UACE PHYSICS PAPER 2017 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

1. (a) (i) State two differences between real and virtual images (02marks)

   (ii) Explain with the aid of a diagram how thick plane mirror forms multiple images (04marks)

(b) A convex mirror forms a real image which is three times the linear size of the object. When the object is displaced though a distance y, the real mage formed is four times the linear size of he object. If the distance between the two image positions is 20 cm, find the

(i) focal length of the mirror (03marks)

(ii) distance, y. (03marks)

(c) Use a geometrical ray diagram to derive the relation, $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ for concave mirror. (05marks)

(d) Explain how mirage is formed. (03marks)

2. (a) Define the following as applied to a converging lens;
   (i) Principal focus (01mark)
   (ii) center of curvature (01mark)

(b) Find the power of a lens of focal length 15 cm (02marks)

(c) Derive an expression for focal length of a lens in terms of the radii of curvature of its surfaces and refractive index (05marks)

(d) Describe an experiment to determine the focal length of a thin converging lens mounted inside a short cylindrical tube. (05marks)

(e) A compound microscope consists of two thin lenses, an objective of focal length 1.0cm and eye piece of focal length 5.0cm. The objective forms an image of an object placed in front of it at a point 16.0cm away. If the final image is formed at the near point of the eye, calculate the

(i) Separation of the lenses (03marks)

(ii) magnifying power of the instrument (03marks)

SECTION B

3. (a) define the following as applied to a wave
   (i) Amplitude (01mark)
   (ii) Wavelength (01mark)

(b)(i) State the conditions for the formation of standing wave (02marks)

(ii) A string fixed at both ends is made to vibrate in different modes. If the frequencies of n^{th} harmonic and fundamental note are f_n and f_l respectively. Show that $f_n = nf_l$.

(c) The mass of a vibrating length of sonometer wire is 1.20g. a note of frequency512Hz is produced when the wire is sounding in second over note. If the tension in the wire is 100N. Calculate the vibrating length of the wire. (04marks)

(d) Explain why the quality of a note from an open pipe is preferred to that given by closed pipe (03marks)

(e) Describe an experiment to investigate the variation of frequency with length for vibrating wires (05marks)

4. (a) Define an optical path (01mark)

(b) With reference to Young's double slit experiment,

(i) Explain how interference pattern is formed (03marks)

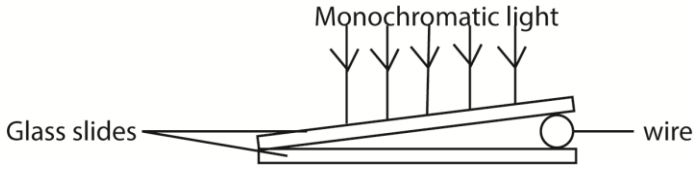
(ii) State what happens to the fringes when the source of light is moved nearer to the slits.

(iii) State what happens to fringes when the separation of slits is changes

(iv)describe the appearance of fringes when white light is used

(v) calculate the separation of the slits if the distance from slits to the screen is 800mm and the 8^{th} bright fringe is formed 5mm from the center of the fringe system given that the wavelength of light is 6.2×10^{-7}m

(c) An air wedge is formed by placing two glass slides of length 5.0cm in contact at one end and separated by a wire on the other end as shown below



When the slides are illuminated with light of wavelength 500nm, 10 dark fringes are observed to occupy a distance of 2.5mm

(i) Explain how the fringes are formed (03marks)

(ii) Determine the diameter of the wire(04marks)

SECTION C

5. (a) Define magnetic flux density. (01mark)

(b) Write the expression for the

(i) Magnetic flux density B at a distance r from long straight wire currying current I. (01mark)

(ii) Force F on a straight wire of length L carrying current I perpendicular to a uniform magnetic field of flux density B.

(c) A moving-coil galvanometer consists of a rectangular coil of N-turns each of area A suspended in a radial magnetic flied of flux density B.

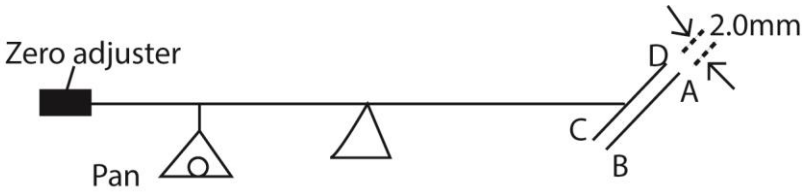
(i) Derive an expression for the torque on the coil when a current I passes through it (04marks)

(ii) If the coil is suspended by a torsion wire for which the couple per unit twist is C, show that the instrument will have a linear scale.(03mark)

(iii) How can current sensitivity of the instrument be measured? (02marks)

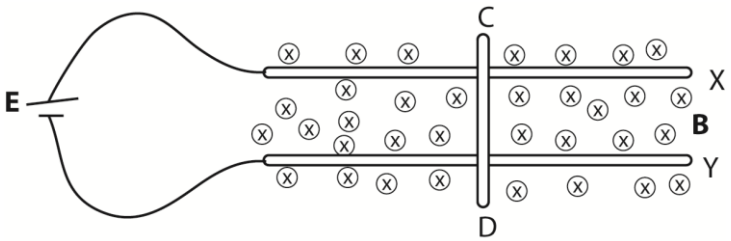
(d) Describe an experiment to determine the magnetic flux density of a uniform magnetic field using a search coil and ballistic galvanometer (05marks)

(e) Figure 2 shows an ampere balance, wires AB and CD each of length 100cm, lie in the same vertical plane and separated by 2.0mm.



When a current I is passed in opposite direction through the wires, a mass of 0.3g is placed in the pan to obtain balance. Find the value of the current I (03marks)

6. In the figure below X and Y are smooth conducting rails connected to a source of e.m.f, E. CD is a metal rod of length L m placed horizontally on X and Y perpendicular to magnetic field of flux density B



(i) Copy the diagram and indicate the direction of Force acting on the rod. (01mark)

(ii) Using the principle of conservation of energy, show that F = BIL, where I is the current supplied by the source. (04marks)

(b) (i) Describe the feature of earth's magnetic field (05marks)

(ii) Sketch the resultant magnetic flux around a wire carrying current vertically upwards in in earth's magnetic field. (02marks)

(c) A circular coil of 50 turns and radius 0.5m is placed with its plane perpendicular to earth's magnetic meridian. It is connected to a ballistic galvanometer of sensitivity 5.7×10^3 radC^{-1} and circuit resistance of 100Ω. When the coil is rotated through 180^0 about a horizontal axis, the galvanometer deflects through 0.8 rads.

Calculate

(i) Horizontal component of earth's magnetic flux density. (04marks)

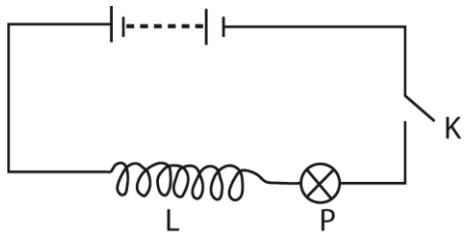
(ii) p.d across a solenoid of 2000 turns per meter and resistance 5Ω that produces the same magnetic flux density as calculated in (c)(i). (04marks)

7. (a) Define root mean square value of an alternating current. (01mark)

(b)(i) Write down and expression for the e.m.f generated by a dynamo and use it to identify the factors which determine the maximum e.m.f. (04marks)

(ii) Explain the structural modification needed to convert an a.c. generator into a d.c. generator.

(c) An iron-cored coil having a low resistance and high inductance is connected in series with a filament lamp, P. the coil and lamp are connected across a d.c. supply as shown in the figure below



Explain what is observed when switch K is closed and then opened. (04marks)

(d) An alternating voltage $V = V_0 \cos\omega t$ is connected across an inductor of inductance L.
(i) Derive the expression for the reactance of the inductor, X_L. (04marks)
(ii) Sketch using the same axes the variation of applied voltage and current through the inductor with time. (02marks)

(e) Describe how a thermocouple ammeter is used to measure an alternating current. (03marks)

SECTION D

8. (a)(i) State the law of conservation of current at a junction in an electric circuit. (01marks)

(ii) Explain why current from a battery is greater when bulbs are connected in parallel than when they are in series across a battery. (03marks)

(b) A conductor of length L and cross sectional area A has n free electrons per unit volume. The average drift velocity of the electrons is v and each electron carries charge e.

Derive an expression for the current which flows (03marks)

(c) A battery with an e.m.f of 12V and internal resistance 2Ω is connected to a wire of resistance 10Ω.

(i) Calculate the p.d across the wire. (02marks)

(ii) What is the p.d across the wire become if a 15Ω resistor is connected parallel to it? (03marks)

(d)(i) Define electrical resistivity and state its units (02marks)

(ii) Describe an experiment to determine the resistivity of the material of a wire using an ammeter, meter rule and voltmeter

9. (a) (i) Define temperature coefficient of resistance and state its units. (02marks)

(ii)Explain why temperature coefficient of resistance is positive for metals. (03marks)

(b) (i) Derive the conditions for balance of meter bridge. (05marks)

(ii) Explain why the meter bridge is unsuitable for comparison of low resistances. (02marks)

(c) A standard resistor is connected across the right hand gap of a meter bridge and a coil X across the left hand gap of meter bridge. When the coil is heated to a temperature of 40^0C, the balance length is 525mm from left-hand end of the bridge.
When the temperature of X is raised to 100^0C, the balance point is 546mm from the left end.
(i) Calculate the temperature coefficient of resistance of the coil X (06marks)

(ii) Why are standard resistors made of alloys such as constantan and magnesium? (02marks)

10. (a) Derive an expression for energy stored in a capacitor of capacitance, C, charged to voltage, V. (04marks)

(b) A parallel plate capacitor with plate area of $2 \times 10^{-2}m^2$ and plate separation of 5.0×10^{-3}m is connected to a 500V supply.
(i) Calculate the energy stored in the capacitor (04marks)
(ii) If the space between the plates is completely filled with oil and the total charge in the capacitor becomes 4.42×10^{-8}C. Find the dielectric constant of the oil (03marks)
(c) Explain how a lightning conductor may protect a building from damage by lightning. (05marks)

(d) Describe an experiment to show that charge on a hollow conductor resides on the outer surface. (04marks)

END