UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

SUPPLEMENTARY EXAMINATION 2013/2014

TITLE O F PAPER:	PHYSICS FOR HEALTH SCIENCES
COURSE NUMBER:	HSC107
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 the vectors $\vec{A} = 2\hat{\imath} + 4\hat{\jmath} - 2\hat{k}$ and $\vec{B} = 3\hat{\imath} - 2\hat{\jmath} + 2\hat{k}$, find

(i) the magnitude of each vector, **(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 is accelerated at 2 m/s^2 for 4 s, and then moves at constant velocity for 5 s after which it accelerated at -2 m/s^2 for 5 s. Sketch

(i) the acceleration-time, **(5 marks)**

(ii) the velocity-time, and **(6 marks)**

(iii) the displacement-time graphs for this motion. **(7 marks)**

QUESTION 2

(a) A hospital worker pushes a 45 kg cart with a force that makes an angle of 37° downward with the horizontal at constant velocity (see Figure 1). The coefficient of kinetic friction between the ground and the wheels of the cart is 0.2.

(i) Make a complete resolved force diagram for the cart. **(4 marks)**

(ii) Write down the force equations for the cart. **(3 marks)**

(iii) Find the force *F* applied to push the cart. **(4 marks)**

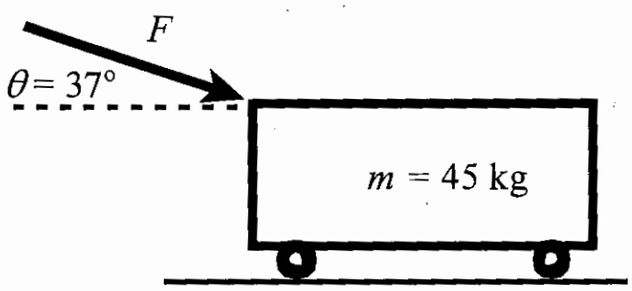

Figure 1

(b)

(i) Define work according to physics. **(2 marks)**

(ii) Define energy. **(2 marks)**

(iii) Discuss one case where work was done in your life today (or where you observed work being done) and give the energy source used. **(3 marks)**

(c) A construction worker of mass 85 kg falls over a height of 20 m. The collision with the ground takes 0.05 s.

(i) Define force in terms of momentum. **(2 marks)**

(ii) Determine the force of impact with the ground. **(5 marks)**

QUESTION 3

(a) A human muscle of length $l_0 = 22$ cm with a cross-sectional area $A = 2.53 \times 10^{-4}$ m^2 is under a tension of 200 N. The muscle stretches by $\Delta l = 0.950$ mm under this load. Determine the Young's Y modulus for this muscle. **(6 marks)**

(b) State Pascal's law and give an example of its application in everyday life. **(5 marks)**

(c) A block of wood of density ρ_b floats on water of density ρ_w.

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

(ii) Make a diagram that illustrates the forces on the floating block in terms of ρ_b, ρ_w and the acceleration due to gravity g. **(3 marks)**

(d) How much energy in joules is required to heat 1 kg of water from -10 °C to steam at 110 °C under standard atmospheric pressure? **(8 marks)**

QUESTION 4

(a) A medical machine at a clinic produces isotropic sound at a power of 0.800 W. What is the sound level (in dB) at a distance of 5 m from the machine? **(9 marks)**

(b) Light is incident from air to water at an angle of 37° with the normal. Find the angle of refraction in the water. **(5 marks)**

(c) Discuss the condition under which total internal reflection occurs, and give am example where it is applied. You can use the aid of diagrams. **(6 marks)**

(d) The near point of a person is 3 m. What should be the focal length of the spectacle lenses for the person to read a newspaper at 25 cm? **(5 marks)**

QUESTION 5

(a) Three resistors $R_1 = 4\ \Omega$, $R_2 = 5\ \Omega$ and $R_3 = 8\ \Omega$ are connected in parallel across an 18 V source.

(i) Find the current through each resistor. **(3 marks)**

(ii) Calculate the power delivered to each resistor. **(3 marks)**

(iii) What is the effective resistance of the network? **(3 marks)**

(b) A Faculty of Health Sciences student owns an electric space heater rated at 2000 W and 220 V rms. She turns on the heater at 6:00 p.m. and switches it off at 11:50 p.m.

(i) How much current is drawn by the heater? **(2 marks)**

(ii) What is the resistance of the heater filament? **(2 marks)**

(iii) How much energy in kilowatt-hours is consumed by the heater during the time it is on? **(3 marks)**

(iv) If electrical energy cost 105 cents per kilowatt-hour, what is the cost of the electricity consumed? **(2 marks)**

(c) A step down transformer is to be used to reduce the voltage from the 220 V rms wall socket voltage to 15 V rms in order to operate a music system. The transformer draws 500 mA from the wall socket.

(i) What is the turns-ratio of secondary to primary in the transformer? **(4 marks)**

(ii) What is the secondary current? **(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