UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION 2008/09

TITLE O F PAPER: INTRODUCTORY PHYSICS II

COURSE NUMBER: P102

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) If an explosion occurs at a large distance from you. Explain why you would feel the tremor before hearing the sound of the explosion. **(4 marks)**

(b) A sound output in a kwaito concert puts out 500 watts of acoustic power.

(i) What is the sound level in decibels 5 m from the source, and is it safe for listening by a human? **(6 marks)**

(ii) What should be the power output for the sound level to be 80 dB at a distance of 5 m?

(6 marks)

(c) A light ray inside glass of refractive index 1.47 makes an angle of incidence of 70° with the normal. The glass is surrounded by air of refractive index 1. Determine what happens to the light ray at the glass-air interface. **(4 marks)**

(d) An object is placed 5 cm in front of a lens of focal length 14 cm. Determine the image distance and state the nature of the image. **(5 marks)**

QUESTION 2

Three charges are arranged at the vertices of a triangle as shown in Figure 1.

(i) Write down the unit vectors $\hat{r}_{1,3}$ (unit vector in the direction from q_1 to q_3) and $\hat{r}_{2,3}$ (unit vector in the direction from q_2 to q_3). **(4 marks)**

(ii) What is the force between q_1 and q_3, $F_{1,3}$ and the force between q_2 and q_3, $F_{2,3}$ **(4 marks)**

(iii) What are the x- and y-components of the force on q_3 due to the other two charges q_1 and q_2? **(4 marks)**

(iv) What are the x- and y-components of the electric field at point P due to all the charges? **(6 marks)**

(v) What is the electric potential at point P? **(3 mark)**

(vi) What must q_3 be replaced by to make the electric potential at point P to be zero? **(4 marks)**

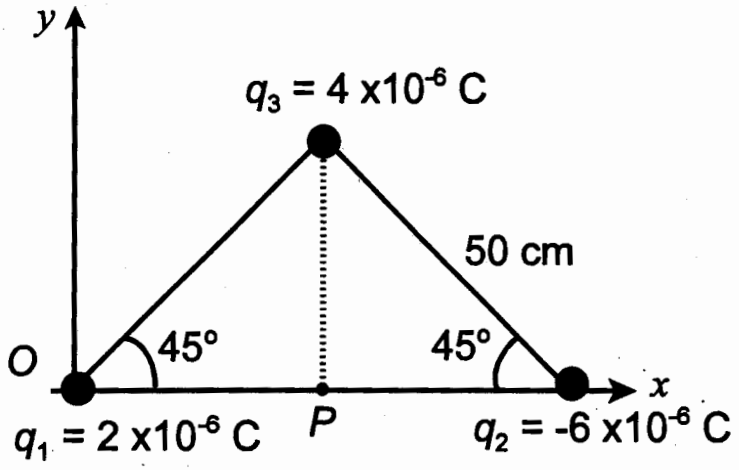

Figure 1.

QUESTION 3

(a) In the circuit shown in Figure 2,

(i) use Kirchoff's laws and a diagram to obtain three equations to determine the currents I_1, I_2, and I_3, and **(6 marks)**

(ii) determine the currents I_1, I_2, and I_3. **(14 marks)**

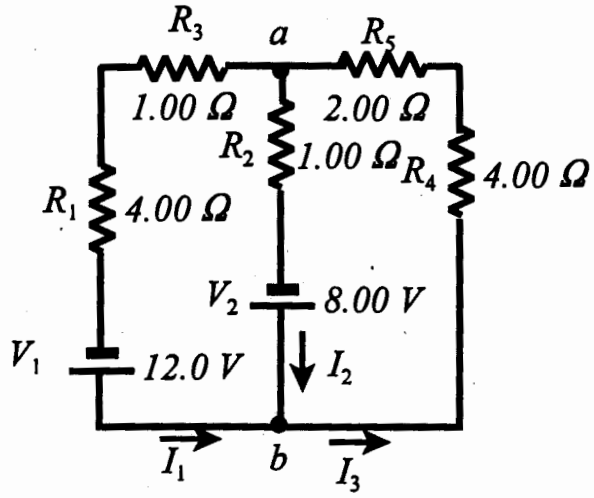

Figure 2.

(b) In Figure 3 the galvanometer of internal resistance 75 Ω is to be used as ammeter and requires a current of 0.500 mA for full scale deflection. What should be the shunt resistor R_s to make an ammeter with a full-scale deflection of 0.500 A? **(5 marks)**

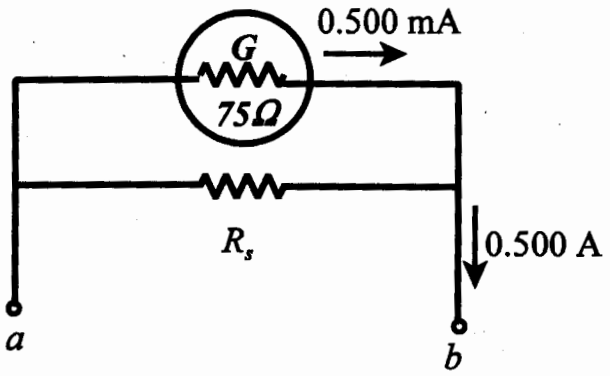

Figure 3.

QUESTION 4

(a) Consider a capacitor of capacitance C charged and discharged through a resistor R by an *emf* $\mathcal{E}$.

(i) Write down the equation for charging a capacitor of capacitance C through a resistor R by an *emf* $\mathcal{E}$. Sketch the graph for charging a capacitor and indicate the charge on each plate after one time constant. **(6 marks)**

(ii) Write down the equation for discharging a fully charged capacitor of capacitance C that was charged by an *emf* $\mathcal{E}$, when discharged through a resistor R. Sketch the graph for discharging a capacitor and indicate the charge left after one time constant. **(6 marks)**

(b) A wire loop is placed in a region with magnetic field $\vec{B}$ that is in the y-direction. The current I is moving clockwise. Determine how the wire will move if it will move at all. **(6 marks)**

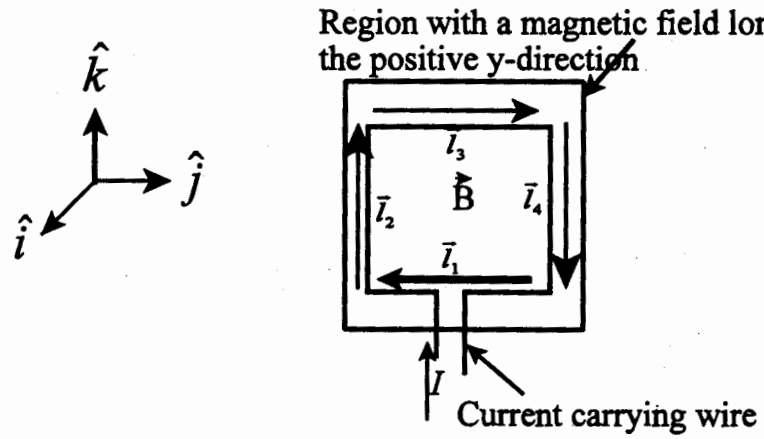

Figure 3.

(c) Determine an expression for the radius of curvature r of a charged particle of charge q and mass m that goes un-deflected through a velocity selector with magnetic field B and electric field E, after it enters an electric field free region with a magnetic field B' perpendicular to the direction of motion of the charged particle in terms of m, E, B, B', and q. **(7 marks)**

QUESTION 5

(a) An independent power company generates 40 MW of electricity to supply the national grid. The resistance of the wires to the national grid is 4 Ω. The voltage is generated at 22 kV and transmitted at 230 kV.

(i) At what current is the power transmitted? **(2 marks)**

(ii) How much electrical energy is lost by the company in kilowatt-hours per day during transmission? **(3 marks)**

(iii) If the company produces the electricity at 50 cents per kilowatt-hour and sells it at 74 cents per kilowatt-hour, how much money does the company lose per day in production and in sales. **(4 marks)**

(iv) If the company were to deliver the power at the production voltage of 25 kV, how much money would it loose per day in production costs? **(6 marks)**

(b) Fully explain the meaning of the following notation in nuclear physics:

$^{A}_{Z}X$. **(4 marks)**

(c) A sample contains 150 μg of a fluorine isotope ^{18}F prepared in the laboratory. This isotope has an activity $\lambda = 1.05 \times 10^{-4}\ s^{-1}$.

(i) What is the initial number N_0 of fluorine 18 nuclei in the sample? **(2 marks)**

(ii) What is the half life for this isotope. **(2 marks)**

(iii) How many nuclei are left after 48 hours? **(2 marks)**

GENERAL DATA SHEET

Avogadro's number $N_A = 6.022 \times 10^{23}$ mol^{-1}
Speed of light in vacuum $c = 2.9978 \times 10^8$ m/s
Speed of sound in air $\upsilon_s = 343$ m/s
Gravitational acceleration = 9.80 m/s^2
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N. m^2/kg^2
Density of mercury = 1.36×10^4 kg/m^3
Density of water = 1000 kg/m^3
Standard atmospheric pressure = 1.013×10^5 Pa
Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J/K
Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W/(m^2.K^4)
Gas constant $R = 8.314$ J/(mol.K)
Threshold of hearing $I_0 = 10^{-12}$ W/m^2
1 calorie = 1 c = 4.186 J
1 food calorie = 1 Calorie = 1C = 10^3 calories = 4.186×10^3 J

c(*water*) = 4186 J/(kg.K) c(*ice*) = 2090 J/(kg.K) c(*steam*) = 2079 J/(kg.K)
L_f(*ice*) = 3.33×10^5 J/kg L_v(*water*) = 2.260×10^6 J/kg

$$k_e = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9 \text{ N.m}^2/\text{C}^2$$

Charge of an electron = -1.6×10^{-19} C
Charge of a proton = $+1.6 \times 10^{-19}$ C
1 atomic mass unit = 1 amu = 1 u = 1.66×10^{-27} kg
Electron mass, $m_e = 9.109 \times 10^{-31}$ kg
Proton mass, $m_p = 1.673 \times 10^{-27}$ kg
Neutron mass $m_n = 1.675 \times 10^{-27}$ 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