

UACE PHYSICS PAPER 2 2019 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	$1.6 \times 10^{-19}\text{C}$
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, μ_0	$4.0\pi \times 10^{-7}\text{Hm}^{-1}$
Permittivity of free space, ϵ_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°C	$1.2 \times 10^{-6}\Omega\text{m}$

SECTION A

1. (a) (i) derive the relationship, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ for convex lens, where u is the object distance, v is the image distance and f is the focal length of the lens. (04marks)

(ii) State three possible reasons under which an image of real object may not be formed by a convex lens on the screen. (03marks)

(b) Describe an experiment to determine the focal length of a convex lens fixed inside a short cylindrical tube (05marks)

(c) A convex lens of focal length 10cm is arranged coaxially with a concave lens of focal length 18cm. the lens system is used to focus an object placed 24cm from the convex lens on the side remote from the concave lens. the final image is formed on a screen placed 18.6cm from the concave lens. Calculate the;

(i) separation between the lenses. (05marks)

(ii) Magnification (03marks)

2. (a) (i) State the laws of refraction of light. (02marks)

(ii) A small object is placed at a distance of 30.0cm from a converging lens of focal length 10.0cm. Calculate the distance from the first lens where a second converging lens of focal length 40.0cm must be placed in order to produce an erect image of the same size as the object. (05marks)

(b) (i) Draw a diagram to show the formation of an image by a compound microscope in normal adjustment and use it to derive an expression for the magnifying power. (06marks)

(ii) A microscope has an objective of focal length 10.0cm and eye piece of focal length 20.0cm. If the distance between the objective and eye piece is 20 cm, calculate the magnifying power of the microscope. (03marks)

(c) What is meant by the following:

(i) total internal reflection (01mark)

(ii) critical angle (01mark)

(d) Briefly explain why an observer sees a spectrum of colors through rain drops when it is raining on a sunny day. (02marks)

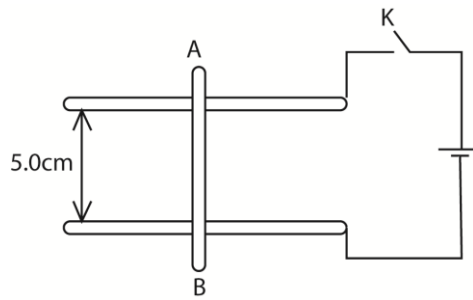
SECTION B

3. (a) What is meant by interference pattern as applied to waves. (03marks)
(b) Explain why it is necessary to use a common source when demonstrating interference in light (03marks)
(c) In an experiment to determine wavelength of light using Young's method, two slits, a separation of 1.2mm were used. When the screen was placed 18.0cm from slits, 30 bright fringes occupying a distance 2.5mm was obtained,
(i) Find wavelength of light used (04marks)
(ii) List the changes that would be observed if the distance of the screen from the slits was increased (02marks)
(d)(i) Derive the expression for angular position of n^{th} order principal maximum produced by transmission diffraction grating.
(ii) Light of two wavelength $5.4 \times 10^{-7}\text{m}$ and $5.7 \times 10^{-7}\text{m}$ incident normally on transmission grating with spacing $2.00 \times 10^{-6}\text{m}$. Find the angular separation of second order principal maxima.
(iii) Suppose white light is used in (d)(ii) , describe the positions of the red and violet lights in the order principal maximum relative central maxima (01mark)
4. (a) Define the following
(i) Transverse waves
(ii) Longitudinal waves
(b) When a plane wave transverse a medium, the displacement of the particle is given by
 $y = 0.01\sin 2\pi(2t - 0.01x)$, where y and x are in meters and t in seconds
Calculate the
(i) Frequency of the wave (02marks)
(ii) Wave velocity (03marks)
(iii) Phase difference at a given instant of time between two particles 50m apart. (02marks)
(c) Describe an experiment to determine the velocity of sound in air by an interference method. (06marks)
(d) (i) state two applications of Doppler effect. (02marks)
(ii) Derive an expression for frequency, f , of sound as heard by stationary observer when the source of sound of frequency, f , approaches with uniform speed, u_s (03marks)

SECTION C

5. (a)(i) Write down an expression for the force on a charge, q coulombs moving with velocity, u , at an angle, α , to a uniform magnetic field of flux density B . (01mark)
(ii) Use the expression in (a)(i), to deduce the force on a conductor carrying a current in magnetic field. (03marks)

(b) Figure below shows an aluminium bar AB resting on two horizontal aluminium rails connected to a battery through switch K. a magnetic field of flux density 0.10T acts perpendicularly into paper.



- (i) Explain what happens to AB when switch K is closed (03 marks)
- (ii) Calculate the angle to horizontal to which the rail must be tilted to keep AB stationary if its mass is 5.0g , current in it is 4.0A and the direction of the field remains unchanged. (04 marks)

(c)(i) With the aid of a labelled diagram, describe the structure and mode of operation of a moving coil galvanometer. (06 marks)

- (iii) Discuss the factors which affect the current sensitivity of a moving coil galvanometer (03 marks)

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

(b)(i) With the aid of a diagram, describe how a simple a.c. generator works (04 marks)

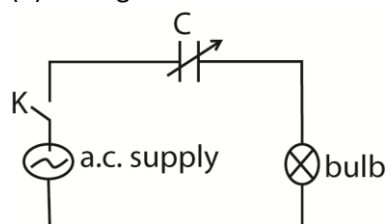
(ii) What are the main energy losses in a practical a.c. generator and how are they minimized? (02 marks)

(c) A circular coil having 20 turns each of radius 8.0cm is rotated about its vertical diameter with angular speed of $50\text{ radians per second}$ in a uniform horizontal magnetic field of magnitude 30mT .

(i) Calculate the r.m.s value of the e.m.f. induced in the coil (03 marks)

(ii) If the coil forms a closed loop of resistance 10Ω , how much power is dissipated as heat in it? (02 marks)

(d) The figure below shows a capacitor and a bulb connected to a.c supply



Explain

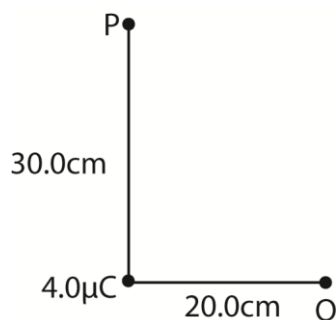
- (i) Why the bulb lights when switch K, is closed (01 marks)
- (ii) What would happen if the capacitance were reduced? (02 marks)
When the capacitance is reduced the reactance increases and therefore the charging and discharging current is decrease. The bulb dims or goes off.

(e) Explain the following observation:

- (i) A spark is seen at the switch when the circuit of a current carrying coil is broken (02marks)
 - (ii) A magnetized iron bar dropped vertically through a hollow region of a thick cylindrical shell made of copper experiences a retarding force. (02marks)
7. (a) Define the following
- (i) Peak value(01mark)
 - (ii) Root mean square (r.m.s) value of alternating current.(01mark)
- (b) Derive an equation relating peak value and r.m.s value of alternating current (03marks)
- (c) An electric current flow through a coil of 4Ω immersed in 200kg of water placed in a container. If the temperature of the water rises by 1K per minute, calculate the peak value of current supplied. (03marks)
- (d) What is meant by resonance in a circuit? (01mark)
- (e) A lamp of resistance 10Ω , a capacitor of capacitance $0.4\mu\text{F}$ and an inductor of inductance 0.4H are connected in series to an alternating voltage source of 0.01V (r.m.s). The frequency, f , is varied from low to high value while maintaining the amplitude of the applied voltage constant.
- (i) Explain how the brightness of the lamp rises. (03marks)
 - (ii) Calculate the resonance frequency. (03marks)
 - (iii) Find the voltage across the capacitor. (03marks)
- (f) Explain why in an R-C circuit, power is only absorbed by resistive part of the circuit. (02marks)

SECTION D

8. (a) State Coulomb's law of electrostatics (01marks)
- (b) (i) Describe how a conductor may be positively charge but remains at zero potential(03marks)
- (ii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere.
- (c) In the figure below, points P and Q are at a distances 30.0cm and 20.0cm from a point charge of $4.0\mu\text{C}$ respectively.



Calculate

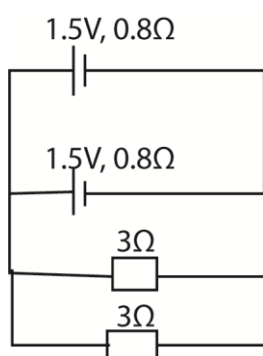
- (i) Electric potential difference between P and Q (05marks)
- (ii) Energy required to bring a charge of $+1.0\mu\text{C}$ from infinity to Q. (03marks)

(d) Describe with the aid of a diagram an experiment to show that excess charge resides only on outside of hollow conductor.

9. (a)(i) Define e.m.f of a battery. (01marks)

(ii) Explain why e.m.f of a battery left standing in a room for long decreases. (02marks)

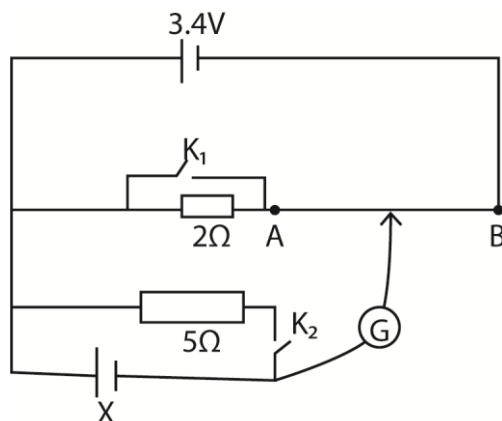
(b) The figure below shows a network resistors connected to show identical cells of e.m.f 1.5V and internal resistance 0.8Ω .



Calculate the current supplied by the cells (04marks)

(c) Describe an experiment which can be carried out to determine the resistance of a wire using a potentiometer. (06marks)

(d) The figure below shows a uniform resistance wire AB, 100cm long and resistance 4.0Ω connected with a 2.0Ω resistor through switch K_2 . When K_1 is closed and K_2 open, the balance length is 53cm.



Find the

- (i) Balance length when K_1 and K_2 are both open (04marks)

- (ii) Internal resistance of cell X if the balance length is 44.1cm when both K_1 and K_2 are closed (01marks)
10. (a)(i) Define farad. (01mark)
- (ii) Describe briefly the energy transformations that take place when charging a capacitor using a dry cell. (02marks)
- (b)(i) What is meant by dielectric constant? (02marks)
- (c) A $60\ \mu\text{F}$ is charged from a 120V supply. It is then connected across the terminals of a $20\ \mu\text{F}$ capacitor. Calculate the
- (i) final p.d. across the combination (03marks)
- (ii) Difference in the initial and final energies stored in the capacitor and comment on the difference. (05marks)
- (d) Explain the principles of operation of a lightning conductor. (05marks)

End