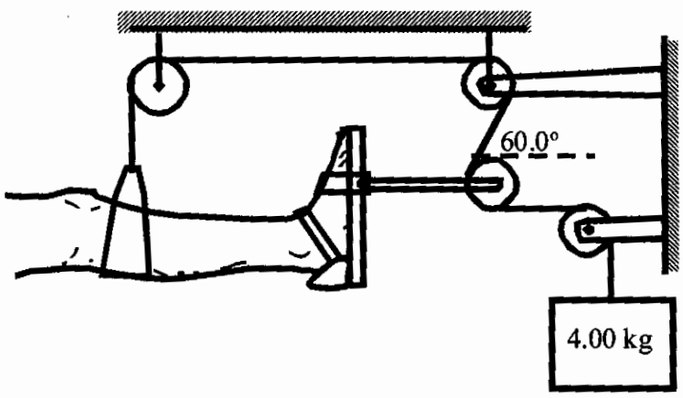

Figure 1.

(b) A shopper at a supermarket pushes a cart with a force of 35.0 N directed at an angle of 25.0° downward from the horizontal. The coefficient of kinetic friction between the wheels of the cart and the floor is 0.105. She pushes the card for 50.0 m. Find the work done by the shopper too push the cart. (The mass of the cart is not needed) **(3 marks)**

(c) A car of mass 1200 kg including the driver, moving at a velocity of 38.9 m/s strike a concrete barrier and stops in 0.135 s.

a. Find the force of impact on the car. **(5 marks)**
b. Find the force of impact on the driver. **(3 marks)**
c. Compare the force of impact on the driver to the weight of the person and comment. **(2 marks)**

QUESTION 3

(a) If you try to cut a material with a knife and you encounter some difficulty. You may decide to sharpen the knife. According to physics, what effect does the sharpened knife have on your ability to cut the material? **(3 marks)**

(b) Sketch a stress-strain diagram for some rubber materials such as vulcanized rubber, explain it and state where such materials can be used. **(7 marks)**

(c) A sprinter of mass 65.5 kg has an Achilles tendon of cross sectional area of 23.0 mm^2, length 203 mm, and Young's modulus 9.82×10^8 Pa. At the inception of a sprint, the sprinter exerts 12.0 times his body weight on the tendon. Find

a. Find the force, and **(2 marks)**
b. stress exerted on the tendon. **(2 marks)**
c. Determine the amount by which the tendon stretches. **(3 marks)**

(d) A uniform Styrofoam slab of thickness $t = 10.0$ cm and density of 550 kg/m^3 is used to support a student of mass $m = 56.5$ kg 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 area of the slab. **(8 marks)**

QUESTION 4

(a) On a day when the temperature is 98.0 in the Fahrenheit scale what is the temperature in the Celsius scale (°C) scale? **(2 marks)**

(b) A EHS103 student of mass 55.5 kg has fever and her temperature rises to 38.5°C. The specific heat capacity of the human body is 3.500×10^3 J/kg·K, and the latent heat of vapourisation for water around human body temperature is 2.42×10^6 J/kg.

a. How much energy must be lost by the student to cool down from 38.5°C. to 37.0°C? **(3 marks)**

b. How much water must the student sweat to cool down to 37.0°C? **(3 marks)**

(c) State the three ways that heat energy can be transferred from one region to another and the medium required for it. **(6 marks)**

(d) An industrial machine produces isotropic sound of acoustic power of 2.75 W.

a. Determine the distance where the sound level is 90.5 dB. **(7 marks)**

b. Find the sound level at a distance of 20.0 m from the machine? **(4 marks)**

QUESTION 5

(a) Light is incident from air to water at an angle of 38.5° with the normal. Calculate the angle of refraction in the water. **(4 marks)**

(b) The far point of a person is 400 m. What should be the focal length of the spectacle lenses for the person who wants to go sight-seeing up to a distance 4 000 m? **(4 marks)**

(c) Explain why sometimes a massive shock of over 200 mA could be better than a shock of between 75 and 100 mA. **(5 marks)**

(d) Consider the network shown in Figure 2 below.

i. Find the effective resistance between points *a* and *b*, and *b* and *c*, R_{ab} and R_{bc}, respectively. Also, find the effective resistance of the circuit R_{eff}. **(7 marks)**

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

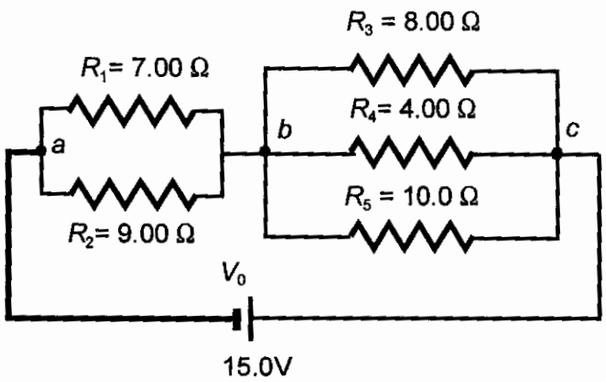

Figure 2.

(e) An industrial heater consumes 10 000 W of power at 440 V.

i. What is the current through the heating element? **(1 mark)**

ii. What is the resistance of the heating element? **(1 mark)**

iii. Find the energy in kWh consumed over an eight hour shift. **(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
Density of water = 1000 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

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
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
1 Ci = 3.7×10^{10} decays/s
1Bq = 1 decay/s

$$MAP = P_{dia} + \frac{(P_{sys} - P_{dia})}{3}$$