UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

MAIN EXAMINATION 2015/2016

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) Give the definition of the dot product between two vectors and give an example of a situation where it is applicable. **(4 marks)**

(b) Given the vectors $\vec{A} = 2\hat{\imath} + 3\hat{\jmath} - 4\hat{k}$ and $\vec{B} = \hat{\imath} + 2\hat{\jmath} - 2\hat{k}$, find

i. the dot product of the two vectors, and **(3 marks)**

ii. the angle between them. **(4 marks)**

(c) The diagram in Figure 1 below illustrates the velocity-time graph of a body.

i. Sketch the acceleration-time and (5 marks)

ii. the displacement –time graphs for this motion. (6 marks)

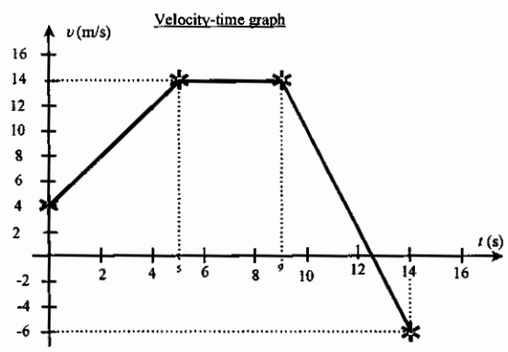


Figure 1.

(d) A body is projected vertically upward with a velocity of 20 m/s. Find the maximum height reached. **(3 marks)**

QUESTION 2

(a) The system shown in Figure 2 is in equilibrium. Find the required mass m that will result in the required horizontal force of 49.0 N to the right. The pulleys are frictionless and their masses can be neglected. **(12 marks)**

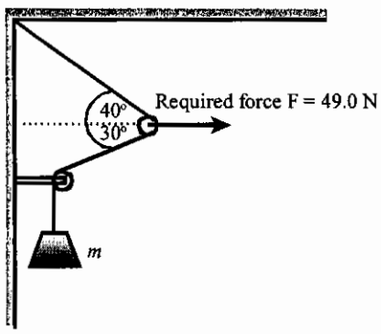


Figure 2.

(b) A student of mass 55 kg needs to climb a mountain of an effective height of 1.50 km.

(i) How much energy is directly needed to increase his elevation by the height stated? **(3 marks)**

(ii) List four other energy needs for the body during the climb. **(4 marks)**

(c) Explain with the aid of equations why you are more likely to be hurt if you collide with concrete than when you collide with a mattress. **(6 marks)**

QUESTION 3

(a) Explain why hypodermic needles have very small cross-sectional areas. **(6 marks)**

(b) A raft made from wood of density 574 kg/m^3 and forms a wooden length 2.00 m by width of 1.50 m, and height of 40 cm. It has to be used to transport relief supplies across a freshwater river. What is the maximum mass of cargo that can be transported across the river using this raft? **(8 marks)**

(c) The blood diastolic over systolic pressure of a patient is 130/90. What are these pressures in Pascal? **(4 marks)**

(d) Use Bernoulli's equation and diagrams to explain how a blood clot occurs in a blood vessel. Also explain why the detected pressure is very high. **(7 marks)**

QUESTION 4

(a) In a clinic a technician has to prepare an ice bath with 3 kg of ice at -10°C and 4 litres of fresh water in a perfectly insulating container. Determine the mass of ice that melts when the system reaches equilibrium. **(10 marks)**

(b) Full beverage containers tend to break when kept in a freezer for too long. Explain what causes this to happen? **(5 marks)**

(c) An industrial machine produces isotropic sound of acoustic power of 1.5 W. What is the sound level at a distance of 5 m, and state whether this sound level is safe to be exposed to for a prolonged period of time? **(6 marks)**

(d) The far point of a person is 50 m. What should be the focal length of the spectacle lenses for the person to watch sports up to 500 m? **(4 marks)**

QUESTION 5

(a) Explain two ways in which electricity can kill a person. **(4 marks)**

(b) A faculty of health student uses an 800 W microwave oven for 10 minutes to heat up his frozen dinner every day. Assume that the cost of electricity is E1.12 per kWh.

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

ii. What is the cost of the electricity used by the student per week. **(3 marks)**

(c) Consider the network shown in Figure 3.

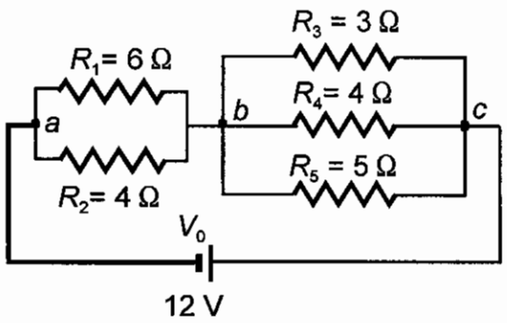
i. Find the effective resistance between points *a* and *b*. **(3 marks)**

ii. Find the effective resistance between points *b* and *c*. **(4 marks)**

iii. Find the effective resistance of the network. **(2 marks)**

iv. What is the total current through the network? **(2 marks)**

v. What is the power dissipated by the network? **(2 marks)**



(d) What do you understand by ionizing radiation. **(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

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

$$P + \rho g y + \frac{1}{2}\rho v^2 = constant$$