**UNIVERSITY OF SWAZILAND**

**FACULTY OF HEALTH SCIENCES**

**DEPARTMENT OF ENVIRONMENTAL HEALTH**

**SUPPLEMENTARY 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) Given two vectors $\vec{A} = 3\hat{\imath} + 2\hat{\jmath} - 4\hat{k}$ and $\vec{B} = \hat{2\imath} - 3\hat{\jmath} + 5\hat{k}$, find

i. the magnitude of the two vectors, **(2 marks)**
ii. the dot product of the two vectors, and **(3 marks)**
iii. the angle between the two vectors. **(2 marks)**

(b) A body starts at the origin with a velocity of 4 m/s and accelerates to 16 m/s in 4 s, and then moves at constant velocity for 5 s after which it accelerates to - 4m/s in 5 s. Sketch

i. the velocity-time, **(5 marks)**
ii. the acceleration-time, and **(6 marks)**
iii. the distance-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 to the forearm. **(10 marks)**

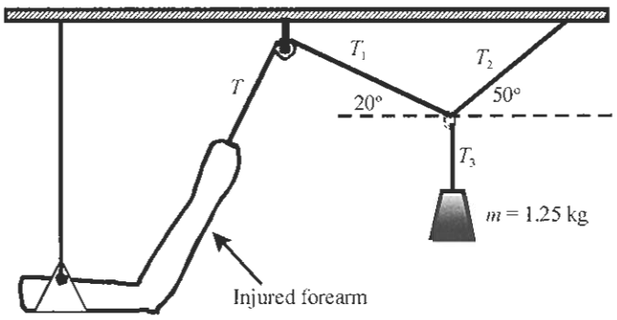


**Figure 1.**

(b) A hospital worker pushes a 50.0 kg cart with a force that makes an angle of 35.0° downward with the horizontal at constant velocity (see Figure 2). The coefficient of kinetic friction between the ground and the wheels of the cart is 0.200.

i. Make a complete resolved force diagram for the cart. **(4 marks)**
ii. Write down the force equations for the cart. **(2 marks)**
iii. Find the force $F$ applied to move the cart. **(3 marks)**
iv. Find the work done by the person if the cart is pushed for 30 m. **(2 marks)**
v. What is the work done by friction? **(2 marks)**
vi. What happens to the work done by friction? **(2 marks)**

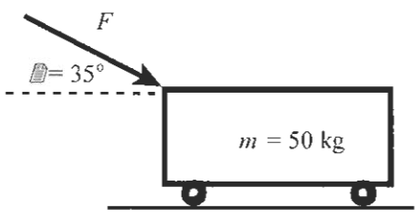


**Figure 2.**

**QUESTION 3**

(a) A bullet of mass $m = 4.20$ g moving with an initial supersonic velocity $v_0 = 965$ m/s strikes a stationary block of mass $M = 4.00$ kg resting on a frictionless surface. The block acquires a velocity $V' = 5.00$ m/s in the original direction of the bullet.

i. What is the final velocity of the bullet $v_f$ after the collision? **(7 marks)**

ii. Describe the motion of the bullet after the collision, and state which of the cases in Figure 3 below resembles the motion of the system after impact. **(3 marks)**

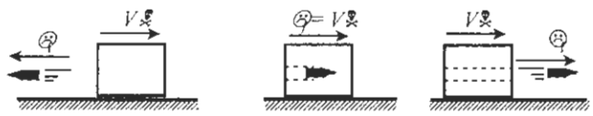

**Figure 3.** (a) (b) (c)

(b) A student taking EHS103, of mass $m = 55.0$ kg who cannot swim but wants to enjoy time in a swimming pool of fresh water. She finds a slab of wood of thickness $t = 10.0$ cm, and a density of 800 kg/m$^3$ (See Figure 4).

i. State Archimedes principle. **(3 marks)**

ii. What should be the minimum area of the slab of wood to support the student? **(8 marks)**

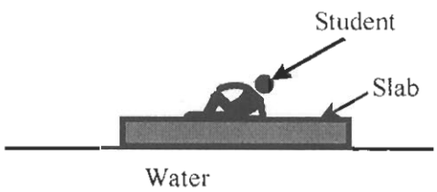


**Figure 4**

(c) A Sphygmomanometer is used to measure the blood pressure of a student and it is found to read 118/72 mmHg. What are these pressures in Pascal? **(4 marks)**

**QUESTION 4**

(a) On a day when the temperature is 98.0°F. What is the temperature in the Celsius and Kelvin scales? **(4 marks)**

(b) A wooden stick and a steel rod are left outside in a cold night. In the morning, a student picks up the rod and the stick. Which of the two will feel colder and why? **(4 marks)**

(c) List the three mechanisms by which heat is transferred from one region to another and the medium required for each case. **(6 marks)**

(d) How much heat energy is required to convert 5.00 kg of ice at −5.00°C to steam at 110°C. **(6 marks)**

(e) Consider a cylinder of Liquefied Petroleum Gas (LPG) that you can buy for your kitchen. After the cylinder has been filled with gas, you can connect it to a stove and use it for cooking.

i. After some time the stove will not light-up. At that time explain what will be the pressure in the gas cylinder. **(2 marks)**

ii. Explain why the gas does not come out to light-up the stove. **(3 marks)**

**QUESTION** 5

(a) A machine in a hospital produces isotropic sound of acoustic power of 1.50 W.

i. Determine the distance where the sound level is 120 dB. **(6 marks)**

ii. What is significant about the sound level of 120 dB? **(3 marks)**

(b) The near point of a person is 4.00 m. What should be the focal length of the spectacle lenses for the person to read a newspaper at 25.0 cm? **(4 marks)**

(c) At a house in Mbabane, four security lights are each rated at 100 W and are turned on at 18:00 and turned off at 06:00 by an automatic switch daily. The cost of electricity is E1.25 per kWh. Find the total cost of the electricity consumed daily by these lights over one normal year. **(4 marks)**

(d) Consider the network shown in Figure 5 below.

i. Find the effective resistance of the network. **(6 marks)**

ii. Find the total current through the network. **(2 marks)**

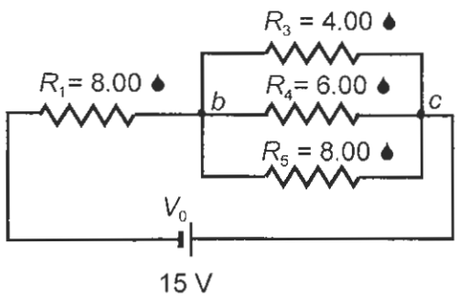


**Figure 5.**

## 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 = $1.36 \times 10^4$ 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 = $1.013 \times 10^5$ 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 = $4.186 \times 10^3$ 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
$\rho$ (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 = $-1.6 \times 10^{-19}$ 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 = $1.66 \times 10^{-27}$ kg
$\epsilon_0 = 8.85 \times 10^{-12}$ C$^2$(N·m$^2$)
1 Ci = $3.7 \times 10^{10}$ decays/s
1Bq = 1 decay/s

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

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