UACE PHYSICS PAPER 2006

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	$1.2 \times 10^{-6}\Omega m$

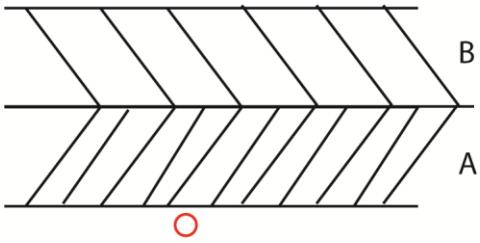
SECTION A

1. (a) (i) What is meant by refraction of light? (01mark)

(ii) State the laws of refraction. (02marks)

(b) Describe how the refractive index of a liquid can be determined using a concave mirror. (05marks)

(c)

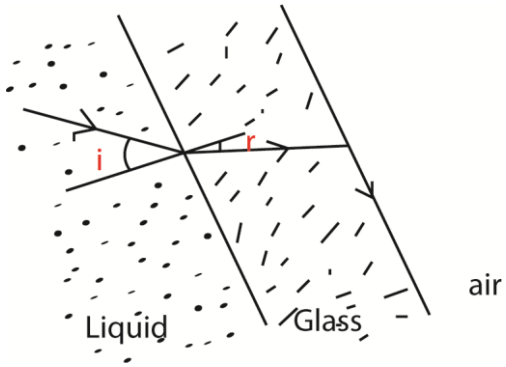


Two parallel sided blocks A and B of thickness 4.0cm and 5.0cm respectively are arranged such that A lies on an object O as shown above.

Calculate the apparent displacement of O when observed from directly above, it the refractive indices of A and B are 1.52 and 1.66 respectively. (05marks)

(d) (i) state two applications of total internal reflection. (02marks)

(ii)



In the figure above, a parallel sided glass slide is in contact with a liquid on one side and air on the other side. A ray of light incident on the glass slide from the liquid emerges in air along the glass air interface.

Derive an expression for the absolute refractive index, n_l, of the liquid in terms of absolute refractive index, n, of glass and the angle of incidence, i.

2. (a) (i) Define angular magnification of a compound microscope. (01mark)

(ii) Draw a labelled ray diagram to show how two converging lenses can be used to make a compound microscope in normal adjustment. (03marks)

(b) An object of size 2.0mm is placed 3.0cm in front of the objective of a compound microscope. The focal length of the objective is 2.5cm while that of the eye piece is 5.0cm. The microscope forms a virtual image of the object at the near point of the eye. Find the

(i) the size of the final image (05marks)

(ii) position of the eye ring

(c) (i) With the aid of labelled diagram, describe the essential parts of a photographic camera. (02marks)

(ii) Explain how chromatic and spherical aberration are minimized in a photographic camera. (02marks)

3. (a) (i) What is meant by amplitude and wavelength as applied to wave? (02marks)

(ii) State differences between progressive and stationary waves

(b) The displacement, y, of a wave travelling in the x- direction is given at time, t, by

$$y = a\sin 2\pi\left(\frac{t}{0.5} - \frac{x}{2.0}\right)\text{meters}$$

Find the speed of the wave (04marks)

(c) (i) What is meant by the terms overtones and beats? (03marks)

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(ii) State two uses of beats (02marks)

(iii) A tube 1m long closed at one end has its lowest resonance frequency at 86.2Hz. With a tube of identical dimensions but open at both ends, the first resonance occurs at 171Hz.

Calculate the speed of sound and the end correction. (06marks)

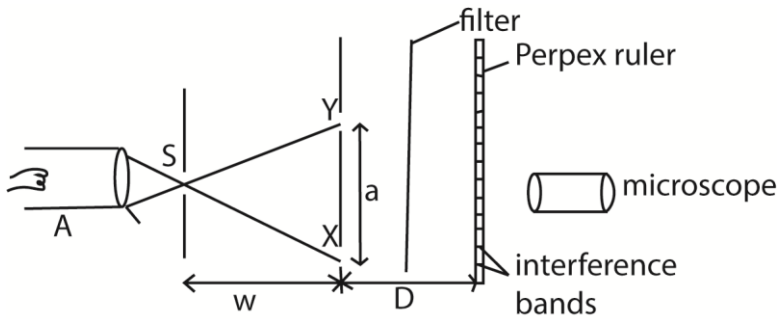
4. (a)(i) State the superposition principle as applied to wave motion. (01mark)

(ii) What is meant by optical path? (01mark)

(b) (i) state the conditions which must be satisfied in order to observe an interference pattern due to two waves (02marks)

(ii) Explain why an oil film on a water surface appears to be colored. (04marks)

(c)



The figure above shows an experiment set up to demonstrate Young's interference fringes. Explain what is observed when the

(i) Slit X is covered. (02marks)

(ii) Slit S is widened (02marks)

(iii) Separation, a, of the slits X and Y is reduced keeping w fixed. (02marks)

(iv) Distance, w, is reduced. (02 marks)

(c) Monochromatic light of wavelength 600mm is incident normally on a plane diffraction grating which has 500 lines per mm. calculate the

(i) Number of maxima observed

(ii) Angular position of the first diffraction maximum (02marks)

SECTION B

5. (a) Define magnetic flux density and state its units (02marks)

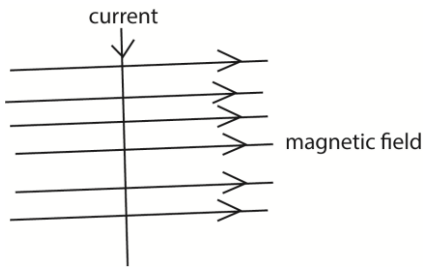
(b) Describe how the magnetic flux density between the poles of a powerful magnet can be determined. (03marks)

(c)(i) Explain with the aid of sketch, the terms angles of dip and declination. (04marks)

(ii) Explain what happens to the angle of dip as one moves along the same longitude from the equator to the North Pole. (02marks)

(iii) Find the force per unit length on a straight horizontal wire carrying a current of 2.0A in the direction north to south if the angle of dip is 70^0 and the earth's horizontal field component is 1.6×10^{-5}T. (04marks)

(d)



A wire is placed vertically in a horizontal magnetic field as shown in figure above. Sketch the resultant magnetic field pattern (03marks)

6. (a) (i) With the aid of diagram, describe how a simple d.c. motor works (06marks)

(ii) Explain the significance of back e.m.f. in the operation of a d.c. motor (02marks)

(b) A motor of armature resistance 0.75Ω is operated from a 240V d.c. supply.

(i) When the motor turns freely without a load, the current in the armature is 4.0A and the motor makes 400 revolution per minute. Calculate the back e.m.f. (02marks)

(ii) When a load is placed on the motor, the armature current increases to 60.0A. Find the new speed of rotation of the motor (04marks)

(c) (i) A circular coil of 10 turns and radius 5.0cm carries a current of 1.0A. Find the magnetic flux density at its center. (02marks)

(ii) A copper wire of cross section area $1.5mm^2$ carries a current of 5.0A.The wire is placed perpendicular to magnetic field of flux density0.2T. If the density of free electrons in the wire is $10^{29}m^{-3}$, calculate the force on each electron. (04marks)

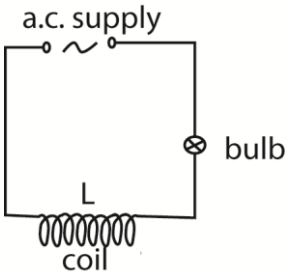
7. (a) Define the terms root mean square, peak of an alternating current and derive the relation between them for a sinusoidal a.c. (06marks)

(b) A sinusoidal alternating current, $I = I_0 \sin\omega t$, passes through a pure inductor of inductance, I

(i) Derive an expression for the reactance of the inductor. (04marks)

(ii) Using the axes, sketch graphs to show the relative phases of the current and voltage across the inductor. (02marks)

(c)



The figure above is a circuit consisting of an air coil, L, a bulb, X and an alternating voltage source connected in series, an iron core is introduced into the coil. Explain why the

(i) Bulb becomes dimmer (03marks)

(ii) Iron core becomes warm. (02marks)

(d) Explain why a moving coil ammeter cannot be used to measure alternating current from the mains. (03marks)

SECTION C

8. (a) Define the terms electrical resistivity and temperature coefficient of resistance (02marks)

(b) (i) Explain why the temperature coefficient of resistance is positive for metals. (03marks)

(ii) what is a super conductor (01marks)

(c) The temperature coefficient of resistance of two wires A and B of diameters 1.20mm and 0.80mm are $0.0004K^{-1}$ and $0.0003K^{-1}$ respectively. If the ratio of their resistances at 0^0C is 1.5, calculate

(i) the ratio of resistances at 100^0C

(ii) their electrical resistance at 100^0C

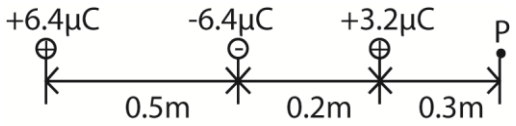
(d) (i) Derive the balance condition for Wheatstone bridge. (04marks)

(ii) Explain why the Wheatstone bridge is not suitable for measuring very low or very high resistances. (04marks)

9. (a)(i) Define electric potential and electric field intensity. (02marks)

(ii) What is the relationship between electric potential and electric field intensity? (01mark)

(b)



Three point charges of +6.4μC, -6.4μC and 3.2μC are arranged in line as shown in the figure above. Find the field intensity at P. (06marks)

(c) (i) Explain with the aid of a diagram, how a charged body cab be screened against external electric fields (03marks)

(ii) Describe briefly how the sign of a charge on a given body can be detected using a gold leaf electroscope (04marks)

(iii) What is meant by action points in electrostatics? (04marks)

10. (a) Define the farad (01mark)

(b) Describe briefly the energy transformations that take place when charging a capacitor using a dry cell. (03marks)

(c) The capacitance of a variable radio capacitor can be can be charged continuously from10pF to 900pF by turning the dial from 0^0 to 140^0. With the dial set at 140^0, the capacitor is connected to a 9V battery. After charging, the capacitor is disconnected from the battery and the dial turned to 0^0. Calculate the

(i) charge on capacitor. (03marks)

(ii) energy stored in the capacitor with the dial at 140^0. (03marks)

(iii) work required to turn the dial from 140^0 to 0^0 if the friction is neglected. (03marks)

(d) Describe an experiment to determine the effect of area of overlap on capacitance of a parallel plate capacitor (04marks)

(e) Explain why the capacitance of a capacitor changes when a dielectric is placed between its plates. (04marks)

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