

UACE PHYSICS PAPER 2016

**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.

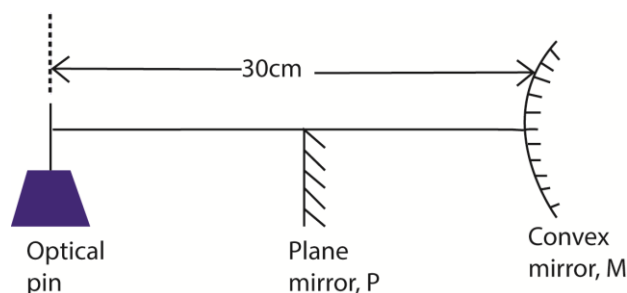
Assume where necessary

Acceleration due to gravity, $g$	$9.81\text{ms}^{-2}$
Electron charge, $e$	$1.6 \times 10^{-19}\text{C}$
Electron mass	$9.11 \times 10^{-31}\text{kg}$
Plank's constant, $h$	$6.6 \times 10^{-34}\text{Js}$
Speed of light in the vacuum, $c$	$3.0 \times 10^8\text{ms}^{-1}$
Specific heat capacity of water	$4.200\text{Jkg}^{-1}\text{K}^{-1}$
Avogadro's number, $N_A$	$6.02 \times 10^{23}\text{mol}^{-1}$
The constant, $\frac{1}{4\pi\epsilon_0}$	$9.0 \times 10^9\text{F}^{-1}\text{m}$
Permittivity of free space, $\mu_0$	$4.0\pi \times 10^{-7}\text{Hm}^{-1}$
Permittivity of free space, $\epsilon_0$	$8.85 \times 10^{-12}\text{Fm}^{-1}$
One electron volt	$1.6 \times 10^{-19}\text{J}$
Resistivity of Nichrome wire at $25^\circ\text{C}$	$1.2 \times 10^{-6}\Omega\text{m}$

## SECTION A

1. (a) (i) Describe how the focal length of a convex mirror can be measured using a convex lens of known focal length. (04marks)

(ii) The plane mirror, P, in the figure below is adjusted to a position 20cm from optical pin, the image of the pin in P coincides with its image in M.



Calculate the focal length of the convex mirror. (04marks)

(b) A pin is clamped horizontally above a concave mirror with its tip along the principal axis. When the pin is adjusted, it coincides with its image at a distance  $R$  from the mirror. When a small liquid of refractive index,  $n$ , is put on the mirror, the pin again coincides with its image at a distance  $R'$  from the mirror. Show that the refractive index,  $n$ , is given by

$$n = \frac{R}{R'} \quad (04\text{marks})$$

(c)(i) Explain the term eye-ring as applied to the telescope. (02marks)

(ii) Draw a ray diagram to show the formation of final image in Galilean telescope in normal adjustment. (03marks)

(iii) Explain two advantages and one disadvantage of the telescope in (c)(ii) above. (03marks)

2. (a)(i) When does light pass through a prism symmetrically? (01marks)

(ii) Find the angle of incidence,  $i$ , on an equilateral prism of refractive index 1.5 placed in air, when light passes through it symmetrically. (03marks)

(iii) Describe what happens to the deviation of light passing through a prism in (a) (ii) when the angle of incidence is increased from a value less than  $i$  to a value greater than  $i$ . (02marks)

(b) Describe how the refractive angle of a prism can be determined using optical pins. (05marks)

(c) (i) Draw a sketch ray diagram showing formation of the image of a finite size real object by a concave lens. (02marks)

(ii) A concave lens of focal length 15.0cm is arranged coaxially with a concave mirror of focal length 10.0cm, a distance of 4.0cm apart. An object is placed 20.0cm in front of the lens on the side remote from the mirror. Find the distance of the final image from the lens. (04marks)

- (d) With the aid of a sketch ray diagram explain spherical aberration in a concave lens, and state how it is minimized. (03marks)

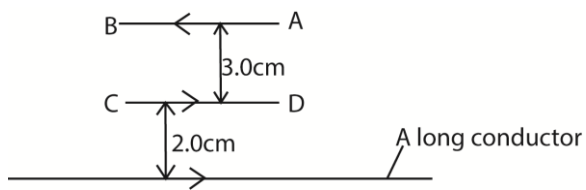
## SECTION B

3. (a) What is meant by the following as applied to waves
- (i) Resonance (01mark)
  - (ii) Frequency (01mark)
- (b) Explain with the aid of a diagram the term fundamental note and overtone as applied to vibrating air in closed pipe. (05marks)
- (c) Describe how you would determine the speed of sound in air using a resonance tube and several tuning forks. (05marks)
- (d) (i) Explain the formation of beat. (02marks)  
(ii) Derive expression for beat frequency. (03marks)
- (e) Two observers A and B are provided with sources of sound of frequency 750Hz. If A remains stationary while B moves away at a velocity of  $2.0\text{ms}^{-1}$ , find the number of beats heard per second by A. (Velocity of sound in air is  $330\text{ms}^{-1}$ ) (03marks)
4. (a) What is meant by diffraction?
- (b) Explain using Huygens's principle the diffraction pattern produced by a single slit. (06marks)
- (c) Light of wavelength  $5.0 \times 10^{-7}\text{m}$  falls on a grating with 600 lines per mm, determine the highest order of diffraction that can be observed. (04marks)
- (d) (i) Explain what is meant by plane of polarized light?
- (ii) A liquid of refractive index 1.3 is used to produce polarized light by reflection. Calculate the angle of incidence on the liquid surface. (02marks)
- (e) (i) Describe how polarized light can be produced by reflection  
(ii) State two uses of polarized light.

## SECTION C

5. (a) (i) what is the difference between a motor and a dynamo? (01mark)
- (ii) Describe with the aid of a labelled diagram the structure and mode of operation of a d.c generator. (06marks)
  - (iii) Describe briefly the factors that determine the peak value of the induced e.m.f. (03 marks)
  - (iv) How can a d.c. generator be converted into an a.c. generator. (01mark)

- (b) Figure below shows two wires AB and CD of length 5.0cm each carrying a current of 10.0A in the direction shown. A long conductor carrying a current of 15A is placed parallel to the wire CD 2.0cm below it.



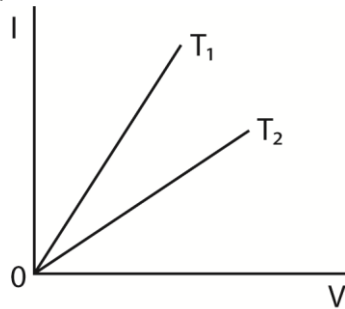
- (i) Calculate the net force on the long wire (06marks)
- (ii) Sketch the magnetic field pattern between the long wire and wire CD after removing wire AB. Use the field pattern to define a neutral point (03marks)
6. (a) What is meant by the following as applied to the earth's magnetic field?
- (i) Magnetic meridian (01mark)
- (ii) Magnetic variance (01mark)
- (b) Describe the structure and mode of action of the deflected magnetometer (06marks)
- (c) A circular coil of four turns and diameter 11cm has its plane vertical and parallel to the magnetic meridian of the earth. Determine the resultant magnetic flux density at the center of the coil when a current of 0.35A flows in it.
- (Take the horizontal component of the earth's magnetic flux density to be  $1.6 \times 10^{-5}\text{T}$ )  
(04marks)
- (d) (i) Define **self-induction** and **mutual induction** (02marks)
- (ii) Give the causes of power loss in an a.c. transformer and state how each can be minimized. (04marks)
- (iii) Explain why the current in the primary coil of a transformer increases when the secondary is connected to the load.
7. (a) Define root mean square (rms) value of alternating voltage (01mark)
- (b) A resistor of resistance  $100\Omega$  is connected across an alternating voltage,  $V = 20\sin 120\pi t$ .
- (i) Find the frequency of the alternating voltage (01mark)
- (ii) Calculate the mean power dissipated in the resistor. (03marks)
- (c) (i) Show that when an inductor is connected to an a.c supply voltage of  $V = V_0\sin 2\pi ft$ , the resulting current lags the voltage by  $90^\circ$ . (04marks)
- (ii) Sketch on the same axes the variation with time of the voltage and current if a capacitor is connected to the voltage supply in (c)(i). (02marks)

- (d) (i) Describe how thermocouple meter works. (04marks)  
(ii) Explain any precautionary measure taken in the design of thermocouple meter (02mark)

- (e) A capacitor of capacitance  $60\mu\text{F}$  is connected to an a.c. voltage supply of frequency  $40\text{Hz}$ . An a.c. ammeter connected in series with the capacitor reads  $2.2\text{A}$ . Find the p.d across the capacitor. (03marks).

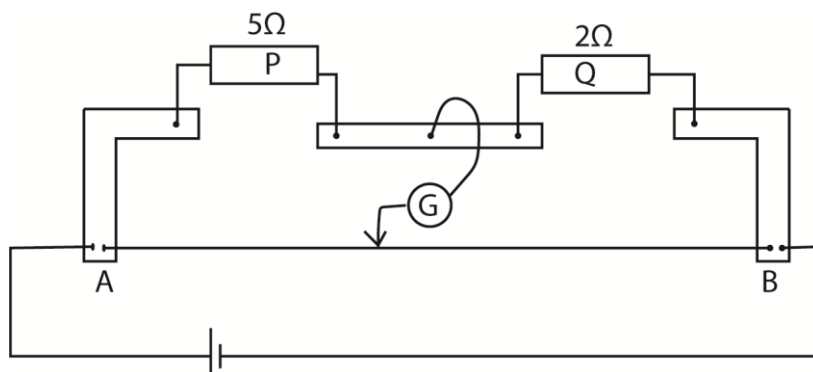
**SECTION D**

8. (a)(i) Define electrical resistivity. (01mark)  
(ii) Explain how length and temperature of a conductor affect its resistance. (04marks)  
(iii) The figure below shows a circuit-voltage graphs for a metallic wire at two different temperatures  $T_1$  and  $T_2$ .



State in which of the two temperatures resistance is greater and explain your answer (03marks)

- (b) (i) Derive the balance condition when using a meter bridge to measure resistance. (03marks)  
(ii) State **two** precautions taken to achieve an accurate measurement. (02marks)  
(c) The figure below shows two resistors P and Q of resistance  $5\Omega$  and  $2\Omega$  respectively connected in the two gaps of the meter bridge.



A resistor X of cross-sectional area  $1\text{mm}^2$  is connected across P so that the balance point is  $66.7\text{cm}$  from A. if the resistivity of wire X is  $1.0 \times 10^{-5}\Omega\text{m}$  and the resistance wire AB of the meter bridge is  $100\text{cm}$  long, calculate the length of X. (04marks)

(d) Explain how electrons attain a steady drift velocity when current flows through a conductor. (02marks).

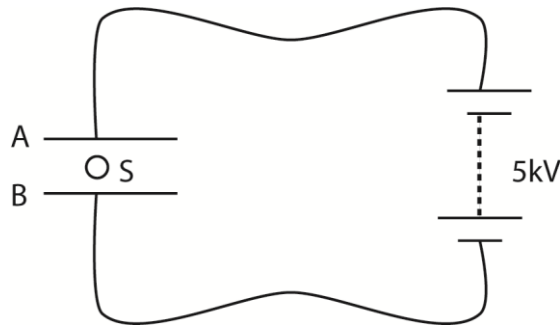
9. (a) (i) Explain equipotential surface. (04marks)

(ii) Give an example of an equipotential surface (01mark)

(b) (i) State coulomb's law. (01 marks)

(ii) With the aid of a diagram, explain the variation of electric potential with distance from the centre of charged metal sphere (03marks)

(iii) Two metal plates A and B,  $30\text{cm}$  apart are connected to a  $5\text{kV}$ dc supply as shown in the figure below.



When a small charged sphere,  $s$ , of mass  $9.0 \times 10^{-3}\text{kg}$  is placed the plates, it remains stationary. Indicate the forces acting on the sphere and determine the magnitude of the charge on the sphere. (04marks)

(c) (i) Define electric field intensity. (01marks)

(ii) With the aid of a diagram, explain electrostatic shielding. (04marks)

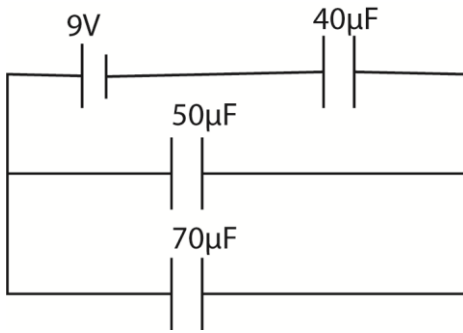
(d) Explain briefly why a neutral metal body is attracted to a charged body when brought near it. (02marks)

10. (a) (i) What is meant by capacitance of a capacitor? (01mark)

(ii) A parallel plate capacitor is connected across a battery and charged fully. When a dielectric material is now inserted between its plates, the amount of charge stored in the capacitor changes. Explain the change. (04marks)

(iii) Describe an experiment to determine the relative permittivity of a dielectric. (04marks)

(b) A network of capacitors of capacitances  $40\mu\text{F}$ ,  $50\mu\text{F}$  and  $70\mu\text{F}$  is connected to a battery of  $9\text{V}$  as shown in the figure below



Calculate

- (i) Charge stored in the  $50\mu\text{F}$  capacitor. (05marks)
- (ii) Energy stored in the  $40\mu\text{F}$  (03marks)

(c) Explain corona discharge

**END**