UACE PHYSICS PAPER 2010 GUIDE

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

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1. (a) (i) Define principal focus of a concave lens. (01marks)

   (ii) Draw a ray diagram to show formation of an image of finite object in a concave lens (02marks)

   (b) A concave mirror of radius of curvature 20cm is arranged coaxially with a concave lens of focal length 15cm, placed 10cm from the mirror. An object, 3cm tall is placed in front the concave lens and its image is formed on a screen 40cm away from the lens.

   (i) Find the position of the object. (07marks)

   What is the height of the image formed? (03marks)

   (iii) Explain what would happen if the lens was replaced with a similar one but of much smaller focal length. (03marks)

   (c) Explain how spherical aberration is minimized in a photographic camera.(03marks)

2. (a) Define refractive index. (01mark)

   (b) (i) Describe with the aid of a diagram, how the refractive index of a liquid can be determined using air cell. (05marks)

   (ii) Derive the expression used to obtain the refractive index of the liquid in (b)(i) (03marks)

   (c) A prism of refractive angle 60^0 has refractive indices 1.515 and 1.529 for red and violet respectively. When white light is incident on one face of the prism, red light undergoes minimum deviation. Calculate the angle of

   (i) incidence for white light (04marks)

   (ii) emergence for violet light. (03marks)

   (d) Describe the adjustment that have to be made before a spectrometer can be used. (04 marks)

3. (a) (i) Define amplitude of a wave. (01mark)
   (ii) State two characteristics of a stationary wave (02 mark)
   (iii) A progressive wave y = asin(ax-kx) is reflected at a barrier to interfere with the incoming wave. Show that the resultant is a stationary wave (04marks)

   (b) (i) What is meant by beats? (02marks)

   (ii) Describe how you can determine the frequency of a musical note using beats. (05marks)

   (c) Two open pipes of length 92cm and 93cm are found to give beat frequency of 3.0Hz when each is sounding in its fundamental note. If the end errors are 1.5cm and 1.8cm respectively, calculate the
   (i) velocity of sound in air (04marks)
   (ii) frequency of each note (02mark)

4. (a) (i) Define the term diffraction. (01mark)

(ii) What is meant by plane polarized light? (01mark)

(b) (i) Describe how polarized light is produced by double refraction. (05 marks)

(ii) State two uses of polarized light (02mark)

(iii) A parallel beam of unpolarized light incident on transparent medium of refractive index 1.62, is reflected as polarized light. Calculate the angle of incident in air and angle of refraction in the medium (03marks)

(c) (i) What is diffraction grating? (01mark)

(ii) Sodium light of wavelength 5.890×10^{-7}m and 5.896×10^{-7}m fall normally on a diffraction grating. If the first order beam, the two sodium lines are separated by 2minutes, find the spacing of grating (03marks)

(d) State three differences between the spectra produced by a prism and that by diffraction grating. (03marks).

SECTION B

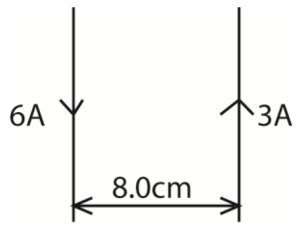
5. (a) Define the term **magnetic flux density**. (01mark)

(b) Write expression for the

(i) magnetic flux density at a perpendicular distance, R, from a long straight wire carrying current, I, in air. (01mark)

(ii) Force on a straight conductor of length, L (meters) carrying current, I (ampere) at an angle, θ, to a uniform magnetic field of flux density, B (tesla)

(c) Two straight long and straight wires of negligible cross-section area carry currents of 6,0A and 3.0A in opposite direction as shown below



If the wire are separated by a distance of 8.0cm, find the;

(i) Magnetic flux density at a point mid-way between the wires (04marks)

(ii) Force per meter between the wire (03marks)

(d) Define:

(i) angle of dip (01mark)

(ii) angle of declination (01mark)

(e) A straight conductor of length, L, is perpendicular to magnetic field of flux density B. If the conductor moves with velocity, U, at an angle θ to magnetic field, derive the expression for e.m.f induced. (04marks)

(f) An aircraft of wing 20m is moving horizontally from west to east at a velocity of 250ms^{-1} in a place where the angle of dip is 40^0. The e.m.f induced across the tips of the wings is 6mV. Find the magnetic flux density of the earth field. (04mrks)

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

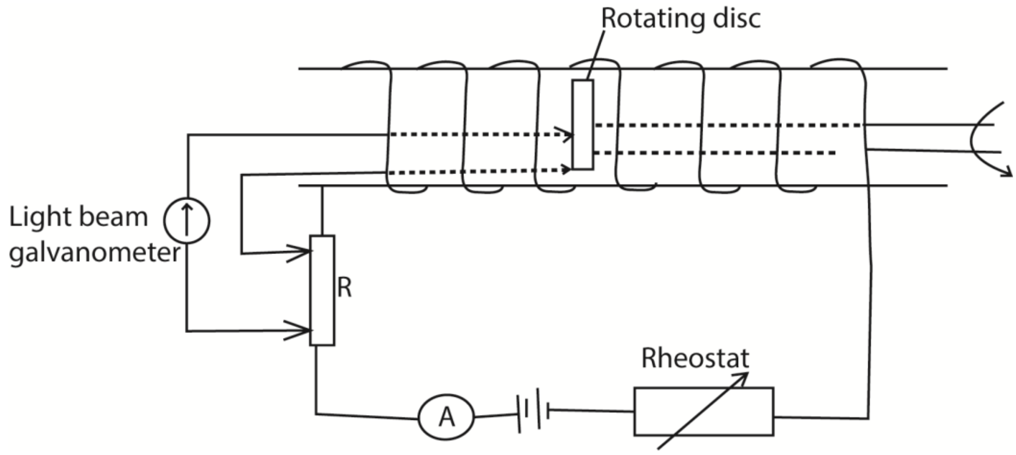
(b) The e.m.f generated in a coil rotating in a uniform magnetic field is given by $E_0 \sin\omega t$.

(i) State the meaning of the symbols used and give their units. (03marks)

(ii) Draw diagrams showing the relative positions of the coil and the magnetic field when t is zero and when the e.m.f generated is E_0. (03marks)

(c) A rectangular coil of 50turnsis 15.0cm wide and 30.0cm long. If it rotates at a uniform rate of 2000 revolution per minute about an axis parallel to its long side and at right angles to a uniform magnetic field of flux density 0.04T, find the peak value of the e.m.f induced in the coil (03marks)

(d)A solenoid of, n, turns per meter, a resistor, R, an ammeter, A, and a rheostat are connected to the battery as shown in the figure below. A disc of radius, r, is mounted inside the solenoid with is axis coincident with that of the solenoid. The center and rim of the disc are connected across, R. The disc is rotated with its plane perpendicular to the axis of the solenoid at a frequency, f.



The rheostat is adjusted until the galvanometer shows no deflection and ammeter reads a current of I amperes.

(i) Show that the e.m.f induced between the center and rim of the disc is $\pi Br^2 f$, where B is magnetic flux density inside the solenoid. (04marks)

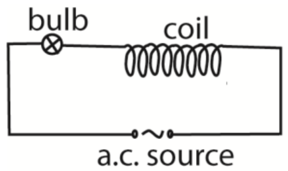
(ii) Deduce an expression for resistance of R, in terms of n, f, I and r.

(iii) State two limitations of the above set up in measurement of resistance.

7. (a) (i) Distinguish between root mean square value and peak value of an alternating current. (02marks)

(ii) What is peak value of voltage from a 240 a.c mains? (02marks)

(b)



An air-cored coil, a bulb and an a.c. source are connected as shown in figure above. When a solid iron core is introduced in the coil, the bulb becomes dimmer and the core hot. Explain the observation. (06marks)

(c) (i) What is meant by the term inductive reactance? (01mark)

(ii) Derive an expression for reactance of an inductor of inductance L when a sinusoidally varying a.c. of frequency, f, passes through it. (05marks)

(iii) A sinusoidal alternating voltage of $6.0V_{r.m.s}$ and frequency 1 kHz is applied to a coil of inductance 0.5H. Assuming that the coil has negligible resistance, calculate the root mean square value of current. (03marks)

(d) State one advantage of a.c over d.c.

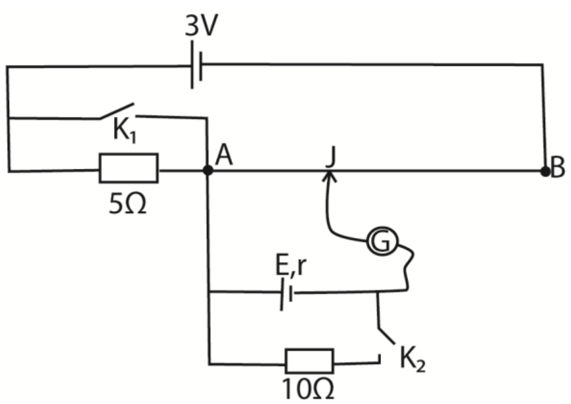
SECTION C

8. (a) (i) Define electrical resistivity and state its units (02marks)
(ii) What is meant by e.m.f and internal resistance of a battery (02marks)

(b)Explain why resistance of a metal increases when temperature of the metal is increased. (02marks)

(c) Describe with the aid of labelled diagram, how a slide wire potentiometer may be used to determine the e.m.f of a battery. (06marks)

(d)

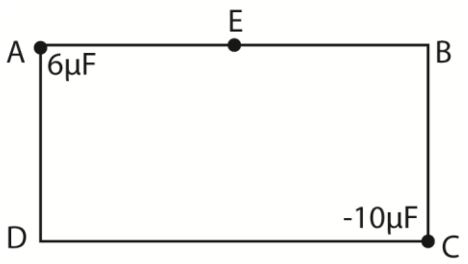


The circuit in the figure above shows a uniform slide wire AB of length 100cm and resistance 10Ω. The wire is connected in series with a resistor of resistance 5Ω across 3.0V battery of negligible internal resistance. A cell of resistance, E and internal resistance, r, is connected as shown. With switches K_1 and K_2 open, the galvanometer, G shows no deflection when AJ is 75.0cm. With K_1 and K_2 closed, the galvanometer shows no deflection when AJ is 65.0cm. Find the

(i) Value of e.m.f, E.
(ii) Internal resistance, r
(iii) Balance length when K_1 is closed, and K_2 is open

9. (a) (i) Define electric potential (01mark)
(ii) Derive an expression for electric potential at a point which is a distance, r, from a point charge Q (04marks)

(b) Two charges of magnitude 6μF and -10μF are placed at the corners of a rectangle ABCD as shown in the figure below



AB = 6cm and BC = 4cm. Point E is the mid-point of AB. Find the work done in taking a point charge of 1.6×10^{-10}C from D to E. (05marks)

(c) A negatively charged ebonite rod is brought up to an uncharged pith ball suspended by a silk thread. The pith-ball first moves to the rod, touches it and then moves away. Explain these observations (04marks)

END