UACE PHYSICS PAPER 2004

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) What is meant by the following terms as applied to a telescope?
   (i) magnifying power (01mark)

   (ii) eye-ring (01mark)

   (b) (i) Draw a ray diagram to show the formation of the final image by an astronomical telescope in normal adjustment. (03marks)

   (ii) With the aid of the diagram in (b) (i), derive an expression for the magnifying power of an astronomical telescope in normal adjustment. (04marks)

   (iii) Give the disadvantage of the telescope in (b)(i) when used to view distant objects on earth. Describe how the telescope can be modified to overcome this disadvantage. (04marks)

   (c) Find the separation of the eye-piece and objective of an astronomical telescope of magnifying power 20 and in normal adjustment, if its eyepiece has a focal length of 5cm. (04marks)

   (d) State three advantages of a reflecting telescope over a refracting telescope. (03marks)

2. (a) Define the terms principal focus and power of a lens. (02marks)

   (b) Derive the relation between the focal length, f, objective distance, u, and image distance, v, for a thin lens. (07marks)

   (c) A thin converging lens, P, of focal length 10cm and a thin diverging lens, Q, of focal length 15cm are placed coaxially 50cm apart. If an object, O, is placed 12cm from P on the side remote from Q.

   (i) find the position, nature and magnification of the final image. (07marks)

   (ii) Sketch a ray diagram to show the formation of the final image. (02marks)

   (d) Explain why lenses of narrow aperture are preferred to lenses of wide aperture in optical instruments (02marks)

3. (a) (i) What is meant by polarized light
   (ii) Describe how plane polarized light can be produced (02marks)
   (iii) Sketch the time variation of electric and magnetic vectors in plane polarized light.

   (b) Two coherent sources a distance, S, apart produce light of wavelength λ which overlap at a point on a screen at distance D from the sources to form interference pattern.
   (i) What is meant by coherent sources? (02marks)
   (ii) Show that fringe width, ω, is given by $\omega = \frac{\lambda D}{S}$ (04marks)

   (iii) If $\lambda = 5.46 \times 10^{-7}$m, $S = 5 \times 10^{-5}$m and D = 0.3m, find the angular position of the first dark fringe on the screen.(04marks)

   (c) (i) What is meant by diffraction of light? (02marks)
   (ii) Light of wavelength 6×10^{-7}m is incident on diffraction grating with 500 lines per cm. find the diffraction angle for the first order image. 03marks)

4. (a)(i) Distinguish between longitudinal and transverse waves (02marks)

(ii) Define wavelength of a wave. (01mark)

(b) Describe with the aid of a diagram, an experiment to show the fundamental frequency varies with the tension in a given wire.

(c) A sound wave propagating in the x-direction is given by the equation
$y = 2 \times 10^{-7}\sin(\sin 8000t - 25x)$ meters. Find
(i) Amplitude (01mark)
(ii) The speed of the wave (05marks)

(d) Explain why the amplitude of a wave goes on decreasing as the distance from the source increases

SECTION B

5. (a) with the aid of a diagram, describe briefly an experiment to illustrate Lenz's law of electromagnetic induction (05marks)

(b) Explain the main precautions taken in the construction of an a.c. transformer. (04marks)

(c) Explain the effect of the following on the voltage across the secondary coil of a.c transformer.

(i) A fall in the supply frequency of the current in the primary (04marks)
(ii) A reduction in the primary turns. (02marks)

(d) A transformer whose secondary coil has 60 turns and primary 1200 turns, has its secondary connected to a 3Ω resistor. If its primary is connected to a 240V a.c supply, calculate the current flowing in the primary assuming that the transformer is 80% efficient. (05marks)

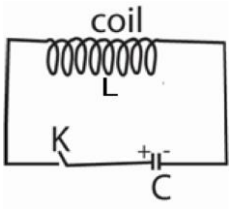
6. (a) When can an alternating current be referred to as being sinusoidal?(01mark)
(b) Define
(i) the root mean square value of an alternating current (01mark)
(ii) reactance (01mark)

(c) Describe the structure and action of a meter that makes use of a thermocouple in measuring the root mean square value of an alternating current. Why this meter does has high sensitivity. (05marks)

(d) (i) Show that current leads voltage by 90^0 when a sinusoidal voltage is applied across a capacitor. (05marks)

(ii) Sketch a phase diagram to illustrate the orientation of the current vector with respect to voltage vector in (d)(i) above. (01mark)

(e)



An inductor, L, a capacitor, C and switch, K, are connected as shown above. Explain, briefly what happens when the switch K is closed (06marks)

7. (a) What is meant by magnetic meridian? (01mark)

(b)(i) Describe the effect of eddy currents in a dynamo and state how they can be reduced? (03mark)

(ii) Explain why eddy currents are useful in a moving coil galvanometer. (03marks)

(iii) What is the difference between a motor and dynamo? (02marks)

(c) Describe how a search coil and calibrated ballistic galvanometer can be used to measure magnetic flux density at a given point near a wire carrying current. (06marks)

(d) An aircraft is flying horizontally at 800kmh^{-1} at a point where the earth's magnetic flux density is 2.31 x 10^{-5}T and angle of dip is 60^{0}. If the distance between the wing tips is 50m, calculate the potential difference induced between its wing tips. (05marks)

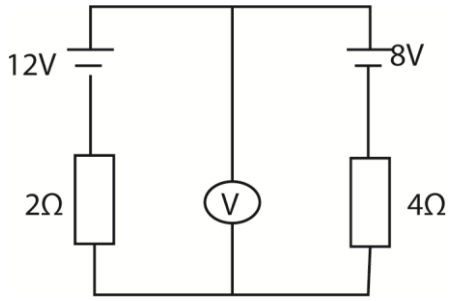
SECTION C

8. (a) (i) define electrical resistivity and state its units (02marks)

(ii) Describe with the aid of circuit diagram, an experiment to determine the electrical resistivity of a given wire using a meter bridge. (07marks)

(iii) The resistivity of mild steel is 15 x 10^{-8}Ωm at 20^{0}C and its temperature coefficient is 50 x 10^{-4}K^{-1}. Calculate the resistivity at 60^{0}C. (05marks)

(b)



Resistors of 2Ω and 4Ω are connected in series with power supplies of 12V and 8V as shown in the figure above. Calculate

(i) The reading of voltmeter (04marks)

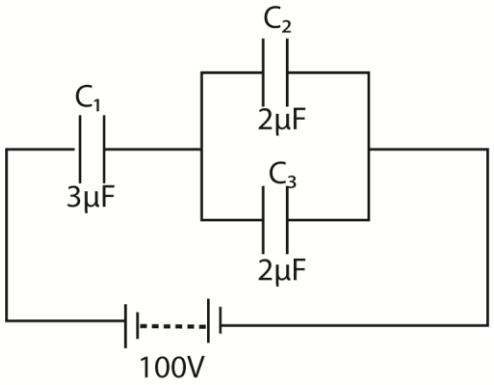
(ii) The power dissipated in the 4Ω resistor (02marks)

9. (a) Define the following
   (i) Capacitance of capacitor (01mark)
   (ii) Dielectric constant (01mark)

(b) Explain the effect of dielectric on the capacitance of a capacitor. (04marks)

(c) Derive an expression for energy stored in a capacitor of capacitance, c, charged to a voltage, V. (05marks)

(d)



In the figure above, C_1, C_2, and C_3 are capacitors of capacitances 3μF, 2μF and 2μF respectively, connected to a battery of e.m.f 100V.

(i) Calculate the energy stored in the system of capacitors if the space between the plates of C_1 is filled with an insulator of dielectric constant 3, and the capacitors are fully charged. (06marks)

(ii) Account for the change in energy stored by an isolated parallel plate capacitor when the plate separation is doubled. (03marks)

END