UACE PHYSICS PAPER 2011

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 following terms as applied to a concave lens:
   (i) principal focus' (01mark)
   (ii) radii of curvature (01mark)

   (b) A point object is placed at a distance u in front of a diverging lens of focal length, f, to form an image at a distance, v, from the lens.

   Derive an expression that relates u. v. and f. (04marks)

   (c) Describe an experiment to determine the focal length of a concave lens using a plane mirror, converging lens and illuminated object. (04marks

   (d) What is meant by a:

   (i) visual angle (01mark)

   (ii) near point (01mark)

   (e) A person with a normal near point distance of 25cm wears spectacles with a diverging lens of focal length 200cm in order to correct the far point distance to infinity. Calculate the near point when viewing using the spectacles. (03marks)

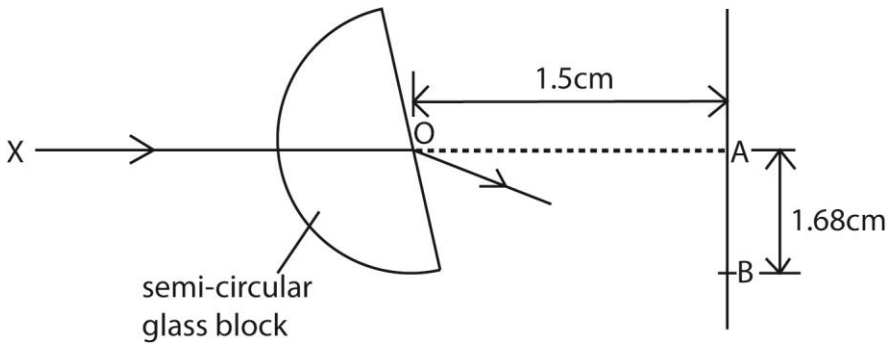
   (f) (i) Draw a ray diagram to show the formation of an image of a distant object in terrestrial telescope in normal adjustment. (03marks)

   (ii) State two disadvantages of terrestrial telescope.(02marks)

2. (a) What is meant by the term:
   (i) refraction. (01mark)
   (ii) absolute refractive index? (01mark)

   (b) Describe an experiment to determine the refractive index of a liquid using a travelling microscope. (04marks)

   (c) The figure below shows monochromatic light X incident towards A on vertical screen.



When the semi-circular glass block is placed across the path of light with its flat face parallel to the screen, a bright spot is formed at A. When the glass block is rotated about a horizontal axis through O, the bright sport moves from A to B and then just disappears. At B, distance 1.68cm from A.

(i) Find the refractive index of the material of the glass block. (04marks)

(ii) Explain whether AB would be longer or shorter if the block of glass of higher refractive index was used.

(d) (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 the deviation, d, of light by the prism, where A is the refracting angle of the prism and n, is the refractive index. (04marks)

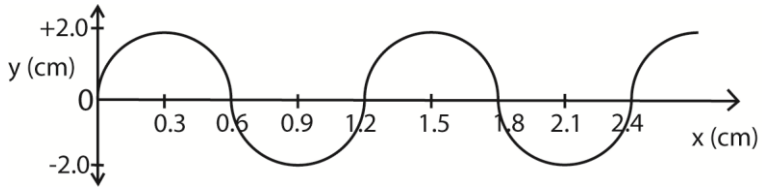
(ii) Calculate the minimum deviation produced by a 60^0 prism if the refractive index of the glass is 1.50. (03marks)

(iii) State any two applications of total internal reflection. (01marks)

3. (a) (i) Define the terms wave front and a ray in reference to a progressive wave (02mark)

(ii) Draw a sketch diagram showing reflection of a circular wave by a plane reflector. (02marks)

(b) The figure below shows a wave travelling in positive x- direction away from origin with a velocity of $9ms^{-1}$.



(i) What is the period of the wave? (03marks)

(ii) Show that the displacement equation for the wave is y = $2\sin\frac{5}{3}\pi(900t - x)$ (03marks)

(c) What is meant by Doppler Effect? (01mark)

(d) One species of bats locates obstacles by emitting high frequency sound waves and detecting the reflected waves. A bat flying at a steady speed of $5ms^{-1}$ emits sound of frequency 78.0 kHz and is reflected back to it.

(i) Derive the equation for the frequency of the sound waves reaching the bat after reflection (05marks)

(ii) Calculate the frequency of sound received by the bat given the speed of sound in air is $340ms^{-1}$. (02 marks)

(e) (i) What is meant by intensity of a sound note? (01mark)

(ii) Distinguish between loudness and pitch of a sound note. (01mark)

4. (a) What is meant by the following terms

(iii) Unpolarized light, (01mark)

(iv) Plane polarized light (01mark)

(b) (i) Describe briefly how plane polarized light is produced by double refraction (03marks)

(ii) Explain briefly one application of polarized light. (02marks)

(c) Explain

(i) How two coherent sources are obtained using a biprism (03marks)

(ii) Why interference effects are not observed in thick films (03marks)

(d) In Young's double slit experiment, the slits are separated by 0.28mm and the screen is 4m away. The distance between the fourth bright fringe and the central fringe is 1.2cm. Determine the wavelength of light used in the experiment. (04marks)

(e) Explain the effect of increasing the number of narrow slits in diffraction grating on the intensity of diffraction fringes. (03marks)

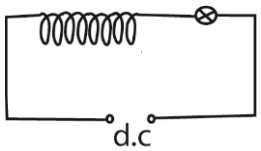
SECTION B

5. (a) Define the following terms as applied to alternating voltage
   (i) Root mean square value (01 marks)
   (ii) Peak value. (01mark)

   (b) (i) An alternating voltage is applied across a capacitor of capacitance, C. show that current in the circuit leads the voltage by $\pi/2$. (03marks)

   (ii) Find the expression for capacitive reactance in terms of frequency, f, and capacitance, C. (02marks)

   (c) A bulb is connected in series with an inductive coil and a d.c source as shown in the figure below



   (i) What happens to the brightness of the bulb when an iron core is inserted in the coil? (01mark)
   (ii) Explain what happens to the brightness of the bulb when the d.c. source is replaced with a.c. and an iron core inserted in the coil. (03marks)

   (d) (i) What is hysteresis loss ? (01mark)

   (ii) How can hysteresis loss be minimized in a.c. transformer? (01mark)

   (iii) Explain why the primary current in the a.c. transformer increases when the secondary coil is connected to the load? (04marks)

6. (a)(i) Draw a well labelled diagram to show the structure of repulsion type moving iron ammeter (02marks)

   (b) (i) Write down an expression for magnetic flux density at the center of a flat circular coil, N, turns each of radius, a, carrying current I. (01mark)

   (ii) Describe how you would determine the value of the earth's magnetic flux density at a place, using a search coil. (06marks)

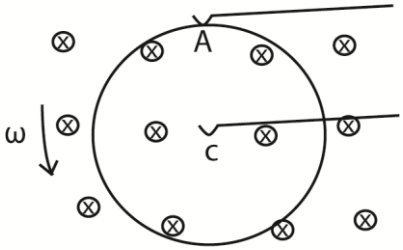
   (c) A coil of 50 turns and radius 4cm is placed with its plane in the earth's magnetic meridian. A compass needle is placed at the center of the coil. When a current of 0.1A passes through the coil, the compass needle deflects through 40^0. When the current is reversed, the needle deflects through 43^0 in opposite direction.

   (i) Calculate the horizontal component of the earth's flux density. (04marks)

(ii) Calculate the magnetic flux density of the earth at that place given that the angle of dip at the place is 15^0.

7. (a) State the laws of electromagnetic induction. (02marks)

(b) (i) A circular metal disc of radius R. rotates in an anticlockwise direction at angular velocity, ω, in a uniform magnetic field of flux density, B, directed in to paper as shown in the figure below



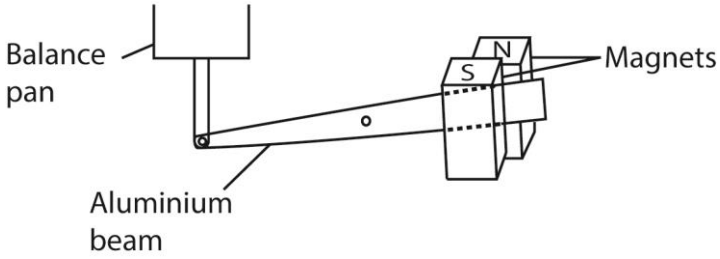
A and C are contact points

Derive an expression for e.m.f induced between A and C. (03marks)

(ii) A copper disc of radius 10cm is placed in a uniform magnetic field of flux density, 0.02T, with its plane perpendicular to the field. If the disc is rotated parallel to the field about an axis through its center at 3000 revmin-1, calculate the e.m.f that is generated between its rim and the centre. (03marks)

(c) Describe an experiment to demonstrate mutual induction (04marks)

(d) The diagram in the figure below shows the arrangement by which a laboratory balance is critically damped. The aluminium beam supporting the pan moves in the magnetic field of two powerful magnets.



(i) Explain how damping is caused. (03marks)

(ii) What change would occur in the performance of the balance if the magnets were replaced by weaker ones (01mark)

(e)(i) Define the ampere (01mark)

(ii) Two parallel wire, P and Q of equal length 0.1m, each carrying a current of 10A are a distance 0.05m apart with P directly above Q. If P remains stationary, find the weight of P. (03marks)

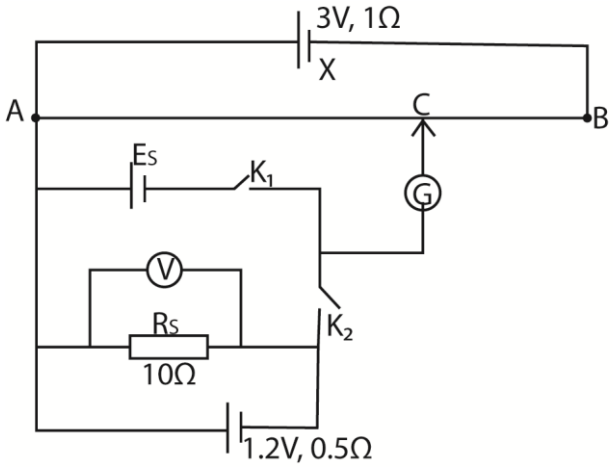
SECTION C

8. (a)(i) Define electromotive force of a battery. (01mark)

   (ii) A cell of e.m.f, E and internal resistance r, drives current through a resistor of resistance, R connected in series with it. Derive an expression for efficiency of the circuit. (04marks)

   (b) Describe with the aid of a diagram how you would standardize a slide wire potentiometer. (03marks)

   (c) In the figure below, AB is a uniform resistance wire of length 1m and resistance 4Ω. X is a driver cell of e.m.f 3V and internal resistance 1Ω and E_S is a standard cell, R_S is a standard resistor of resistance 10Ω which is connected in series with cell Y of e.m.f 1.22 V and internal resistance 0.5Ω



   With switch K_1 closed and K_2 open, the balance length, AC is 60cm while the voltmeter reading is 1.14V.with K_1 open and K_2 closed, the balance length is 80cm. Calculate the

   (i) E.m.f E_S, of standard cell. (03marks)
   (ii) Percentage error in the voltmeter reading (03marks)

   (d) Describe with the aid of a circuit diagram how you would measure the temperature coefficient of resistance of a material in form of a wire. (06marks)

9. (a) State coulomb's law of electrostatics. (01marks)

   (b) Derive the relation between electric field intensity, E, and electric potential, V, due to a charge at a point. (04marks)

   (c) Two pith ball P and Q each of mass 0.1gare separately suspended from the same point by threads 30cm long. When the balls are given equal charges, they repel each other and come to rest 18cm apart. Calculate the magnitude of charge on each ball. (06marks)
   (d) Describe how you would investigate the distribution of charge on pear shaped conductor. (04marks)
   (e) Explain how a charged body attracts uncharged conductor. (03marks)

(f) Describe how an electroscope can be used to distinguish a conductor from an insulator. (01mark)

10. (a) Define dielectric strength. (01mark)

(b) (i)Explain briefly how a capacitor in which the potential difference, V_0 across the plates, can be fully discharged. (02marks)

(ii) Sketch a graph showing a variation of potential difference with time for the process in (b)(i) above(01mark)

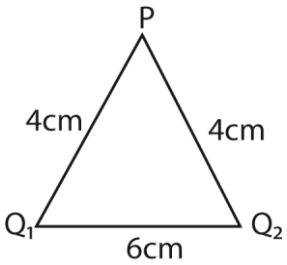
(c) (i) Two capacitors of capacitance C_1 and C_2 are connected in series. Show that the effective capacitance, C, is given by

$$C = \frac{C_1 C_2}{C_1 + C_2}$$ (04marks)

(ii) A 10.0μF capacitor charged to 200V is connected across uncharged 50μF capacitor. Calculate the total energy stored in both capacitors before and after connection (04marks)

(iii) Account for the difference in the energies calculated in (c)(ii) above. (01mark)

(d) In the figure below, Q_1 and Q_2 are point charges of magnitude +5.0μCand -5.0μC respectively



Calculate the

(i) Electric field intensity at P (04marks)

(ii) Potential energy of appoint charge Q_3 of 0.8μF placed at P. (03marks)

END