

**ST. HENRY'S COLLEGE KITOVU  
END OF TERM I EXAMINATIONS 2004**

**PHYSICS PAPER 2**

**TIME: 2 ½ HRS.**

**S.6B/M**

**INSTRUCTIONS:**

Attempt any five questions with at least one but not more than two questions in each of the sections A, B, and C.

Acceleration due to gravity	=	$9.8 \text{ ms}^{-2}$
Permittivity of free space	$\epsilon_0$ =	$8.85 \times 10^{-12} \text{ Fm}^{-1}$
The constant	$\frac{1}{4\pi\epsilon_0}$ =	$9 \times 10^9 \text{ F}^{-1} \text{ m}$

Permeability of free space,  $\mu_0$  =  $4\pi \times 10^{-7} \text{ Hm}^{-1}$

Speed of sound in air =  $330 \text{ ms}^{-1}$

1. (a) What is meant by radii of curvature as applied to a converging lens? (1)

(b) (i) Show that the focal length of a converging lens is given by:  

$$\frac{1}{f} = (n - 1) \left( \frac{1}{r_1} + \frac{1}{r_2} \right)$$

Where  $n$  is the refractive index of the material of the lens and  $r_1$  and  $r_2$  are the radii of curvature of the surfaces of the lens. (5)

(ii) Calculate the focal length of a converging meniscus with radii 25 cm and 20 cm and refractive index 1.5. (2)

(c) (i) Explain the terms refraction and refractive index. (2)

(ii) State the condition necessary for minimum deviation to occur when a ray of light is passing through a prism. (1)

(iii) Describe how you would measure the minimum deviation,  $D$ , of a ray of light passing through a glass prism. (6)

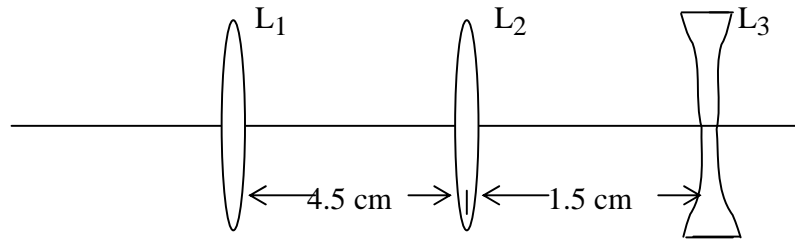
(iv) Find the angle of minimum deviation in c (iii) above, for a glass prism of refractive angle  $60^\circ$  and refractive index 1.52. (3)

2. (a) (i) What is meant by reflection of light. (1)

(ii) State the laws of reflection of light. (2)

(b) Explain, with the aid of a diagram, why a thick plane mirror forms multiple images. (4)

(c) Three thin lenses  $L_1$ ,  $L_2$  and  $L_3$  are arranged coaxially as shown below.



The focal lengths of the lenses are 20 cm, 15 cm and 5 cm respectively.

An object O is placed at a distance of 30 cm from  $L_1$ . Find:

(i) the position. (4)

(ii) size and nature of the image formed by this lens system. (5)

(d) Sketch a graph of image distance against object distance for a concave mirror and use it to describe the image formed by the mirror as the object distance varies from very large to very small values. (4)

3. (a) The equation  $y = a \sin(\omega t - kx)$  represents a plane wave traveling in a medium along the x-direction, y being the displacement at the point x at time t.

(i) Deduce whether the wave is travelling in the positive x-direction or in the negative x-direction. (3)

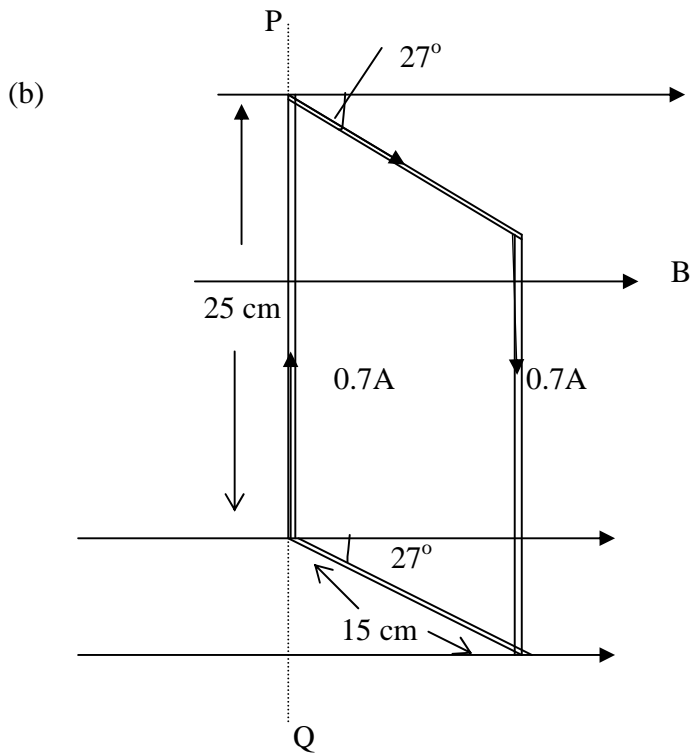
(ii) If  $a = 2 \times 10^{-2}$  m,  $\omega = 6.6 \times 10^3$  s<sup>-1</sup> and  $K = 20$  m<sup>-1</sup>, calculate the speed of the wave and the maximum speed of a particle of the medium due to the wave. (6)

(b) Explain how beats are produced and derive an expression for the beats frequency. (6)

(c) A whistle of frequency 1000 Hz is sounded on a car travelling with a velocity of 18ms<sup>-1</sup> towards a stationary source of sound of frequency 900Hz, calculate the frequency of the beats heard by the driver of the car. (5)

## SECTION B

4. (a) (i) Explain the differences between magnetic flux and magnetic flux density. (3)
- (ii) A circular coil of 50 turns and area  $0.03 \text{ m}^2$  is placed on a plane plank inclined at an angle of  $36^\circ$  to the horizontal with its plane area parallel to the plane of the plank. A vertical magnetic field of flux density  $0.2 \text{ T}$  is threading the region of the plank. Calculate the flux linking the coil. (3)
- (b) (i) Write an expression for the magnetic flux density at the center of a circular coil radius  $R$  and  $N$  turns carrying current  $I$ . (1)
- (ii) With the aid of a diagram, describe an experiment to investigate the variation of magnetic flux density at the center of the circular coil with the current through the coil. (6)
- (c) Two horizontal thin rods,  $1.0 \text{ m}$  in length carry currents of equal magnitude and are oriented so that one of the rods is located  $5.0 \times 10^{-3} \text{ m}$  above the other. The lower rod is fixed. The upper rod is kept in equilibrium by magnetic repulsion. The mass of each rod is  $1.0 \times 10^{-2} \text{ kg}$ .
- (i) What is the magnitude of the current in each rod? (5)
- (ii) What are the directions of currents in each rod? (1)
- (d) State why the electrostatic force is always ignored in the definition of an ampere. (1)
5. (a) (i) A small rectangular coil of  $N$  turns with cross sectional area  $A$  is suspended so that it can rotate about a vertical axis through the center of its shorter sides. The coil is arranged so that the vertical sides are perpendicular to a uniform magnetic field of flux density  $B$ .
- Derive an expression for the torque on the coil when a current  $I$  amperes flows and the plane of the coil makes an angle  $\theta$  with the direction of the magnetic field. (4)
- (ii) Explain the additional requirements needed if the arrangement described in (i) above is to be used to measure current; with the arrangement giving a linear scale. (4)

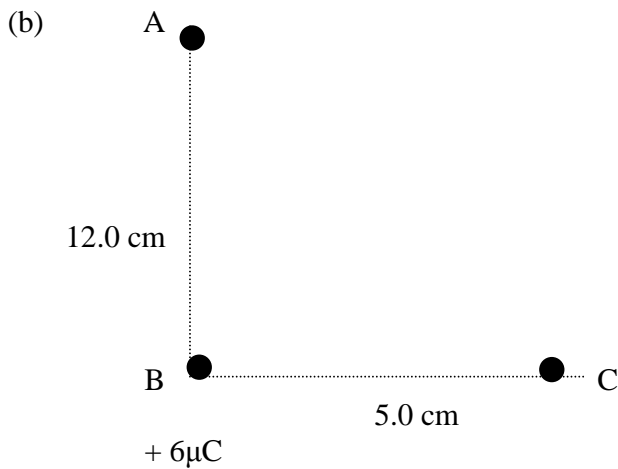


A rectangular coil of 50 turns has dimensions  $25\text{ cm}$  by  $15\text{ cm}$ . The coil is hinged along an axis  $PQ$  and the plane of the coil makes an angle of  $27^\circ$  with the uniform magnetic field of flux density  $0.4\text{ T}$  as shown above.

- (i) What is the magnitude of the torque exerted on the coil when a current of  $0.7\text{ A}$  is passed through the coil as shown? (3)
  - (ii) What is the expected direction of rotation of the coil? (1)
- (c)
- (i) What is meant by back e.m.f. in a d.c. motor. (2)
  - (ii) Show how the back e.m.f. in motor is related to the efficiency of the motor. (3)
  - (iii) State the power losses in a d.c. motor and how these power losses are minimized in practice. (3)

### SECTION C

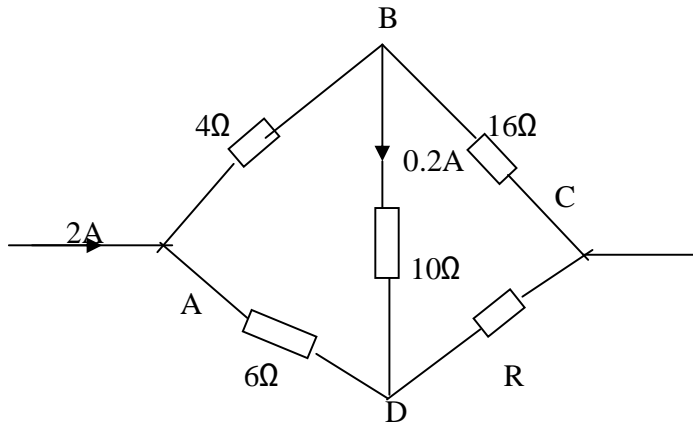
6. (a) (i) Define electric potential and electric field intensity. (2)
- (ii) Derive the relationship between electric potential and electric field intensity. (4)



Two points A and C at distance of 12.0 cm and 5.0 cm respectively, from a point charge of 6 $\mu$ C situated at B as shown in the figure above.

- (i) Find the electric potential difference between A and C. (5)
- (ii) Calculate the energy required to bring a charge of 2 $\mu$ C (2)
- (c) (i) What is meant by corona discharge? (2)
- (ii) Explain how the lightning conductor works. (5)
7. (a) (i) What is relative permittivity of a medium? (1)
- (ii) Describe an experiment to determine the relative permittivity of a medium. (5)
- (ii) State two physical properties desirable in a material to be used as the dielectric in a capacitor. (2)
- (b) Two capacitors of 4 $\mu$ C and 2 $\mu$ C respectively, are joined in series with a battery of e.m.f. 90V. When they are completely charged, their connection are broken and the like terminals of the capacitors joined. Find the final charge on each capacitor. (5)
- (c) (i) Derive an expression for the energy stored in a capacitor C. when there is a p.d. V between the plates. (4)
- (ii) Show that when the battery is used to charge a capacitor through a resistor, the heat dissipated in the circuit is equal to the energy stored in the capacitor. (3)
8. (a) (i) With the aid of a labelled circuit diagram, describe how a Wheatstone bridge can be used to determine the value of a resistance of approximately 5 $\Omega$ . (6)
- (ii) State two factors on which the accuracy of the measurement obtained from the Wheatstone bridge depends. (2)

- (b) The diagram below shows an electrical network in which the currents and resistances are as indicated.



Find

- (i) the value of R (5)  
(ii) the potential drop across AC (2)
- (c) Outline the principle of operation of a slide wire potentiometer. (5)

**END**