UACE PHYSICS PAPER 2014

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) A ray of light is incident on a plane mirror. The mirror is then turned through an angle α keeping the direction of the incident ray constant. If a reflected ray turned through angle β, find the relationship between α and β.

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

(c) Describe an experiment to determine the refractive index of a small quantity of a liquid using a concave mirror. (05marks)

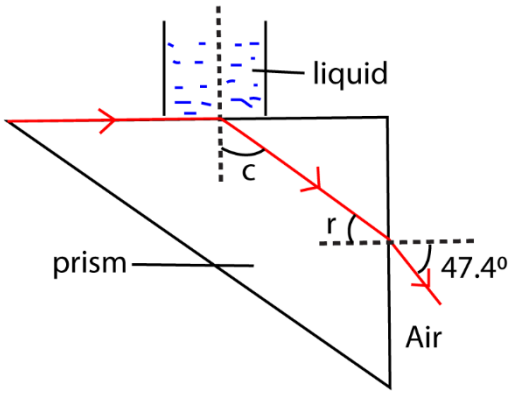
(d) A plane mirror is placed 10cmin front of a convex mirror so that it covers about half of the convex mirror surface. A pin placed 20cm in front of the plane mirror gives an image which coincides with that of the pin in the convex mirror. Find the focal length of the convex mirror. (04marks)

2. (a) Define **angular magnification** of an optical instrument. (01marks)

(b) (i) Describe with the aid of a ray diagram, the operation of telescope made of a converging lens and a diverging lens when used in normal adjustment. (05mrks)

(ii) State two limitations of this type of telescope. (01marks)

(c) The diagram in the figure below shows a path followed by a ray of monochromatic light through a right angled prism of refractive index 1.52. The light emerges in air at an angle of 47.4^0.



Find the refractive index of the liquid. (06marks)

(d) Explain the following as applied to lenses.

(i) chromatic aberration (02marks)

(ii) spherical aberration (02marks)

(e) Explain how chromatic and spherical aberration are minimized in a reflecting telescope (03marks)

SECTION B

3. (a) What is meant by the following as applied to wave motion?
   (i) Wavelength (01mark)
   (ii) Wave front (01mark)
   (b) (i) Define Resonance (01mark)
   (ii) Describe how velocity of sound can be determined using a resonance tube.(05mark)

   (c) (i) Explain how stationary waves are formed. (03marks)
   (ii) A tuning fork of 760Hz is sounded near the open and closed pipe of length 40 cm. f sir in the tube resonates with the tuning fork, determine the mode vibration and the end correction. (Velocity of sound in air is $300ms^{-1}$). (05marks)

   (d) (d)(i) Explain reverberation as applied to sound waves (02marks)

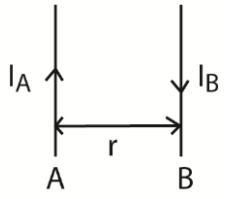
   (ii) Explain how reverberation can be minimized in a large hall. (02marks)

4. (a) (i) State **two** conditions necessary for interference patterns to be formed. (02marks)

   (ii) With the aid of a diagram, describe how interference can be produced by division of wave front. (04marks)
   (b) In Young's double slit experiment, the slits are 0.5mm apart and interference is observed on the screen placed a distance of 100cm from the slits. It is found that the 9^{th} bright fringe is at a distance of 8,84cm from the second dark fringe from the center of the fringe patterns. Find the wavelength of light used. (05marks)
   (c) Explain what is observed on the interference pattern fringes in Young's double experiment when the monochromatic source of light is replaced by a source of white light? (05marks)
   (d) Describe how interference fringes are formed in wedge shaped film of air.

SECTION C

5. (a) State the laws of electromagnetic induction (02marks)
   (b) Describe a method of measuring the magnetic flux density in the region between the poles of a magnet. (06marks)
   (c) Two straight parallel wires A and B carrying steady currents IA and IB respectively are placed close to each other as shown in figure below



   (i) Sketch the resultant magnetic field pattern (02marks)
   (ii) Explain what happens when the current I_A and I_B are steady currents. (04marks)
   (iii) Find the force per unit length of the wires when IA = 8.0A , I_B =11.0A and r = 3.0cm (04marks)
   (d) Explain how eddy currents are produced (02marks)

6. (a) (i) Write an expression for the force exerted on a straight wire of length, L meters carrying a current, I, amperes, placed at right angles to a uniform magnetic field flux density B teslas. (01 marks)

(ii) Explain the origin of the force n (a) (i). (04marks)

(b) A rectangular coil of N turns each of length, L, and breadth, b, is inclined at an angle θ to a uniform magnetic field of flux density B. Derive an expression for torque of the coil when a current I is passed through it.

(c) A single rectangular loop of wire with dimensions 35cm by 75cm is arranged such that part of it is inside a region of uniform magnetic field of flux density 0.45T and part of it is outside the field. The total resistance of the loop is 0.23Ω. Calculate the force required to pull the loop from the field at a constant velocity of $3.4ms^{-1}$ perpendicular to the field. (05marks)

(d)(i) Define the term magnetic flux. (01marks)

(ii) An electron resolves in a circular orbit of radius 2.0×10^{-10}m at a frequency of 6.8×10^{15} revolution per second. Calculate the magnetic flux density at the center of the orbit (04marks)

7. (a)(i) What is a sinusoidal alternating current? (01mark)

(ii) Define peak value, root mean square (r.m.s) value and frequency of alternating current. (03marks)

(b) A sinusoidal voltage of r.ms value 13.2V is connected across a 50μF capacitor.

(i) Find peak value of the charge on the capacitor (02marks)

(ii) Sketch using the same axes the graphs of charge Q on the capacitor and current I in the circuit against time. (02marks)

(iii) If the frequency of the alternating current is 49.6Hz, calculate the r.m.s value of current through the capacitor. (03marks)

(c) Explain why a capacitor in a circuit blocks the flow of direct current but allows the flow of alternating current. (04marks)

(d) Describe the structure and mode of operation of the repulsion type moving iron meter. (05marks)

SECTION D

8. (a) (i) Define the following; electric field intensity and electric potential at a point (02marks)

(ii) Show that the electric field intensity at a point is equal to the negative potential gradient at that point. (04marks)

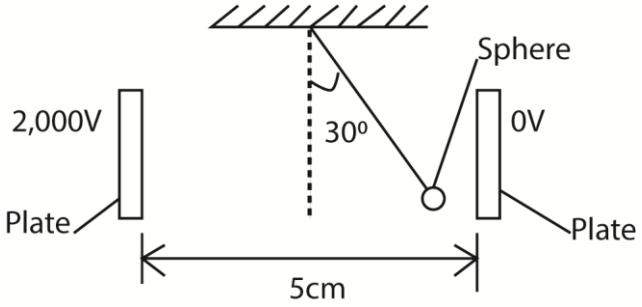
(b) (i) Explain with the aid of a diagram, how an insulated metal sphere can be charged by induction using a negatively charged rod. (03marks)

(ii) Describe how a gold leaf electroscope can be used to detect the presence of a charge on the body

(c) (i) Write down the equation for the electrostatic force between two isolated point charges in a vacuum. (01mark)

(ii) Sketch the electric field lines between two negatively charged spheres carrying unequal charges and use the sketches to explain a neutral point. (02marks)

(d) A charged polystyrene sphere of mass 2g is suspended by affine nylon thread between two plates 5cm apart as shown in the figure below



When a p.d. of 2000V is supplied across the plates, the thread attached to a sphere deflects through an angle of 30^0. Calculate the charge on the sphere. (06marks)

9. (a) Describe an experiment to verify Ohm's law, (04marks)
(b) Derive an expression for combined resistance of three resistors in parallel. (04marks)

(c)(i) Explain the principle of operation of a slide wire potentiometer. (04marks)

(ii) Two cells A and B connected in series give a balance length of 80.0cm along a potentiometer wire. When Cell B is reversed, the balance length falls to 15.0cm. If the e.m.f of cell A is 1.5V, calculate the e.m.f of cell B. (04marks)

(d) A battery of e.m.f 20.0V and internal resistance 4.0Ω is connected to a resistor of resistance 10.0Ω. Calculate
(i) Power generated (02marks)

(ii) Efficiency of the circuit (02marks)

10.(a)(i) Define **capacitanc**e and **dielectric constant**. (02marks)
(ii) State the factors which affect the capacitance of a capacitor. (02marks)

(b) A capacitor of capacitance C_1 is charged by a battery of e.m.f, V_0. The charging battery is then removed and the capacitor is connected to uncharged capacitor of capacitance, C_2. Show that the loss of energy after connection is given by

$$E = \frac{1}{2}\left[\frac{C_1C_2}{C_1+C_2}\right]V_0^2$$ (05marks)

(c) Describe an experiment to measure the capacitance of a capacitor using a ballistic galvanometer. (05marks)

(d) A capacitor, X of 5.0μF and another, Y of 8.0μF are connected in series with a 20V supply.

Calculate the;

(i) Charge on X (04marks)
(ii) Potential drop across X (02marks) **END**