UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

MAIN 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 (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 the vectors $\vec{A}$ and $\vec{B}$, $\vec{A} = -3\hat{\imath} + 4\hat{\jmath} - 2\hat{k}$ and $\vec{B} = 2\hat{\imath} + 3\hat{\jmath} - 2\hat{k}$, use the dot product to find the angle between the two vectors. **(6 marks)**

(b) A body with an initial velocity of 3 m/s is accelerated at 2 m/s^2 for 4 s. It then moves at constant velocity for 3 s, after which it is accelerated at -3 m/s^2 for 4 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 short vertically upward with a velocity of 50.0 m/s. Find the maximum height and the time it takes to reach the highest point. **(4 marks)**

QUESTION 2

(a) Figure 1 illustrates a traction system in equilibrium used to align a broken leg. The pulley is frictionless and has negligible mass. Find the mass m required to make the tension $T' = T_1$ to be 50 N. **(10 marks)**

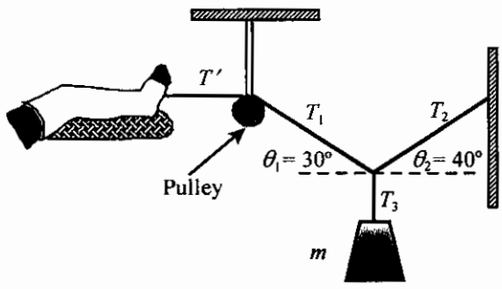

Figure 1.

(b) Define these two terms according to physics:

i. Work and **(2 marks)**

ii. energy **(2 marks)**

(c) At an industry a conveyor belt carries some substance over an effective height of 10.0 m and delivers it at a rate of 50.0 kg per minute at a speed of 1.38 m/s. How much power is used to deliver the substance? Neglect energy used for horizontal motion? **(5 marks)**

(d) A student of mass $m = 50.0$ kg stealing mangoes from a tree a height $h = 5.00$ m above ground is stung by a wasp and falls from the tree. The collision with the ground takes 0.0256 s. What is the force of impact on the student? **(6 marks)**

QUESTION 3

(a) 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)**

(b) A human tissue of length 20.0 cm and cross-sectional area 1.25×10^{-4} m^2 has a Young's modulus of 1.74×10^7 Pa. It is subjected to a force of 0.943 N. Determine the amount by which the tissue stretches. **(4 marks)**

(c) A cube of wood of density 400 kg/m^3 is 30.0 cm on each edge, floats on fresh water. Determine the depth to which the cube is below the water surface. First state the principle used in solving this problem. **(7 marks)**

(d) A horizontal pipe has a cross-sectional area $A_1 = 1.96 \times 10^{-3}$ m^2 and has a constriction of area $A_2 = 7.85 \times 10^{-5}$ m^2 as shown in Figure 2. Water flows through the pipe with a velocity of 0.694 m/s in the larger area and a pressure of 4.90×10^5 Pa.

i. Determine the velocity in the smaller section of the pipe. **(2 marks)**

ii. Find the pressure in the smaller section of the pipe and compare it to the pressure at the larger section. **(5 marks)**

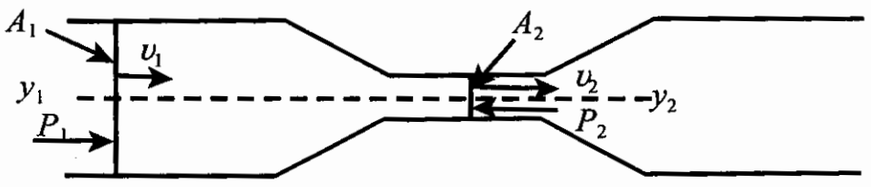

Figure 2.

QUESTION 4

(a) On a day when the temperature is 298 K in the Kelvin scale what is the temperature in

i. the Celsius (°C) and **(1 mark)**

ii. and Fahrenheit (°F) scales? **(2 marks)**

(b) A person is exposed to an effective amount of steam of 5.00 kg at a temperature of 110°C that cools down and condenses to water that in turn cools down to the body temperature of 37.0°C. Find the amount of heat transferred to the person in this process. **(7 marks)**

(c) What is meant by the amplitude, wavelength, period and frequency of a wave? **(4 marks)**

(d) What is the frequency range of the human ear? **(2 marks)**

(e) What is sound intensity and sound level at the threshold of pain? **(2 marks)**

(f) An industrial machine produces isotropic sound of acoustic power. An occupational health inspector using a sound level meter determines that the sound level is 85.0 dB a distance of 12.0 m from the machine. Find the power of the sound source. **(7 marks)**

QUESTION 5

(a) Light scattered from a fish under water is incident from water to air at an angle of 60.0° with the normal. Determine whether the angle of refraction exists for this light. If it does not exist state what happens to the light. **(3 marks)**

(b) The near point of a person is 2.50 m. What should be the focal length of the spectacle lenses for the person to read a newspaper at 24.5 cm? **(4 marks)**

(c) An object is placed 8.00 cm in front of a lens of focal length 14.0 cm.

i. Determine the image distance. **(3 marks)**

ii. Find the magnification of the image. **(1 mark)**

iii. Explain whether the image real or virtual? **(2 marks)**

(d) Discuss two harmful effects of electricity in the human body, and also state the currents at which these effects occur. **(4 marks)**

(e) Consider the network shown in Figure 3 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)**

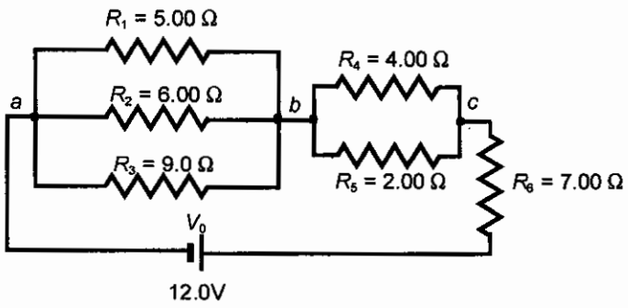

Figure 3.

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

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