UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION 2009/10

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) An isotropic source produces sound level of 125 dB at a distance of 15 m from the source.

(i) What is the sound intensity of the sound at the distance of 15 m? **(4 marks)**

(ii) What is the power of the source? **(2 marks)**

(iii) At what distance from the source is the sound level at 80 dB? **(4 marks)**

(b) A slab of material of refractive index 1.688 floats on water. Above the slab is air. The arrangement is shown in Figure 1. A light ray enters the slab from air at an angle $\theta = 70°$ with the normal. Determine by calculation the path of the light ray (i.e determine whether it is transmitted to air, reflected to the water, or trapped in the slab and transmitted to the right end). **(8 marks)**

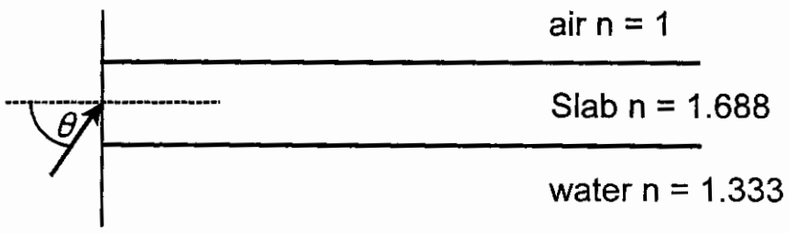

Figure 1.

(c) A lens has a focal length of 8 cm and an object is placed in front of the lens.

(i) Find the image distance when the object is placed 4 cm from the lens? **(2 marks)**

(ii) Find the image distance when the object is placed 12 cm from the lens? **(2 marks)**

(iii) What is the nature of the image in each of the two cases in (i) and (ii)? Justify your answers. **(3 marks)**

QUESTION 2

Three point charges are located at the corners of a triangle as shown in Figure 2.

(a) Make a diagram that can be used to determine the unit vectors $\hat{r}_{1,3}$ (the unit vector for the direction from the position of q_1 to q_3) and $\hat{r}_{2,3}$ (the unit vector for the direction from the position of q_2 to q_3), and write down the two unit vectors. **(4 marks)**

(b) Find the force on q_3 due to q_1, $F_{1,3}$, and the force on q_3 due to q_2, $F_{2,3}$. **(4 marks)**

(c) Determine the x- and y-components of the force on q_3 due to the other two charges. **(4 marks)**

(d) What is the electric field due to all the charges at point P? **(4 marks)**

(e) What is the electric potential at point P? **(3 marks)**

(f) How much work would be required to move a charge $q' = 6 \times 10^{-5}$ Coulomb from infinity to point P? **(2 marks)**

(g) By what charge must q_3 be replaced by to make the electric potential at point P to be zero? **(4 marks)**

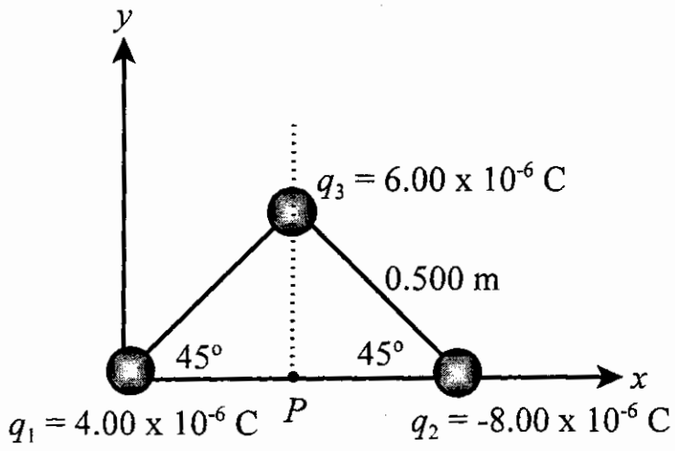

Figure 2.

QUESTION 3

(a) In the circuit shown in Figure 3,

(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. **(10 marks)**

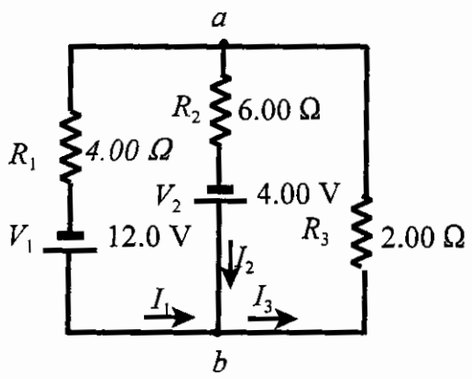

Figure 3.

(b) An *RC* circuit consists of a charging/discharging resistor $R = 4.7\ \text{k}\Omega$, a capacitor of capacitance $C = 20\ \mu\text{F}$ and the capacitor is fully charged by an *emf* of 24 V.

(i) What is the total charge in the capacitor? **(2 marks)**

(ii) What is the total energy stored in the capacitor? **(2 marks)**

(iii) What is the charge left in the capacitor after one time constant? **(2 marks)**

(iii) What is the power delivered by the capacitor in one time constant? **(3 marks)**

QUESTION 4

(a) In Figure 4 the galvanometer of internal resistance 50 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)**

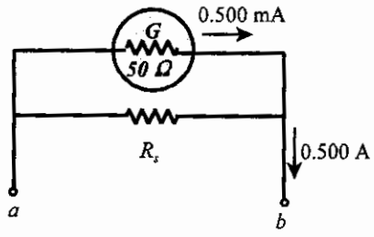

Figure 4.

(b) In a mass spectrometer charged particles enter the velocity selector with some velocity, after which they enter the electric field free region which only has a magnetic field. Discuss with the aid of diagrams and equations what happens to the charged particles in the velocity selector and in the magnetic field free region. **(12 marks)**

(c) The rectangular wire loop shown in Figure 5 carries a current I in the anticlockwise direction. It is placed in a region with a magnetic field $\boldsymbol{B}$ in the negative x-direction. Use the cross product to determine how the wire will move if it will move at all. **(8 marks)**

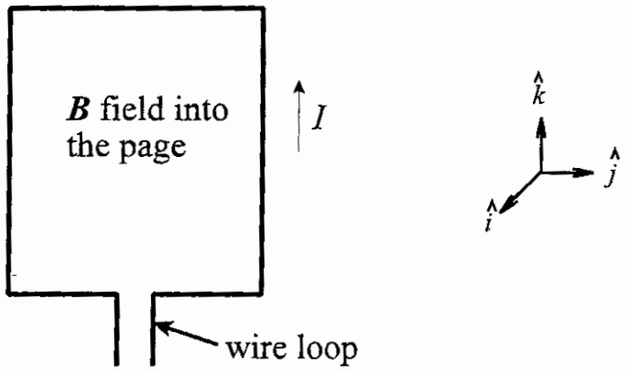

Figure 5.

QUESTION 5

(a) An appliance is rated at 1500 W at 220 V(rms).

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

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

(iii) If the kettle is kept on for 20 minutes what is the cost of the electricity consumed assuming that electrical energy cost 64.5 cents per kilowatt-hour. **(4 marks)**

(b) A step-up transformer is used for power transmission. The turns ratio in the transformer are 1:15 and is used with a 25 kV (rms) household service. The primary current is 1200 A.

(i) What is the secondary voltage? **(2 marks)**

(ii) What is the secondary current? **(2 marks)**

(c) A series RLC circuit has the following circuit parameter: $R = 470\ \Omega$, $L = 200$ mH, and $C = 4.47\ \mu$F. The applied AC voltage at 50 Hz has a peak voltage of 150 V.

(i) Find the impedance Z of the circuit. **(4 marks)**

(ii) Determine the peak current I_{max}. **(2 marks)**

(iii) Find the phase angle and state what it means? **(3 marks)**

(iv) What is the apparent power dissipated by the circuit? **(2 marks)**

(v) What is the true power dissipated by the circuit? **(2 marks)**

GENERAL DATA SHEET

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)
Avogadro's number $N_A = 6.022 \times 10^{23}$ mol^{-1}
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