UACE PHYSICS PAPER 2015

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) Explain what is meant by conjugate points. (02marks)

(b) A converging lens forms an image of height, h_1 on a screen of an object O of height, h. When the lens is displaced towards the screen, an image of height, h_2 is formed on the screen.

(i) Sketch a ray diagram to show the formation of the images on the screen. (02marks)

(ii) Show that h = $\sqrt{h_1 h_2}$ (04marks)

(c) Describe an experiment to determine focal length of a diverging lens using a concave mirror of known focal length. (05marks)

(d) The objective of astronomical telescope in normal adjustment has a diameter of 150mm and focal length of 3.0m. The eyepiece has focal length of 25.0mm. Calculate

(i) the position of the eye ring (03marks)

(ii) diameter of the eye-ring (03marks)

(c) Give one advantage of placing the eye at the eye-ring (01mark)

2. (a) Show that for a ray of light passing through layers of transparent media separated by parallel boundaries,

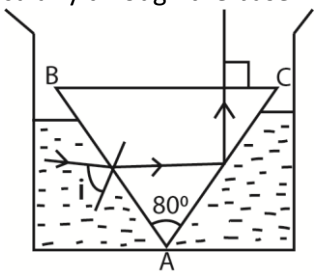
nsini = a

where a is a constant and n is the refractive index of the medium containing angle i. (04marks)

(b) (i) What is meant by critical angle? (01mark)

(ii) Describe an experiment to determine the critical angle for a water-air boundary. (05marks)

(c) The figure below shows an isosceles prism ABC of refractive index 1.51, dipped in a liquid with refractive edge downwards. A ray of light incident on the prism at an angle i = 34.6^0 emerges perpendicularly through the base.



Calculate the refractive index of the liquid (04marks)

(d) Explain how an optical cable transmits light. (03marks)

(e) An optical pin held above a concave mirror containing water of refractive index 1.33, coincides with its image at a distance of 12cm above the mirror. When the water is replaced by a little quantity of a certain liquid, the point of coincidence of the object and the image becomes 13.3cm. Calculate the refractive index of the liquid. (03marks)

SECTION B

3. (a) Distinguish between progressive and stationary waves

(b)(i) What are overtones?

(ii) Explain why a music tone played on one instrument sound differently from the same note played on another instrument.

(c) A stretched string of length L, is fixed at both ends and then set to vibrate in its allowed modes. Derive an expression for frequency of the second overtone in terms of fundamental frequency. (04marks)

(d) A wire of length 0.60m and mass 9×10^{-4}kg is under tension of 135N. The wire is plucked that it vibrates in its third harmonic. Calculate the frequency of the third harmonic. (05marks)

(e) Describe the variation of pressure with displacement of air in a closed pipe vibrating with fundamental frequency. (04marks)

4. (a) What is meant by the following as applied to waves
   (i) Phase difference
   (ii) Optical path difference

(b)(i) Explain how interference fringes are formed in an air wedge.

(ii) Two glass slides are separated by a thin wire to form an air wedge. When the wedge is illuminated normally by light of wavelength 5.6×10^{-7}m, a total of 20 fringes occupying a distance of 15mm are obtained. Calculate the angle of the wedge. (03marks)

(c) In Young's double slit experiment, 21 bright fringes occupying a distance of 3.6mm were visible on the screen. The distance of the screen from double slit was 29cm and the wavelength of the light used was 5.5×10^{-7}m.Calculate the separation of the slit. (03marks)

(d)(i) Describe how plane polarized light can be produced by double refraction (02marks)

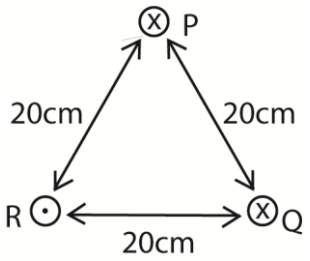
(ii) Describe practical use of polarized light

SECTION C

5. (a) What is meant by the following as applied to the earth's magnetic field?
   (i) Magnetic meridian (01 mark)
   (ii) Angle of dip (01marK)

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

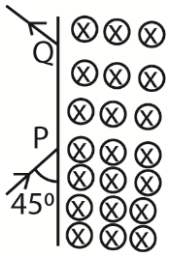
(ii) there conductors P, Q and R carrying currents 3A, 6A and 8A respectively are arranged as shown in the figure below



Calculate the force experienced by conductor P. (06marks)

(c) (i) Define magnetic flux and magnetic flux density (02marks)

(ii) A charge particle of mass 1.4 x 10^{-27}kg and charge 1.6 x 10^{-19}C enters a region of uniform magnetic field of flux density 0.2T at point P and emerges at a point Q as shown in the figure below



If the speed of the particle is $10^{7}ms^{-1}$, calculate the distance PQ. (04marks)

(d) Describe an experiment to measure the magnetic flux density between the pole pieces of a strong magnet. (05 marks)

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

(ii) Describe with aid of a diagram, an experiment to verify Faraday's law of electromagnetic induction (05marks)

(b) Explain

(i) Why when a plate of copper is pushed into a strong magnetic field between the poles of a powerful electromagnet, considerable resistance to the motion is felt, but no such effect is felt with a sheet of glass. (04marks)

(ii) How damping is achieved in moving coil galvanometer (03marks)

(c) An aero plane of wing span 30m flies horizontally at a speed of 1000kmh^{-1}.

What is the p.d across the tips of its wings, if the horizontal component of the earth's magnetic field is 1.46 x 10^{-4}T? (Angle of dip at the place is 70^{0}) (03marks)

(d) A coil of 500 turns and area 80cm^2 is rotated at 1200 revolution per minute about an axis perpendicular to its plane and magnetic field of flux density 0.25T.

Calculate the maximum e.m.f induced in the coil (03marks)

7. (a) (i) Define root mean square (r.m.s) current of an a.c (01mark)

(ii) Derive an expression for capacitive reactance (04marks)

(iii) Sketch on the same axes, the graphs showing variation of applied p.d and current when an inductor is connected to an a.c. supply. (02marks)

(b) (i) A capacitor of capacitance, C, and an ammeter are connected in series across an alternating voltage, V, of frequency f. Explain why current apparently flow through the capacitor. (03marks)

(ii) A sinusoidal p.d of r.m.s value of 20V and frequency50Hz is applied across a 100μF capacitor. Calculate the capacitive reactance of the circuit. (02 marks)

(c) Describe the mode of operation of a transformer. (04marks)

(d) A transformer connected to a.c supply of peak voltage 240V is to supply a peak voltage of 9.0V to a mini-lighting system of resistance 5Ω. Calculate the

(i) r.m.s current supplied to the lighting system (02marks)

(ii) average power delivered to the lighting system. (02marks)

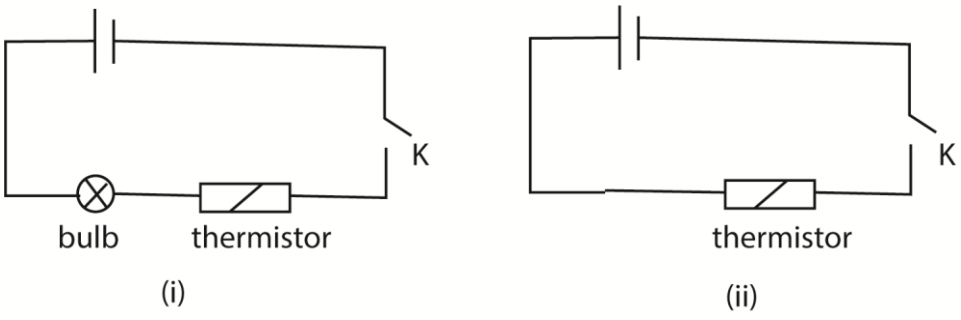
SECTION D

8. (a)(i) Define temperature coefficient of resistance (01mark)

(ii) Explain the origin of the heating effect of electric current in metal conductor. (03marks)

(iii) Describe with the aid of an I-V sketch the variation of current with p.d across a semiconductor diode. (02marks)

(b) A cell, a bulb, a switch and a thermistor with negative temperature coefficient of resistance are connected as shown in the figures (i) and (ii) below

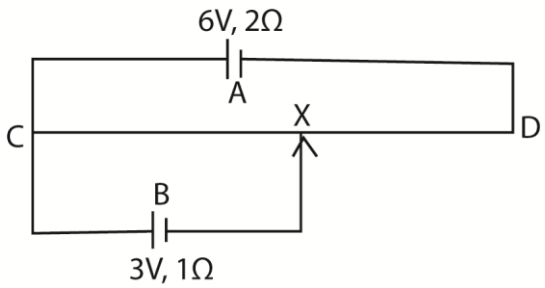


(i) Explain what would happen when in figure (i) switch K is closed (04marks)

(ii) If the bulb in figure (i) is removed and the circuit connected as shown in figure (ii), explain what would happen when switch K is closed (03marks)

(c) State the law of conservation of current at the junction (01mark)

(d) Two cells A of e.m.f 6V and internal resistance 2Ω and B of e.m.f3V and internal resistance 1Ω respectively are connected across a uniform resistance wire Cd of resistance 8Ω as shown in the figure below



If X is exactly in the middle of the wire CD, Calculate the

(i) Power dissipated in CX.(04marks)

(ii) P.d across the terminals of cell A.(02marks)

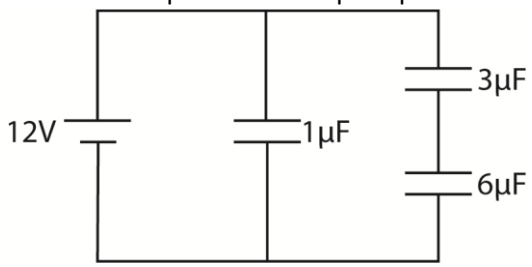
9. (a)(i) Define **capacitance** of a capacitor (01mark)

(ii) Describe briefly an experiment to show the effect of placing a sheet of glass or mica between the plates of a capacitor on capacitance. (05marks)

(b) Describe how the unknown capacitance of a capacitor can be determined using a ballistic galvanometer. (04marks)

(c) Explain briefly how a charged capacitor can be fully discharged. (02marks)

(d) A 3μF capacitor is connected in series with a 6μF capacitor. The combination is then connected in parallel with 1μF capacitor to 12V battery as shown in the figure below



Calculate

(i) Charge stored on each capacitor (05marks)

(ii) Energy stored in the 6μF capacitor when fully charged (03marks)

END