UACE PHYSICS PAPER 2012

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

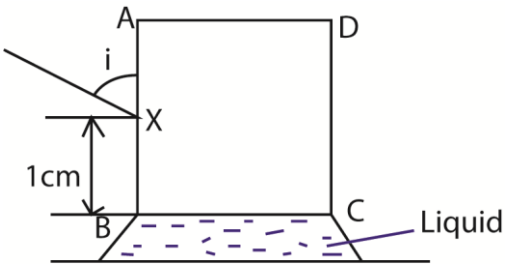
1. (a) (i) State the laws of refraction of light (02marks)

(ii) State the conditions for total internal reflection to occur. (02marks)

(b) (i) Describe an experiment to determine refractive index of a liquid using air cell. (06marks)

(ii) Explain the difficulty encountered in the experiment described in (b)(i) if white light is used (02marks)

(c) A cube of glass of side 3cm and refractive index 1.5 is placed on a thin film of liquid as shown in the figure below



A ray of light in the vertical plane strikes AB of the glass cube at an angle i = 410. After refraction at X, the ray is reflected at the critical angle for glass-liquid interface.

(i) Calculate the critical angle for glass –liquid interface. (03marks)

(ii) Find the position from B where the ray strikes the glass-liquid interface

(d) Explain why the rays from the sun can still be seen shortly after sunset (03marks)

2. (a) with the aid of ray diagram, explain the following as applied to lenses
(i) conjugate points. (02marks)

(ii) spherical aberration (02marks)

(b) An object, O, placed in front of a converging lens forms a real image, I, on the screen. The distance between the object and its real image is d. while that of the image from the lens is x.

Derive the expression for the least possible distance between the object and its real image (05marks)

(c) Give the properties of lenses in achromatic combination. (03marks)-

(d) A compound microscope consists of two converging lenses of focal lengths 1.0cm and 5.0cm respectively. An object is placed 1.1cm from objective and the microscope is adjusted so that the final image formed 30cm from the eye- piece. Calculate

(i) the separation of the lenses (03marks)

(ii) the magnifying power of the lenses. (03marks)

(e) State two differences between a compound microscope and an astronomical telescope. (02marks)

SECTION B

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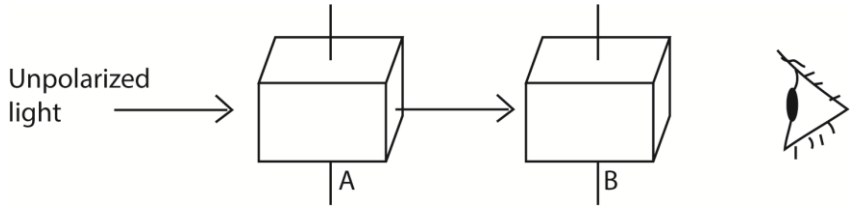
3. (a) What is meant by the following terms as applied to sound?
   (i) Resonance (01mark)
   (ii) Fundamental frequency (01mark)
   (b) Describe an experiment to determine end- correction of resonance tube. (05mark)
   (c) A wire of length 50cm, density 8.0gcm^{-3} is stretched between two points. If the wire is set to vibrate at fundamental frequency of 15Hz, calculate
   (i) The velocity of the wave along the wire. (03marks)
   (ii) The tension per unit area of cross section of wire.(03marks)
   (d) Explain using the principle of superposition of wave the formation of
   (i) Beats (04marks)
   (ii) Stationary waves (03marks)
4. (a) (i) what is plane polarized light? (01mark)
   (ii) Why is it not possible to polarize sound waves? (01mark)
   (e) (i) Unpolarized light is incident on a sheet of polaroid, A, as shown below



Explain what would be observed if a second polarized sheet B is rotated about an axis perpendicular to the direction of incidence. (03mark)

(ii) Sunlight is reflected off a glass window of refractive index 1.55. What should be the elevation of the sun be if the reflected light is to be completely polarized? (03marks)

(c) Given the diffraction grating and spectrometer, describe how you would use them to measure the wavelength of light from a given source.(07marks)

(d) A parallel beam of monochromatic light of wavelength 650nm is directed normally to diffraction grating which has 600 lines per mm. Determine
(i) the number of diffraction image. (03marks)

(ii) the angle of diffraction of the highest order diffraction image. (02marks)

SECTION C

5. (a) Define the following:
   (i) Weber (01mark)
   (ii) Ampere (01mark)

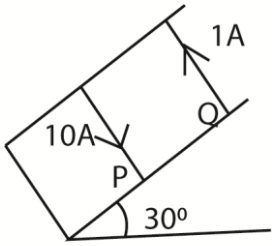
(b) A circular coil of N turns, each of radius R carries a current I.

(i) Write an expression for the magnetic flux density at the center of the coil (01mark)

(ii) Sketch the magnetic field pattern associated with the coil. (02marks)

(c) Describe how deflection magnetometer can be used to investigate the variation of magnetic flux density at the center of a circular coil with the current flowing through the coil. (06marks)

(d) Two parallel wires P and Q, each of length 0.2m carry currents of 10A and 1A respectively



The distance between the wires is 0.04m. If both wires remain stationary and the angle of the plane with the horizontal is 30^0. Calculate weight of Q. (05marks)

Solution

(e) (i) State why the damping in the ballistic galvanometer should be as small as possible. (01mark)

When the oscillation in the ballistic galvanometer is damped, the deflection is not proportional to the charge.

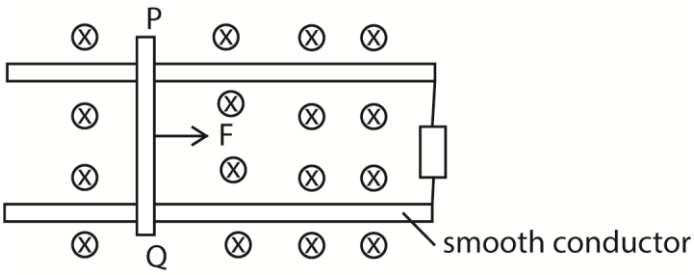
(ii) Describe how the damping can be reduced in practice (03marks)

6. (a)(i) Define the terms self-induction and mutual induction. (02marks)
(ii) State Faraday's law of electromagnetic induction (01mark)

(b) (i) Describe the structure and action of a.c transformer. (06marks)

(ii) Explain why the voltage at a generating power station must be stepped up to very high value for long distance transmission (03marks)

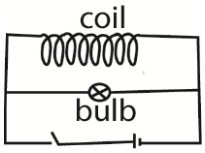
(c) In the figure below, a conducting rod PQ of length 20mm rests on a smooth conducting frame to form a complete circuit of resistance 4.0Ω. When a force, F, is applied, the rod moves at a constant velocity of $6.0ms^{-1}$ perpendicular to a uniform magnetic field of flux density 1.5T.



(i) Explain why the rod PQ moves with constant velocity. (03 marks)
(ii) Calculate the amplitude of the induced e.m.f (02marks)
(iii) Calculate the magnitude of the force, F. (03marks)

7. (a) Define the term peak value and root mean square value of an alternating current. (02 marks)

(b) A coil of many turns of wire is connected in parallel with an electric bulb to a d.c supply as shown in the figure below.



At the instant switch K is closed, the bulb flashes briefly for a short time and then goes off. Explain the observation.(04marks)

(c) A sinusoidal alternating voltage of 20V (r.m.s) and frequency 60Hz is applied across a coil of wire of inductance 0.2H and negligible resistance.
(i) Find the reactance of the coil at this frequency. (03marks)

(ii) Calculate the r.m.s value of the current which passes through the coil (02marks)

(iii) Explain why on average the power delivered to the inductor in one cycle is zero. (03marks)

(d) Describe with aid of a labelled diagram the structure and action of a hot wire ammeter. (06marks)

SECTON D

8. (a) What is meant by electromotive force of a cell? (01mark)

   (b) Describe an experiment to determine e.m.f and internal resistance of a cell using ammeter, a resistance box and voltmeter. (05marks)

   (c) (i) Define temperature coefficient of resistance (01mark)

   (ii) Explain why the resistance of a thermistor reduces when current is passed through it. (02marks)

   (d) (i) Derive the balance conditions for Wheatstone bridge. (04marks)

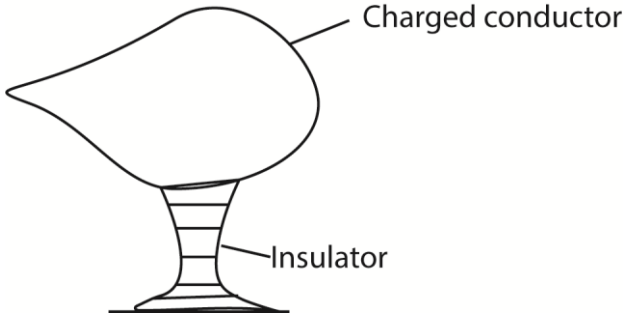
   (ii) Explain one reason other than faulty apparatus and poor electrical contact, why it may not be possible to obtain balance in a Wheatstone bridge in an experiment to compare two resistances. (02marks)

   (e) In an experiment to investigate the variation of resistance with temperature, a nickel wire and a 10Ω standard resistor were connected in the left-hand gap and right-hand gap respectively of Meter Bridge. When the nickel wire was at 0^0C, a balance point is 40cm from the end of the bridge adjacent to the nickel wire. When the nickel wire is at 100^0C, the balance point is 50cm from the same end of the bridge.

   Calculate the temperature of the nickel wire if the balance length is 42cm. (05marks)

9. (a) (i) What is meant by electric field intensity at a point? (01mark)

   (ii) Describe how distribution of charge on a charged conductor of the shape shown below can be investigated. (04marks)

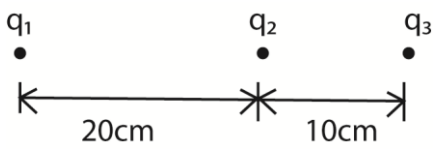


   (iii) Explain how a lightning conductor protects a house from lightening. (04marks)

   (b) (i) what is electric field line? (01mark)

   (ii) Derive an expression for electric potential at a point a distance, a, from an isolated charge of magnitude Q in air. (04marks)

   (c) The figure below shows charges q_1, q_2 and q_3 of +46.3μF, -34.7μF and +23.4μF respectively, placed in straight line in air.



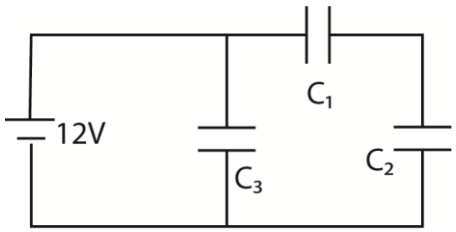
   Find the force on q_3. (06marks)

10. (a) Define the following terms
    (i) The farad (01mark)
    (ii) Relative permittivity (01mark)

(b) You are provided with the following apparatus, a battery, two switches, a capacitor of known capacitance, a ballistic galvanometer and connecting wires.

Describe an experiment that can be carried out using the above apparatus to determine the unknown capacitance of a capacitor (05marks)

(c) The diagram below shows arrangement of three capacitors C_1, C_2, and C_3 of capacitance 8μF, 2μF and 6μF respectively.



Calculate the total energy stored;

(i) In all capacitors when fully charged. (04marks)
(ii) When the space between the plates of C_2 is filled with a dielectric of constant 1.25. (04marks)

(d) A capacitor of capacitance, C, is charged by a battery and then later isolated. When the plates of the capacitor are taken apart, deduce what happens to the potential difference between the plates. (03marks)

(e) Explain what happens if a conductor instead of dielectric is placed between the plates of charged capacitor. (02marks)

END