UACE PHYSICS PAPER 2003

Instructions to the candidates:

Answer **five** questions taking at least one from each of the sections **A, B, C** and **D**, but not more than one question should be chosen from either section **A** or **B**

Any additional question (s) will not be marked.

Mathematical tables and squared paper will be provided

Non programmable calculators may be used.

Assume where necessary

Acceleration due to gravity, g	$9.81ms^{-2}$
Electron charge, e	$1.6 \times 10^{-19}C$
Electron mass	$9.11 \times 10^{-31}kg$
Plank's constant, h	$6.6 \times 10^{-34}Js$
Speed of light in the vacuum, c	$3.0 \times 108ms^{-1}$
Specific heat capacity of water	$4.200Jkg^{-1}K^{-1}$
Avogadro's number, N_A	$6.02 \times 10^{23}mol^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_0}$	$9.0 \times 10^{9}F^{-1}m$
Permittivity of free space, μ_0	$4.0\pi \times 10^{-7}Hm^{-1}$
Permittivity of free space, ε_0	$8.85 \times 10^{-12}Fm^{-1}$
One electron volt	$1.6 \times 10^{-19}J$
Resistivity of Nichrome wire at 25^0C	$1.2 \times 10^{-6}\Omega m$

SECTION A

1. (a) (i) State the laws of reflection of light. (02marks)

   (ii) Show that an incident ray of light reflected successively from two mirrors inclined at an angle θ to each other, is rotated through 2θ. (04marks)

   (b) Describe how a sextant is used to measure the angle of elevation of a sun. (05marks)

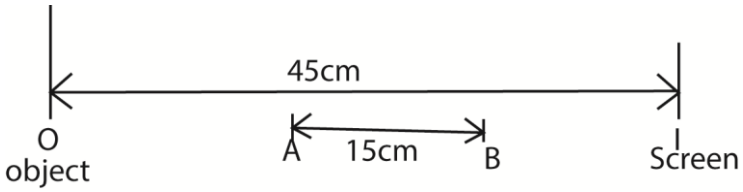
   (c) (i) Describe an experiment to measure the focal length of a convex mirror. (05marks)

   (ii) A concave lens of focal length 20cm is placed 10cm in front of a concave mirror of focal length 16cm. Calculate the distance from the lens at which an object would coincide with its image. (04marks)

2. (a) Explain with aid of a diagram, why a thick plane mirror forms multiple images. (04marks)

   (b) Derive an expression for the focal length of a combination of two thin converging lenses in contact, in terms of their focal lengths. (05marks)

   (c)



   In the diagram above, the image of the object is formed on the screen when a convex lens is placed at A or B. if A and B are 15cm apart, find the

   (i) Focal length of the lens. (03marks)
   (ii) Magnification of the image formed when the lens is at B. (03 marks)

   (d) Draw a ray diagram of a Galilean telescope and derive the expression for magnifying power when in normal adjustment. (05marks)

3. (a) Define wavelength of a wave (01mark)
   (b) A source of sounding moving with velocity u_s approaches an observer moving with velocity u_0 in the same direction, derive an expression for frequency of sound heard by the observer. (05mark)
   (c) Explain what happens to the pitch of the sound heard by the observer in (b) above when
      (i) Observer moves faster than the source (02marks)
      (ii) Observer's velocity is equal to that of the sound. (02marks)
   (d) State and explain one application of Doppler Effect. (05marks)
   (e) The wire of the guitar of length 50cm and mass per meter 1.5×10^{-3}kg is under tension of 173.4N. If it is plucked at the middle point, find the
      (i) Frequency (03marks)
      (ii) The wavelength of the fundamental note (02marks)

4. (a) (i) What is meant by interference of waves? (02marks)
   (ii) State conditions for observation of an interference pattern (02)
   (iii) Describe how interference can be used to test for flatness of the surface.
   The surface under test is made to form an air-wedge with a plane glass surface of standard smoothness.
   (b) Describe with the use of a diagram, how the wavelength of monochromatic light can be measured using Young's double slit method (05marks)
   (c) Two microscope slides are in contact at one end and are separated by a thin piece of paper at the other end. Monochromatic light is directed normally on the wedge.
      (i) What types of fringes will be observed? (02marks)
      (ii) Explain what will be observed if a liquid is introduced between the slides (02mark)
   (d) When monochromatic light of wavelength 5.8×10^{-7}m is incident normally on a transmission grating. The second order diffraction line is observed at an angle of 27^0. How many lines per centimeter does the grating have? (04marks)

SECTION B

5. (a) (i) Write down the expression for the force exerted on a straight wire of length, L meter carrying a current, I amperes at right angles to magnetic field of flux density B tesla (01marks)

   (ii) A rectangular coil of N-turns and area A m^2 is suspended in a uniform magnetic field of flux density B tesla. Initially the plane of the coil is at right angles to the magnetic field. Derive an expression for the initial couple on the coil when a current I amperes flows through the coil. (05marks).

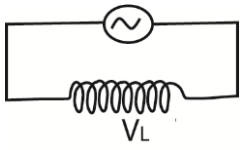
   (b) Draw a labelled diagram of a moving coil galvanometer and explain how it works (06 marks)

   (c) A small circular coil of 10 turns and mean radius 2.4cm is mounted at the center of a long solenoid of 750 turns per meter with its axis at right angles to the axis of the solenoid. If the current in the solenoid is 2.0A, calculate the initial torque on the circular coil when a current of 1.0A is passed through it. (05marks)

   (d) Explain why a current carrying conductor placed in a magnetic field experience a force. (03marks)

6. (a) (i) What is meant by the root mean square value of alternating current? (01mark)
   (ii) Describe with the aid of a labelled diagram, the structure and action of a moving iron meter. (05marks)
   (iii) What is meant by the term reactance? (01mark)

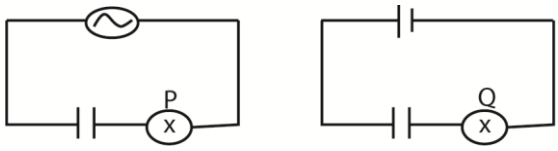
   (b) In the diagram below, V_L is the voltage drop across the inductor.



(i) Draw a vector diagram to show the orientation of V_L with respect to current I (01mark)

(ii) Using the same axes, sketch graphs to show the variation of V_L with current I with time (02marks

(c)



The bulb P and Q have the same rating. P is connected in series with a capacitor across an a.c source while Q is connected in series with an identical capacitor across a d.c., source of e.m.f equal to root mean square voltage of the a.c as shown in the figure above. Explain why bulb P light continuously while bulb Q does not. (05marks)

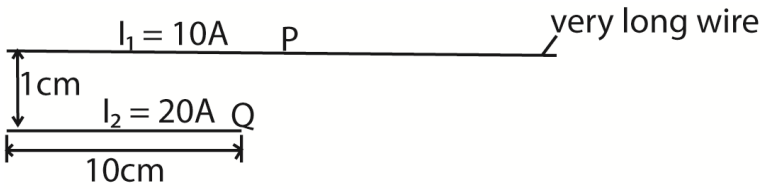
(d) A 240V, 60W alternating voltage is applied across a capacitor of capacitance 10μF. Calculate the

(i) root mean square value of the current which flows (04marks)

(ii) power expended. (01marks)

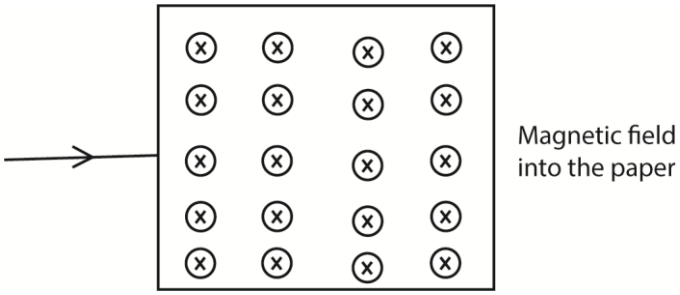
7. (a) (i) Define ampere (01mark)

(ii)



The diagram in the figure above show a parallel wire P and Q placed 1cm apart and carrying current currents of 10A and 20A respectively in the same direction. If wire Q is 10cm long, find the magnetic force acting on it. (04marks)

(b) A stream of electrons enter normally, a uniform magnetic field which is perpendicular to and directed into the plane of the page as shown below



Explain, with the aid of a diagram, the path of electrons while inside the field and after leaving it (06marks)

(c) Explain why, when a current is switched off in some circuits, a spark is seen across the gap of the switch. (03mark)

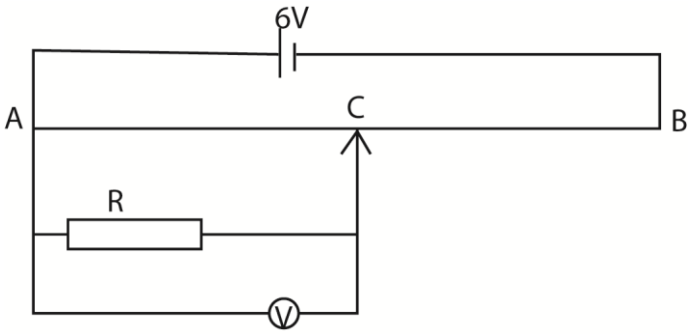
(d) Show that the total charge which passes through a coil depends only on the resistances of the coil and the total flux linked. (06marks)

SECTION C

8. (a) (i) Define electrical resistivity and the ohm. (02marks)

(ii) Describe an experiment to determine electrical resistivity of a material in form of a wire using a meter bridge. (07marks)

(b)



In the figure above wire AB of length 1.00m has a resistance of 10Ω. If point C is the midpoint of AB, and the voltmeter reading is 2.0V, find the value of R. (06marks)

(c) Describe the current versus voltage characteristics of a

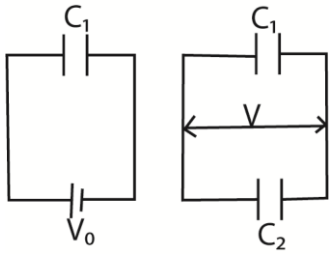
(i) semi-conductor diode (02marks)

(ii) filament lamp (02marks)

(d) Why does Ohm's holds at constant temperature only? (01mark)

9. (a) Define the terms dielectric constant and capacitance (02marks)

(b) An air capacitor of capacitance 400μF is charged to 180V and then connected across an uncharged capacitor of capacitance 500μF.



(i) find the energy stored in the 500μF capacitor. (04marks)

(ii) With the capacitor still connected a dielectric of dielectric constant 1.5 is inserted between plates of the 400μF capacitor.
If the separation between the plates remains the same find the new p.d across the two capacitors. (03marks)

(c) (i) state the characteristics of an equipotential surface. (02marks)

(ii) Describe how a conductor can be charged at zero potential (03marks)

(d) Describe with the aid of a diagram how a high voltage can be generated using a Van de

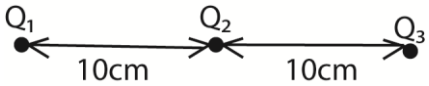
10. (a) (i)State coulomb's law (01marks)

(ii) Show that the electric flux through a spherical surface enclosing a charge in vacuum is Q/E_0

(02marks)

(b) Define the term electric field intensity and electric potential (02marks)

(c)



Three point charges Q_1, Q_2, and Q_3 of magnitude +5μF, +6μF and -20μF respectively are situated along a straight line as shown in figure above. Calculate the electric field

(i) Intensity midway between Q_1 and Q_2 (03marks)

(ii) Potential midway between Q_1 and Q_2 (03marks)

(d) (i) Explain why two insulating bodies rubbed together acquire equal and opposite charges. (03marks)

(ii) Describe how a gold leaf electroscope can be used to verify the observation in (d)(i) above (06marks)

END