UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

RESIT 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 $\vec{A} = 2\hat{\imath} + 3\hat{\jmath} - 2\hat{k}$and $\vec{B} = 4\hat{\imath} - 2\hat{\jmath} + \hat{k}$. Find

i. the magnitude of each vector, **(2 marks)**
ii. the dot product of the two vectors, and **(2 marks)**
iii. theangle between the two vectors. **(2 marks)**

(b) A body starts at the origin with an initial velocity of 2 m/s and is accelerated to10 m/sin4 s. It then moves at constant velocity for 4 s, after which it is accelerated to -2 m/sin4 s. Sketch the

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

(c) A bullet is shot vertically upward with a velocity of 1 500 m/s. Determine the maximum height reached by the bullet, neglecting air resistance and wind. **(4 marks)**

QUESTION 2

(a) Figure 1 illustrates a mass $m$suspended on cords in air. The system is in equilibrium. Find thetensionsT_1, T_2 and T_3in each cord. **(9 marks)**

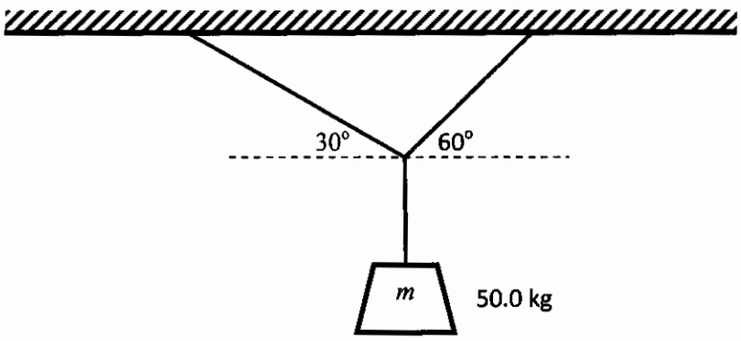

Figure 1.

(b) A technician in a clinic climbs up a ladder a vertical distance of 3.25 m to fetch supplies stored above.

i. How much gravitational potential energy does he gain? **(2 marks)**

ii. If at the height of 3.25 m he drops a set of keys to the floor, use energy methods to determine the speed with which the keys hit the floor. **(4 marks)**

(c) A linear spring of spring constant $k = 1250$ N/m is compressed a distance of 5.75 cm with a mass of 2.36 kg.

i. What is the energy stored in the compressed spring? **(2 marks)**

ii. If the system is let go, find the velocity of the mass when the spring returns to its original length. **(3 marks)**

(d) A bullet of mass $m = 39.5$ g travels at 1 155 m/s in the positive x-axis and strikes a stationary block of mass2.37 kg at rest on a frictionless surface. Find the final velocity of the bullet after the collision. **(5 marks)**

QUESTION 3

(a) A human bone specimen of cross-sectional area $A = 6.25 \times 10^{-6}$ m^2 and length $l_0 = 7.00$mm is subjected to a force of 993.75 N. The specimen has Young's modulus of 18.89×10^9 Pa.

i. What is the stress on the specimen? **(2 marks)**

ii. Find the strain on the specimen and determine how much it(specimen) stretches under the load? **(3 marks)**

(b) Sketch a stress-strain diagram for a ductile metal and label all its parts. **(7 marks)**

(c) State Pascal's law and give an example with explanations how it is applied in everyday life. **(5 marks)**

(d) An open tank contains water to a height of 5.00 m. A small hole develops at the bottom of the tank and the water leaks. Use Bernoulli's equation with explanations to determine the velocity with which the water leaks out of the tank. **(8 marks)**

QUESTION 4

(a) On a day when the temperature is 35.0 in the Celsiusscale what is the temperature in the Fahrenheit scale (°F)scale? **(2 marks)**

(b) In the laboratory a EHS103 student heats up a brass ball of mass 45.2 g to a temperature of 300°Cand then drops it into an insulating container with 250 ml of water at 18.0°C. Find the final temperature reached by the system assuming that the container absorbs no heat. The heat capacity of brass is 380 J/kg·K **(6 marks)**

(c) Discuss how a thermo-flask prevents heat exchanges between its contents and the surroundings. **(6 marks)**

(d) A machine in a medical laboratory produces isotropic sound that is measured to be as a sound level of95.0 dB at distance of 7.28 m from the machine.

a. Determine the power of the sound source. **(7 marks)**
b. At what distance is the sound level 85.0 dB? **(4 marks)**

QUESTION 5

(a) Light starts inside a glass of refractive index$n = 1.47$ at an angle of incidence $65.2°$ with the normal. Outside the glass is air. Find the angle of refraction (if it exists) for the light ray travelling from the glass to air and comment on the result you obtained. **(4 marks)**

(b) The near point of a person is 4.38 m. What should be the focal length of the spectacle lenses for the person to read a newspaper at a distance 24.5 cm? **(4 marks)**

(c) Four security lights are each rated at 35.0 W are kept on for 12.0 hours a day. How much does it cost to operate them for a year if electricity cost E145.00 per kW·h. **(4 marks)**

(d) A person standing on the ground and touches an 11.0 kV power line. The effective resistance of the person is 30 000 Ω.

i. Find the current through the person. **(2 marks)**

ii. State whether the person can be in dangerunder this electric shock. **(2 marks)**

iii. State any three effects of electric shock on the human body. **(3 marks)**

(e) Under the pressure of examinations, aEHS103 student wants to use a 220 V power-strip to try to power a 1500 W electric iron, a 1200 W electric kettle, a 800 W microwave oven and a 1800 W hot plate at once. The circuits breaker to where the power strip is connected to 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. **(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

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