UACE PHYSICS PAPER 2000 GUIDE

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) Define the principal focus of a converging lens. (1mark)

(b) A converging lens of focal length, f, is placed between a finite object and a screen. The position of the screen is adjusted until a clear magnified image is obtained on the screen. Keeping the screen fixed in this position, a distance L from the object, the lens is displaced through a distance, d, to obtain a clear diminished image on the screen.

(i) Draw a ray diagram to show the formation of the image in the two cases. (02marks)

(ii)Show that $L^2 - d^2 = 4df$ (05marks)

(iii) Find the product of the magnifications produced in the two cases. (02marks)

(c) (i) Draw a ray diagram to show how two converging lenses, one of long focal length, f_1, and the other of shorter focal length, f_2, can be arranged to make an astronomical telescope in normal adjustment. (02marks)

(ii) Derive the expression for the magnifying power of the telescope in this setting. (03marks)

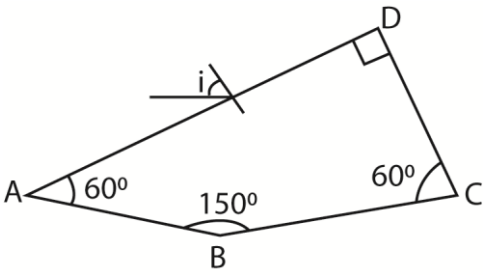
(d) The objective of a compound microscope has focal length of 2.0cm while the eyepiece has a focal length of 5.0cm. An object is placed at a distance of 2.5cm in front of the objective. The distance of the eyepiece from the objective is adjusted so that the final image is 25cm in front of the eyepiece. Find the distance between the objective and the eyepiece. (05marks)

2. (a) (i) What is meant by refraction of light? (01mark)

(ii) State laws of refraction (02marks)

(b) Describe how the refractive index of a material of a glass prism of known refractive angle can be determined using a spectrometer (06marks)

(c)



A ray of light is incident on face Ad of a glass bloc as shown in the figure above. The refractive index of the material of the glass block is 1.52. If the ray emerges normally through face BC after total internal reflection, calculate the angle, i. (05marks)

(d) Explain how a mirage is formed. (03marks)

(e) An object at a depth of 3.0m below the surface of water is observed directly from above the surface. Calculate the apparent displacement of the object if the refractive index is 1.33. (03marks)

3. (a) State the principle of superposition of waves (1mark)

(b) Two loud speakers producing sound of the same frequency are placed 50m apart facing each other. An observer walks from one speaker to the other along the line of the speaker.

(i) What does the observer hear? (2marks)

(ii) Explain the observation in (b)(i) (4marks)

(c) Describe with the aid of a diagram how you can determine the velocity of sound in air by a method which uses interference of sound. (6marks)

(d) A progressive wave and stationary wave each has a frequency of 240Hz and speed of 80ms^{-1}. Calculate

(i) Phase difference between two vibrating points in progressive waves, which are 6cm apart. (04marks)

(ii) Distance between nodes in stationary wave. (03marks)

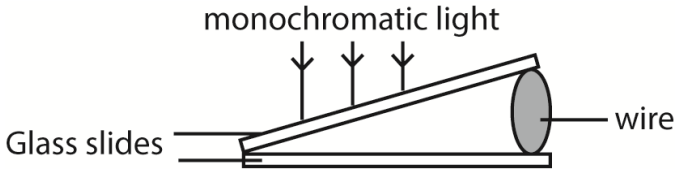
Distance between nodes = $\frac{\lambda}{2}$

4. (a) What is meant by coherent source of light? (03marks)

(b) (i) outline the principles of Young's double slit interference and derive the expression for fringe separation. (07marks)

(ii) What would be the effect of replacing monochromatic light by white light in Young's double slit experiment. (03marks)

(c) An air wedge is formed by placing two glass slides of length 5.0cm in contact at one end and a wire at the other end as shown in the figure below



Viewing from vertically above, 10 dark fringes are observe to occupy a distance of 2.5mm when the slides are illuminated with light of wavelength 500mm.

(i) Explain briefly how the fringes are formed. (03marks)

(ii) Determine the diameter of the wire. (04marks)

For the first 10 dark fringes, L = 5.0cm = 5.0 x 10^{-2}m;

SECTION B

5. (a) Write down an expression for the magnetic flux density at
   (i) A perpendicular distance, d, from a long straight wire carrying a current I, in vacuum. (01mark)
   (ii) The center of a circular coil of N turn of radius, R, and carrying a current, I(01mark)
   (iii) The center of an air-cored solenoid of a turns per meter each carrying a current I. (01mark)

   (b) Sketch the magnetic field pattern around a vertical current carrying straight wire in the earth's field and used it to explain a neutral point in a magnetic field. (04marks).

   (c) What is meant by terms:

   (i) magnetic meridian (01mark)

   (ii) angle of dip? (01marks)

   (d) A circular coil of 10 turn and diameter 12cm carries current I. The coil is placed with its plane in the magnetic meridian. A small magnetic needle placed at the center of the coil makes 30 oscillation per minute about a vertical axis.

   When the current is cut off, it makes 15 oscillations per minute. If the horizontal component of the earth's magnetic flux density is 2.0×10^{-5}T, calculate the magnitude of I.

   (Assume that the square of frequency of oscillation is proportional to the magnetic flux density) (07marks)

   (e) Explain what is meant by eddy currents and give four of their applications. (04marks)
   When the magnetic flux cutting across a metal changes, an e.m.f is induced in the metal. This causes eddy currents to circulate within the metal. These currents flow in a direction as to oppose the magnetic flux threading the metal

6. (a) State laws of electromagnetic induction. (02 marks)

   (b) (i) With the aid of a labelled diagram, describe the structure and mode of action of a.c. transformer (05mark)
   (ii) What are the main energy losses in a practical a.c. generator and how are they minimized? (02marks)

   (c) An a.c. transformer operates on a 240V mains. The voltage across the secondary which has 900 turns is 20V.

   (i) Find the number of turns in the primary. (02marks)

   (ii) If the efficiency of the transformer is 80%, calculate the current in the primary coil when a resistor of 40Ω is connected across the secondary. (04marks)

(d) Two long parallel wires X and Y are separated by 8cm in a vacuum. The wires carry currents of 10A and 5A respectively in the same direction. At What points between the wires is the magnetic flux density is zero? (03marks)

7. (a) Define the terms amplitude and root mean square (r.m.s) value an alternating current. (02marks)

(b) A sinusoidal current I = 4sin (100πt) amperes flows through a resistor of resistance 2.0Ω. Find the mean power dissipated in the resistor. Hence deduce the r.m.s value of the current. (04marks)

(c) Describe, with the aid of a labelled diagram, how a hot wire ammeter works. (05marks)

(d) An inductor of inductance, L is connected across a source of alternating voltage, $V = V_0 \sin\omega t$.
(i) Find the current which flows (03marks)

(ii) Sketch using the same axes, the variation with time of the voltage across the inductor and the current through it, and explain the phase difference between them (06marks)

SECTION C

8. (a) Distinguish between e.m.f and terminal p.d of a battery. (02marks)

(b)(i) define electrical resistivity (01mark)
(ii) Explain any two factors on which the resistance of a conductor depends. (05marks)

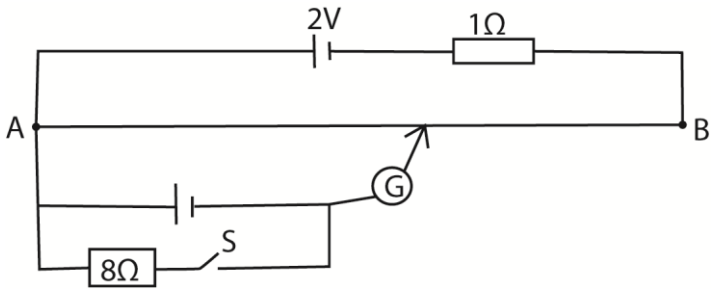
(c) Two wires A and B have length which are in ratio 4:5, diameter which are in ratio 2:1, and resistances in ratio of 3:2. If the wires are arranged in parallel and a current of 1.0A flows through the combination, find the
(i) Ratio of resistance of wire A to that of wire B (04marks)
(ii) Current through wire A (03marks)

(d) Explain why a wire becomes hot when current flows through it. (05marks)

9. (a)(i) State Ohm's law (01marks)
(ii) State the factors which affect the resistance of a conductor. (02marks)
(iii) A conductor of length L and cross section area A has free electrons per unit volume each of charge e. find the drift velocity, v, of these electrons if a current, I, flows through the conductor. (04marks)

(b) Outline the principle of a slide wire potentiometer. (04marks)

(c)



In the figure above the slide wire AB is 1m long and has resistance 4Ω. When switch S is:

(i) Open the balance length Ac is 88.8cm. find the value of the e.m.f of the cell (03mark)

(ii) Closed, the balance length is found to be 82.5cm.

(iii) Calculate the internal resistance of a cell. (04marks)

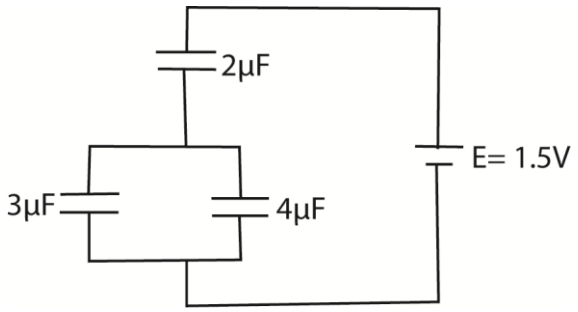
(e) State two advantages of using a potentiometer for measuring voltage (02marks)

10. (a) What is a dielectric material

(b) A capacitor filled with a dielectric is charge and then discharged through a milliammeter. The dielectric is then withdrawn half way and the capacitor charged to the same voltage, and discharged through the milliammeter again, show that the relative permittivity, E_r of the dielectric is given by $E_r = \frac{I}{2I'-I}$ where I and I' are the readings of the milliammeter respectively. (06marks)

(c) Describe with the aid of a diagram how you would determine the capacitance of a capacitor. (05marks)

(d)



A battery of e.m.f 15V is connected across a system of capacitors as shown above, find the

(i) Charge on the 4μF capacitor (04marks)

(ii) Energy stored in the 3μF capacitor. (04marks)

END