UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

SUPPLIMENTARY EXAMINATION 2011/2012

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 GIVEN 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 GRANTED BY THE CHIEF INVIGILATOR

QUESTION 1

(a) Given the vectors $\vec{A} = 3\hat{\imath} + 4\hat{\jmath} - 2\hat{k}$ and $\vec{B} = 2\hat{\imath} + 3\hat{\jmath} - 4\hat{k}$, find the dot product of the two vectors. **(3 marks)**

(b) A body with an initial velocity of 2 m/s is accelerated at 3 m/s^2 for 4 s. It then moves at constant velocity for 4 s after which it is accelerated at -4 m/s^2 for 4 s. Sketch

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

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

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

(c) A body is shot vertically upward with a speed of 80 m/s. Calculate the highest distance reached by the ball. **(4 marks)**

QUESTION 2

(a) The system shown in Figure 1 is in equilibrium. Find the tension in each cord (T_1, T_2 and T_3). **(12 marks)**

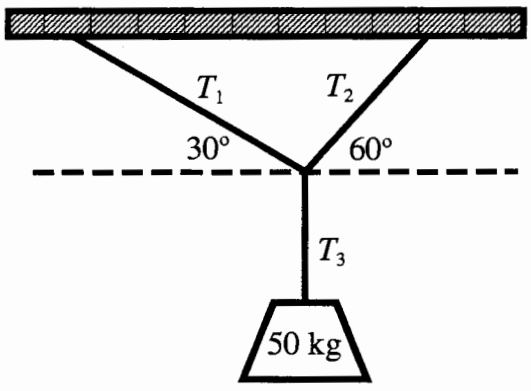


Figure 1.

(b) The system shown in Figure 2 is in equilibrium. The beam is uniform, 12 m long and weighs 2000 N. The box of mass m_b = 120 kg is placed 4 m from the pivot on the wall. The cable supporting the beam on the other side from the wall makes an angle of 40° with the horizontal as shown in the Figure.

i. Determine the tension on the cable. **(8 marks)**

ii. Find the x- and y-components of the reaction force by the wall. **(5 marks)**

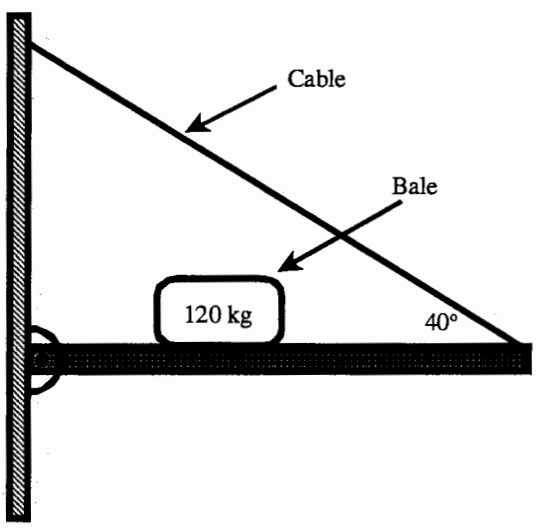


Figure 2.

QUESTION 3

(a) Work and energy:

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

ii. Define energy according to physics. **(2 marks)**

iii. Discuss whether or not a living plant does any work. **(3 marks)**

(b) A HSC107 student gets a vacation job to load 50 kg bags of cement placed at ground level on to a flat-bed truck 1.5 m from the ground. He eats a meal constituting 20 g white bread toast, one large egg and a 250 ml glass of milk. The calorific values are 2.65×10^3 calories per gram of white bread toast, 149×10^3 calories per large egg and 2.4×10^6 joule per litre of milk, where the calories are the scientific calories (4.186 J). How many bags of cement can the student load on the truck before getting hungry again, assuming that all the energy consumed is used to lift the bags? **(9 marks)**

(c) A bullet of mass $m = 200$ g moving with an initial speed $L_0 = 390$ m/s strikes a stationary block of mass $M = 5$ kg. The block acquires a velocity $V' = 15$ m/s after the impact.

i. What is the final velocity of the bullet L_f? **(7 marks)**

ii. Comment on the motion of the bullet after the impact. **(2 marks)**

QUESTION 4

(a) The Achilles tendon of a 75 kg athlete has a cross-sectional area of 56.3 mm^2, and a length of 26.5 cm. During a high jump, the athlete exerts a force equal to 10 times his weight on the tendon and the tendon stretches by 0.634 cm. Determine

i. the stress on the tendon, **(3 marks)**
ii. the strain on the tendon, and **(2 marks)**
iii. the Young's Modulus of the tendon. **(2 marks)**

(b) What is the blood pressure at 140 mm of Mercury? **(3 marks)**

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

(d) State Pascal's law and give an example of its application in everyday life. **(4 marks)**

(e) Find the temperature in Celsius on a day when it is 98°F? **(2 marks)**

(f) How much heat energy is required to convert 5 kg of water at minus ten degrees Celsius (-10°C) to steam at 120°C? **(6 marks)**

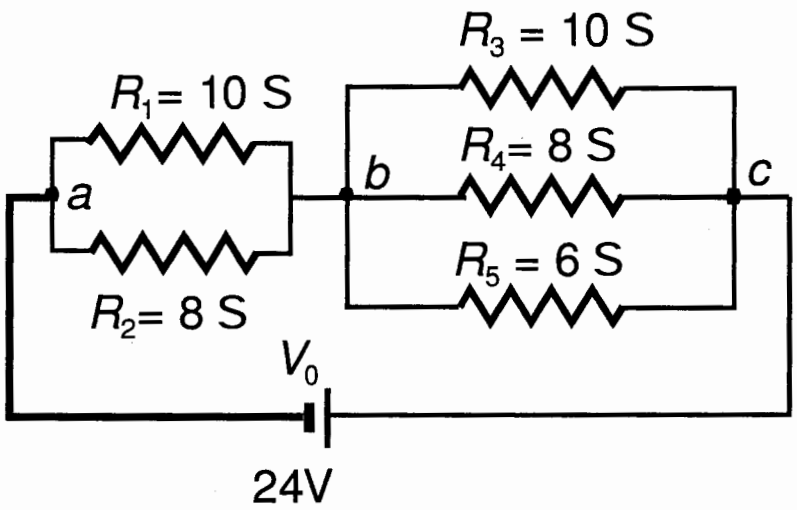
QUESTION 5

(a) An industrial machine produces 3 W of acoustic isotropic power. At what distance is the sound level 90 dB? **(9 marks)**

(b) The near point of a person is 2.5 m. What should be the focal length of his spectacle lenses to enable him to read a book at a distance of 24 cm? **(4 marks)**

(c) Consider the network shown in Figure 4.

i. Find the effective resistance between points a and b (R_{ab}). **(2 marks)**
ii. Find the effective resistance between points b and c. (R_{bc}). **(3 marks)**
iii. Find the effective resistance of the circuit R_{eff}. **(1 mark)**
iv. What is the voltage drop V_{ab} between junctions a an b? **(2 marks)**
v. What is the total current through the network? **(2 marks)**
vi. Determine the power consumed by the network. **(2 marks)**



GENERAL DATA SHEET

General data

Air refractive index = 1.00
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
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 $L_s = 343$ m/s
Stefan-Boltzmann constant $F = 5.67 \times 10^{-8}$ 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
$_{,0} = 8.85 \times 10^{-12}$ C^2(N.m^2)
1 Ci = 3.7×10^{10} decays/s
1Bq = 1 decay/s