UACE PHYSICS PAPER 2018 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	$1.6 x10^{-19}C$
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) Define the following as applied to telescope
   (i) Eye-ring (01marks)
   (ii) Magnifying power(01mark)

   (b) What is the significance of the eye-ring of an astronomical telescope? (01mark)

   (c) State two advantages of a reflecting telescope over a refracting telescope (02marks)

   (d) The figure below shows an optical system consisting of two thin converging lenses arranged coaxially. Lens A has a focal length of 40mm and lens B has a focal length of 375mm. an object O of height 5mm is placed 50mm from A. I_1 is the real image of O and I_2 is the virtual image of I_1 in B and is 250mm from B.

   (i) Determine the value of distance, Y of image I_1 from lens A (02marks)
   (ii) Calculate the distance, x, between the images I_1 and I_2. (02marks)
   (iii) Find the linear magnification produced by the lens system. (02marks)

   (e) Name one defect of the image formed by a lens and explain how the defect is minimized in practice. (03marks)

   (f) Explain the following

   (i) total internal reflection (03marks)

   (ii) Formation of mirages (03marks)

2. (a) State the laws of refraction of light. (02marks)
   (b) Derive an expression for refractive index of a prism in terms of the refractive angle A and the angle of minimum deviation D. (05marks)
   (c) A ray of light is refracted through a prism in a plane perpendicular to its edge. The angle of incidence is 30^0 and the refractive index of the prism is 1.50. Calculate the angle of the prism such that the ray does not emerge when it strikes the second face. (05marks)

   (d) (i) Describe with the aid of a labelled diagram, the structure and operation of projection lantern. (04marks)

   (ii) A projector produces an image of area $2m^2$ on a screen placed 5m from the projection lens. If the area of the object slide is $8cm^2$, calculate the focal length of the projection lens. (02marks)

SECTION B

3. (a) define the following as applied to wave motion
   (i) Amplitude (01mark)
   (ii) Frequency (01mark)
   (iii) Wavelength (01mark)
   (iv) Derive the relationship between velocity, wavelength and frequency of a wave (03marks)

   (b) The displacement, y, of a progressive wave is given as $y= 2\cos \pi(t-\frac{x}{20})$; where x is horizontal distance in meters and t is time in seconds.

   Determine the

   (i) Velocity of the wave (03marks)
   (ii) Maximum velocity of particles of the medium. (02marks)

   (c) (i) What is meant by the Doppler effect? (01marks)

   (ii) A source of sound moving with velocity, u. approaches an observer moving with velocity u_0 in the same direction. Derive the expression for frequency of sound heard by observer. (05marks)

   (d) Two whistles are sounded simultaneously. The wavelengths of the sounds emitted are 5.5m and 6.0m respectively. Find the beat frequency if the speed of sound is $330ms^{-1}$.

4. (a) What is meant by the following as applied to light waves
   (i) Diffraction (01mark)
   (ii) Polarization (01mark)

   (b) A diffraction grating of spacing d, is illuminated normally with light of wavelength, λ.
   (i) Derive the condition for concurrence of diffraction maxima. (03marks)

   (ii) Describe briefly the intensity distribution on screen placed beyond the grating (02marks)

   (iii) What is the effect on diffraction pattern when grating with larger number of lines is used (02marks)

(c) Light of wavelength 5.8×10^{-7}m is incident on diffraction grating of 500 lines per mm. Find the
   (i) Diffraction angle for second order image (03marks)
   (ii) Maximum number of images formed. (02marks)

(d) (i) Describe how polarized light can be produced by reflection. (04marks)

   (ii) List for used of polarized light.

SECTION C

5. (a) With the aid of a sketch graph, explain the hysteresis curve for ferromagnetic material (07mark)

(b)(i) Describe with the aid of a labeled diagram, the structure and mode of action of a moving coil galvanometer (06marks)

(i) Explain why eddy currents are useful in a moving coil galvanometer. (02marks)

(c) A conducting disc of radius 0.05m with its plane perpendicular to uniform magnetic field of flux density 0.25T, rotates at 15 revolution per second about an axis through its center and perpendicular to its plane.
Calculate

(i) Magnetic flux threading the disc at any time (03marks)

(ii) E.m.f generated between the center of the disc and any point on its rim.

6. (a) state **Faraday's law** of electromagnetic induction (01 mark)

(b) With the aid of a diagram describe an experiment to illustrate **Lenz's law** of electromagnetic induction. (05marks)

(c) Define **magnetic moment** of a coil. (01mark)

(d) A small circular coil of 20 turns of wire lies in a uniform magnetic field of flux density 5.0×10^{-2}T. The normal to the coil makes an angle of 30^0 with the direction of the magnetic field. If the radius of the coil is 4cm and the coil carries a current of 2.0A, find the

(i) magnetic moment of the coil (02marks)

(ii) torque on the coil

(e) (i) State and define the unit of magnetic flux density.

(ii) Show that when the magnetic flux linking a coil changes, the total charge which passes through is depends only on the resistance of the coil and total flux linking it (05marks).

(iii) State any two factors which determine the efficiency of a transformer. (01mark)

7. (a)(i) What is meant by **capacitive reactance**? (01mark)

(ii) Peak value of an alternating voltage. (01mark)

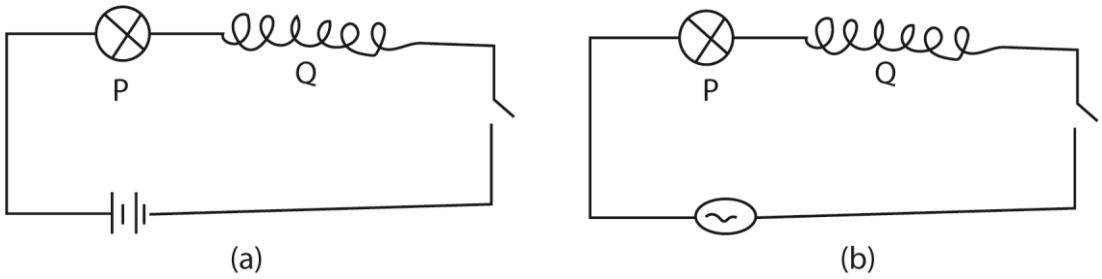
(iii) Show that the r.ms value of an alternating voltage is $V_{r.ms} = \frac{V_0}{\sqrt{2}}$, where V_0 is the peak voltage (03marks)

(b) Distinguish between mutual and self-induction. 02marks)

(c)(i) Describe with the aid of a diagram, the structure and working of a.c. transformer (02marks)

(ii) Explain the steps taken to minimize power losses in electric power transformation. (03marks)

(d) In figure below, P is a 6V lamp and Q is a coil of negligible resistance



(i) Explain which of the lamps in the figure above will be brighter when K is closed (02marks)

(ii) Explain what happens when a soft iron core is introduced in the coil in each of the circuit (03marks)

SECTION D

8. (a) Define the following as applied to a battery:

(i) Electromotive force

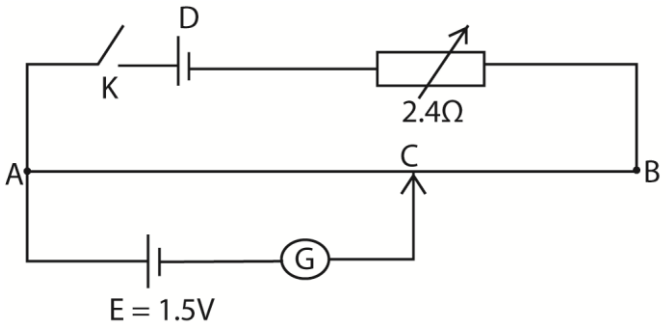
(ii) Internal resistance

(b) A battery of e.m.f E and internal resistance, r, is connected across a load of resistance, R. Derive an expression for maximum power delivered to the load. (04marks)

(c) Determined how resistance of a resistor may be determined using a slide wire potentiometer (05marks)

(d) Explain why the potentiometer is more suitable for measuring small resistance than Wheatstone bridge (02marks)

(e) In the figure below, AB is a uniform resistance wire of resistance 2.0Ω, and length 100cm, E is a cell of e.m.f 1.5V and D is a driver cell of negligible internal resistance. When switch K is closed the balance length AC is 82.5cm.



(i) Find e.m.f of D (03marks)

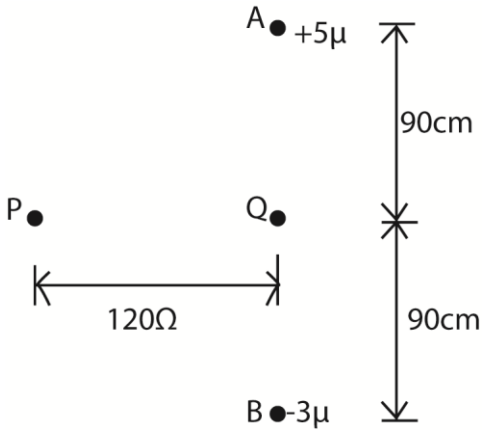
(ii) If E and the galvanometer are replaced by a voltmeter of resistance 20.0Ω, find the reading of the voltmeter when contact C is placed at the mid-point of AB and the value of R is 1.0Ω.

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

(ii) Derive an expression for electric potential difference between two points a and b in the field of a single point charge +Q (04marks

(b) Describe an experiment to show that when two dissimilar dielectrics are rubbed together, they acquire equal but opposite charge.

(c) Two point charges of +5μF and -3μF are placed at points A and B as shown in the figure below.



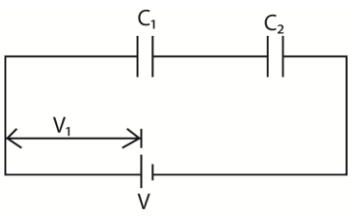
Calculate the

(i) Electric potential at P (03marks)
(ii) Work done in moving a charge -3μC from P to Q. (04marks)

(d) State any two characteristics of an equipotential (02marks)

10. (a) Define the following
(i) Capacitance (01mark)
(ii) Relative permittivity (01mark)

(b) Two capacitors of capacitances C_1 and C_2 are connected in series with a battery of e.m.f V as shown below.

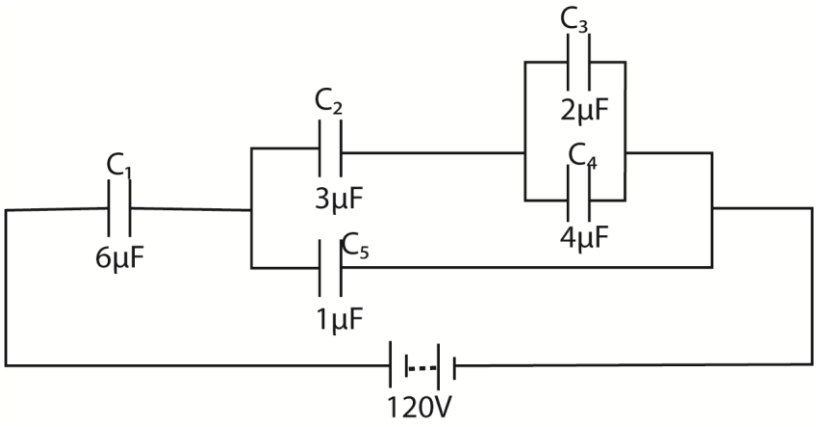


If the p.d across the capacitor of capacitance C_1 is V_1 show that

$$\frac{1}{V_1} = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)\frac{C_1}{V}$$

(c) Describe an experiment to determine the capacitance of a capacitor using a vibrating reed circuit.

(d) A battery of e.m.f120V is connected to a network of capacitors as shown in the figure below



Calculate the

(i) Charge on C_1 (04marks)

(ii) Energy stored in C_5 (03marks)

(e) Describe how the effect of a dielectric medium on the capacitance of a capacitor may be determined. (03marks)

End