UACE PHYSICS PAPER 2005

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) Define the focal length of a concave mirror. (01mark)

(b) An object is placed at a distance u from a concave mirror, the mirror forms an image of the object at a distance v. Draw diagrams to show the path of light rays when an image formed is

(i) real (02marks)

(ii) virtual (02marks)

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

(d) A concave mirror of radius of curvature 40.0cm contains a liquid to a height 2.0cm. A pin clamped horizontally and viewed from above is observed to coincide with its image when it is 27.0 above the surface of the liquid. Calculate the refractive index of the liquid. (04marks)

(e) You are provided with the following pieces of apparatus:

A screen with a cross wire, a lamp, a concave mirror, and a meter rule. Describe an experiment to determine the focal length of the concave mirror using the above apparatus. (06marks)

2. (a) (i) Explain the terms chromatic and spherical aberration in lenses. (04marks)

(ii) How are the aberrations in (a)(i) above minimized in reflecting telescope? (03marks)

(b) With the aid of a diagram, explain why the image seen in the magnifying glass is almost free from chromatic aberration when the eye is close to the lens. (04marks)

(c) A converging lens is used to form an image of an object 1.2m away on the screen 0.05m from the lens.

(i) Find the focal length of the lens. (03marks)

(ii) If the lens is now used to form an image of a distant object, how far from the screen would the clear image be formed? (02marks)

(iii) State the type of lens that should be placed close to the first lens in order to enable the image in (c)(ii) above be formed on the screen. (01mark)

(iv) Calculate the focal length of the lens you have stated in (c)(iii) above. (03marks)

3. (a) Distinguish between progressive and stationary waves. (04marks)

(b) Briefly describe an experiment to show that a wire under tension can vibrate with more than one frequency.

(c) A uniform wire of length 1.00m and mass 2.0×10^{-2}kg is stretched between two fixed points. The tension in the wire is 200N. The wire is plucked in the middle and released. Calculate the

(i) Speed of the transverse waves. (03marks)

(ii) Frequency of the fundamental note (03marks)

(d) (i) Explain how beats are formed. (02 marks)

(ii) Derive an expression for the beats frequency. (03marks)

4. (a) Distinguish between longitudinal and transverse waves (02marks)

(b)(i) Describe the method of producing plane polarized light by reflection. (02marks)

(ii) Mention two practical application of plane polarized light and describe one of them. (04marks)

(c)(i) State the conditions necessary for formation of standing waves. (02marks)

(ii) A Uniform tube, 50cm long is filled with water and vibrating tuning fork of frequency 512 Hz is sounded and held above it.

When the level of water is gradually lowered, the air column resonates with the tuning fork when the length is 12cm and again when it is 43.3cm.

Estimate the lowest frequency to which the air in the tube could resonate if the tube were empty. (08marks)

SECTION B

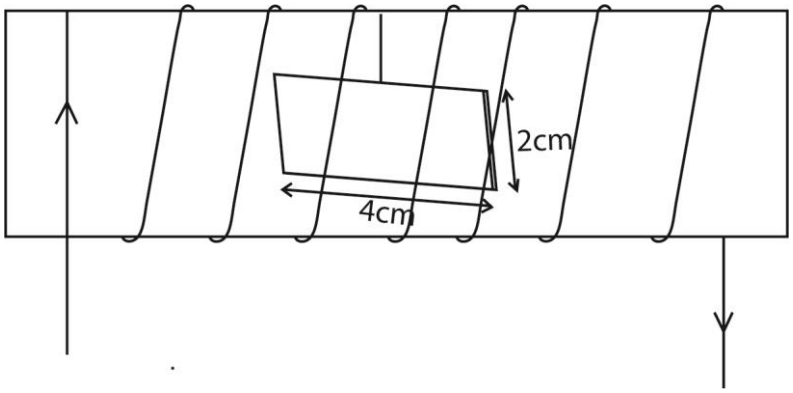
5. (a) Define magnetic flux density. (01mark)

(b) Two identical circular coils are placed coaxially at distance equal to the radius of each coil.

(i) Sketch the magnetic field pattern which results when equal current are passed through the coils. (02marks)

(ii) Describe how you would investigate the variation of magnetic flux density with distance along the axis of the coils. Draw a sketch graph to show the expected results. (06marks)

(c) A small rectangular coil of 10turns and dimensions 4cm by 2cm is suspended inside a long solenoid of 1000 turns per meter so that its plane lies along the axis of the solenoid as shown in the figure below. The coil is connected in series with solenoid.



The coil deflects through 300 when a current of 2.0A is passed through the solenoid. Find the torsion constant of the suspension. (05mark)

(d) A moving coil galvanometer reads 15mA when it is connected in series with a source of e.m.f of negligible internal resistance is replaced with one of resistance 100Ω.

The galvanometer reads 10mA when the 100Ω resistor is replaced with one of resistance 200Ω. Find the

(i) Resistance of the galvanometer

(ii) E.m.f of the source.

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

(b) A coil of 100turns is wound round the middle of a long solenoid of 500 turns per meter and radius 8.0cm

A sinusoidal current $I = 10\sin(120\pi t)$, amperes, is passed through the solenoid winding. Find the amplitude of e.m.f induced across the terminals of the coil. (05mark)

(c)(i) With the aid of labelled diagram, describe the structure and action of a simple d.c. motor. (07marks)

(ii) Explain the term back e.m.f in a motor and derive its relation to the efficiency of the motor. (03marks)

(d) Briefly explain one application of eddy currents (03marks)

7. (a) (i) Describe with the aid of a diagram, the structure and mode of operation of a.c. generator. (05marks)

(ii) Explain the structural modifications needed to convert an a.c generator to a d.c generator. (02marks)

(b)(i) Define the terms peak value and root mean square (r.m.s) value of alternating voltage (02marks)

(ii) An electric kettle draws 1.5 x 10^3W from a 240V mains supply. Find the peak value of the current drawn by the kettle, if the voltage is sinusoidal. (03marks).

(c) An alternating voltage of 12V and variable frequency, f, is connected in series with a capacitor of capacitance, C.

(i) Explain why current apparently flows through the capacitor. (05marks)

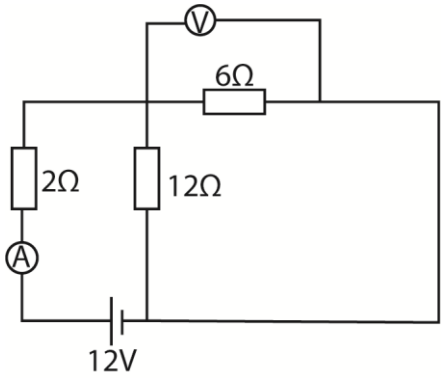
(ii) Calculate the value of the current in the circuit when f and C are 1kHz and 0.5μF respectively. (03marks)

SECTION C

8. (a) (i) Define a volt. (01mark)

(ii) Derive the formula for the combined resistance of three resistors in parallel. (04marks)

(iii)



In the circuit above, has negligible internal resistance. Find the ammeter and voltmeter readings (04marks)

(b) (i) Draw a labelled diagram of a meter bridge and derive the relation for balance. (05marks)

(ii) Explain why the balance point should be close to the middle of the wire (02marks)

(c) A coil of a wire has resistance of 30Ω at 200C and 34.5Ω at 600C. Calculate its temperature coefficient of resistance. (04marks)

9. (a) Explain the principle of a slide wire potentiometer. (03marks)

(b)(i) Using a labelled diagram, describe how an ammeter is calibrated using a slide wire potentiometer. (06marks)

(ii) What is the advantage of the potentiometer over an ordinary voltmeter in measurement of voltages? (02marks)

(c) Two cells A and B connected in series, give a balance length of 758mm along a potentiometer wire. When cell B is reversed, the balance length falls to 123mm. If the e.m.f of cell A is 1.5V, calculate the e.m.f of cell B. (04marks)

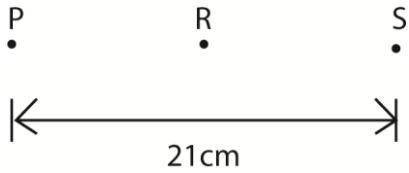
(d) The resistance of a nichrome element of an electric fire is 50.9Ω at 20.0^0C. When operating on a 240V supply, the current flowing through it is 4.17A. Calculate the steady temperature reached by the electric fire if the temperature coefficient of resistance of nichrome is $1.7 \times 10^{-4}K^{-1}$ (05marks)

10. (a) Explain the meaning of an equipotential surface as applied to electric field. (02marks)

(b) With the aid of a diagram, describe an experiment to show that excess charge resides only on the outside surface of a hollow conductor. (05marks)

(c) State Coulomb's law of electrostatics (01mark)

(d)



Two point charges P and S of -17.6μC and -9.0μC respectively are placed in a vacuum at a distance of 21cm apart. When a third charge, R, is placed midway between P and S as shown above, the net force on S is zero.

(i) Determine the charge on R (05marks)

(ii) Calculate electric potential at position of R (05marks)

(iii) Sketch the electric field lines corresponding to the charge distribution (02marks)

END