UACE PHYSICS PAPER 2002

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, with the aid of a ray diagram, that the radius of curvature of a concave mirror is twice the focal length of the mirror. (05marks)

(b) An object is placed 20cm in from of a diverging lens place coaxially with a concave mirror of focal length 15cm. When the concave mirror is 20cm from the lens, the final image coincides with the object.

(i) Draw a ray diagram to show how the final image is formed. (02marks)

(ii) Determine the focal length of the diverging lens. (04marks)

(c) (i) Define angular magnification of an optical instrument. (01mark)

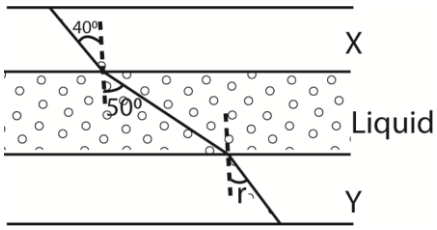
(ii) What is meant by exit pupil of a compound microscope? (02marks)

(iii) Describe with the aid of a diagram, the structure and action of a compound microscope in normal adjustment. (04marks)

2. (a) (i) What is meant by a refractive index of a material? (01marks)

(ii) Mono chromatic light incident on a block of material placed in a vacuum is refracted through an angle θ. If the block has a refractive index, n and is of thickness, t, show that light takes a time $\frac{ntsec\,\theta}{c}$ to emerge from the block where c is the speed of light in the vacuum. (03marks)

(b)



In the figure above, a layer of liquid is confined between two transparent plates X and Y of refractive indices1.54 and 1.44 respectively. A ray of monochromatic light making an angle of 40^0 with the normal to the interface between X and the liquid is refracted through an angle of 500 by the liquid. Find the

(i) Refractive index of the liquid (03marks)
(ii) Angle of refraction, r, in the medium, Y. (02marks)
(iii) Minimum angle of incidence in medium X for which the light will not emerge in Y (04marks)

(c) (i) A ray of monochromatic light is incident at a small angle of incidence on a small angle prism in air. Obtain the expression, d = (n-1)A for deviation of light by the prism (05marks)

(ii) Light of two wavelengths is incident at a small angle on a thin prism of refractive angle 50 and refractive indices 1.52 and 1.50 for the two wavelength. Find the angular separation of the two wavelengths after refraction by the prism. (03marks)

3. (a) Why is light referred to as a transverse wave? (01mark)

(b) (i) State Huygens' Principle. (02marks)

(ii) Use Huygens' Principle to show that refractive index of medium 2 relative to medium 1 is given by

$_1n_2 = \frac{v_1}{v_2}$ where v_1 and v_2 are the velocities of light in medium 1 and 2 respectively. (07marks)

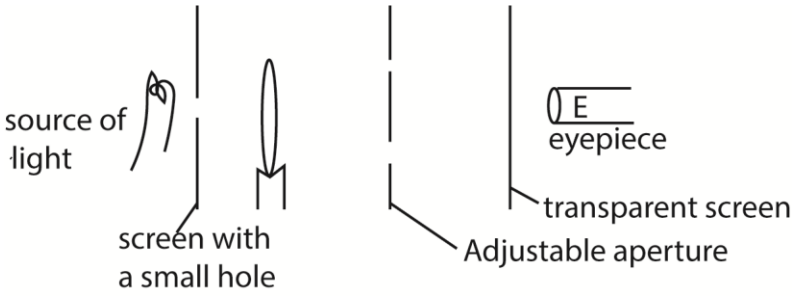
(c) (i) What is meant by division of wave fronts as applied to interference of waves (02marks)

(ii) Two slits A and B are separated by a distance d and illuminated with light of wavelength, λ. Derive an expression for separation between successive fringes on a screen placed a distance D from slits, (05marks)

(iii) In Young's double slit experiment, the 8^{th} bright fringe is formed 5mm away from the center fringe system when the wavelength of light is 6.2×10^{-7}m. Calculate the separation of the two slits if the distance from slits to the screen is 80cm. (03marks)

4. (a) Explain the term interference of light (04marks)

(b)



In the experiment to observe diffraction, the set up in figure 2 is used.

(i) Describe what you would see at E if the aperture is gradually reduced (04mark)

(ii) Explain your observation in (b)(i) above. (04marks)

(c) A diffraction grating has 550lines per mm. when illuminated normally by monochromatic light, the angle between the central maximum and the first maximum is 19.1^0. Find the

(i) wavelength of light (04marks)

(ii) number of diffraction maxima obtained (02marks)

(c) State two uses of diffraction of light. (02marks)

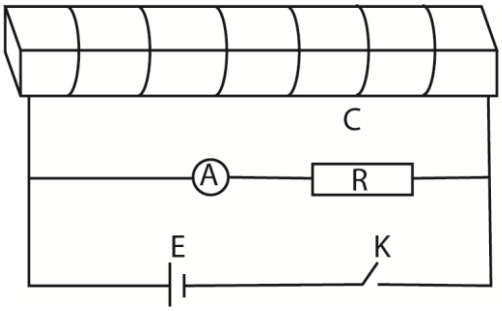
SECTION B

5. (a) Distinguish between self-induction and mutual induction. (03marks)

   (b) (i) explain the factors which affect the efficiency of a transformer. (04marks)

   (ii) Power of 6000W is produced at 100V is to be transmitted over a distance of 2km through cables of resistance 0.2Ω. Determine the voltage at the output of transformer needed to transmit the power so that only 5% of it is lost.
   (assume the transformer is 100% efficient) (05 marks)

   (c)



   In the diagram above, C is a coil of large number of turns connected in series with a center zero meter, A and a resistor R across cell E. The switch K is closed for some time and then opened.

   (i) Sketch a graph to show the variation of current with time observed on the ammeter from the moment K was first closed. (01mark)

   (ii) Explain the variation of current observed in in (c)(i) (05marks)

   (iii) Describe the effect of placing a bunch of soft iron wire inside the coil, on the observations in (c)(i) and (c)(ii) (02marks)

6. (a) (i) Write down the expression for the force on a charge q coulombs moving with velocity V at an angle, θ, to a uniform magnetic field of flux density, B.

   (ii) Use the expression in (a)(i) above to deduce the force on a conductor carrying a current in magnetic field. (03marks)

   (iii) Two thin, long parallel wires A and B carry current of 5A and 2A respectively in opposite directions, if the wires are separated by a distance of 2.5cm in vacuum, calculate the force exerted by wire B on 1m of wire A (03 marks)

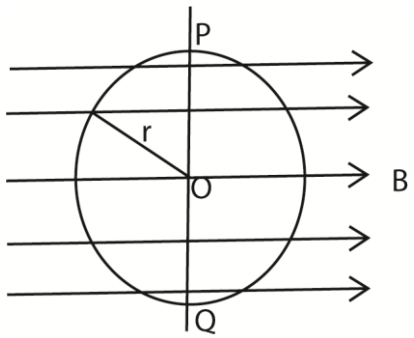
   (b) With the aid of a diagram, explain the terms angle of dip and magnetic meridian, as applied to earth's magnetic field. (04marks)

   (c)(i) Describe, using an appropriate circuit diagram, an expression to investigate the dependence of magnetic flux density at the center of circular coil on the current through the coil. (07mark)

   (ii) State two other factors on which the magnetic flus density in (c)(i) depends. (02marks)

7. (a)(i) Define magnetic flux. (01mark)
   (ii) Describe an experiment to investigate the relationship between the force on a current conductor situated in a uniform magnetic field and the current, using the ampere/current balance. (06marks)

   (b)



   A circular loop of wire of radius, r, is placed in a uniform magnetic field of flux density, B, with the axis to the field as shown above. Explain what happens to the loop when current starts to flow in it a clockwise direction if the loop is pivoted about the axis POQ. (04marks)

   (c) A vertical coil of side 5cm has 100 turns and carries a current of 1A. Calculate the torque

   (c) Explain why a moving coil galvanometer should have a radial magnetic field, fine springs and many turns. (06marks)

SECTION C

8. (a) State ohm's law (01mark)

   (b) Describe with the aid a circuit diagram, an experiment to determine the relationship between the resistance and the length of the wire. (06marks)

   (c) A dry cell gives a balance length of 84.8cm on a potentiometer wire. When a resistor of resistance 15Ω is connected across the terminals of the cell, a balance length of 75.0cm is obtained. Find the internal resistance of the cell. (04marks)

   (d) A battery of e.m.f 18.0V and internal resistance 3.0Ω is connected a resistor of resistance 8Ω. Calculate the:
   (i) Power generated (02marks)

   (ii) efficiency. (02marks)

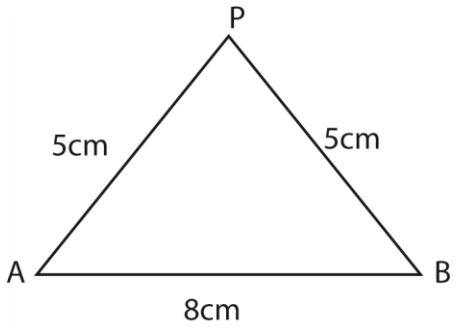
   (e) If the 8Ω resistor in (d) is replaced by a variable resistor, sketch graphs to show the variation of power and efficiency with the load. (03marks)

   (f) Explain why a metal wire gets hot when current is passed through it. (02marks)

9. (a) Define electric potential. (01mark)

(b) Obtain an expression for the electric potential at a point a distance, r, from a point charge, Q, situated in a vacuum. (04marks)

(c)



Two point charges A and B of charges +0.10μC and +0.05μC are separated by a distance of 8.0cm along the horizontal as shown in the figure above. Find the electric potential at P. (09marks)

(d) Sketch the electric field pattern due to the charge distribution in (c). (02marks)

(e) Explain how a lightning conductor works. (04marks)

10. (a) Sketch the electric field lines between two large parallel metal plates across which a p.d is applied. (01mark)

(b) (i) Describe, with aid of a diagram, how you would investigate the factors which affect the capacitance of a parallel plate capacitor. (07marks)

(ii) Calculate the capacitance of parallel capacitor whose plates are 10cm by 10cm separated by an air gap of 5mmm. (02marks)

(c) A hollow spherical conductor of diameter 21.4cm carrying a charge of 6.9×10^{-10}C is raised to a potential of 50V. Find the permittivity of surrounding medium.

(d) (i) show that the effective capacitance, C, of two capacitances, C_1 and C_2, connected in series is given by $C = \frac{C_1 C_2}{C_1 + C_2}$ (04marks)

(ii) A 20μF capacitor is charged to 40V and then connected across uncharged 60μF capacitor. Calculate the potential difference across the 60μF capacitor. (03marks)

END