KING'S COLLEGE – BUDDO
UACE INTERNAL MOCK EXAMINATIONS 2020

P510/2 PHYSICS

PAPER TWO

2hours 30minutes

INSTRUCTION TO CANDIDATES

Answer any five questions, including at least one from each section, but not more than one from either section A or B.

Where necessary assume the following constants:

Acceleration due to gravity,	g	=	$9.81ms^{-2}$
Speed of light in vacuum,	c	=	$3.0 \times 10^8 ms^{-1}$
Speed of sound in air	v	=	$330ms^{-1}$
Electronic charge,	e	=	$1.6 \times 10^{-19}C$
Electronic mass,	m_e	=	$9.1 \times 10^{-31}kg$
Permeability of free space,	μ_0	=	$4.0\pi \times 10^{-7}Hm^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12}Fm^{-1}$
The Constant	$1/4\pi\varepsilon_0$	=	$9.0 \times 10^9 F^{-1}m$

SECTION A

1 (a) (i) Draw a ray diagram to show how a concave mirror forms a real image of a finite size object. (1)

(ii) From the diagram in (i) derive the relation $\dfrac{1}{f} = \dfrac{1}{u} + \dfrac{1}{v}$, where u, v and f are object distance, image distance and focal length of the mirror respectively. (5)

(b) Describe an experiment including a graphical analysis of the results to determine the focal length of a concave mirror using the no parallax method. (6)

(c) A convex lens of focal length 12cm is arranged co-axially with a convex mirror of focal length 20cm, such that they are 4cm apart. An object is placed 30cm in front of the lens.

(i) Find the position of the final image. (6)

(ii) Using a point object sketch a ray diagram the image formation. (2)

2. (a)(i) Define refractive index of a material

(ii) State the laws of refraction

(b) Describe how the refractive index of a liquid may be determined using an air cell. (5)

(c) Derive the expression for the apparent displacement of an object placed at the bottom of a parallel sided glass block. The glass is h cm thick and its refractive index is n. (4)

(d) A glass of thickness 3cm contains liquid to a depth of 5cm. A scratch at the bottom of the glass appears to be 5.6cm below the surface of the liquid. Find the refractive index of the liquid. (3)

(e) (i) Monochromatic light is at an angle of 43^0 on a glass prism of refracting angle 65^0in air. The emergent light just grazes the other refracting surface of the prism. Find the refractive index of the glass. (5)

SECTION B

3 (a) Using Huygens principle of construction explain how diffraction takes place through small openings. (4)

  (b) (i) What is a diffraction grating? (1)

   (ii) Describe an experiment to determine the wavelength of light using a diffraction grating. (5)

  (c) A beam of monochromatic light of wavelength 5.78×10^{-7}m is incident normally on a diffraction grating of 500lines per cm. Find the angular deviation of the second order image. (3)

  (d) What is meant by

   (i) constructive interference, and (2)

   (ii) destructive interference as applied to light? (2)

  (e) In Young's double slit experiment, eight bright fringes are counted in a space of 2.72cm. If the slit separation is 0.35mm and the screen is 1.8m away from the slits, find the wavelength of the light used. (3)

4(a) Distinguish between progressive and stationary waves. (3)

  (b) Describe an experiment to show how the frequency of a stretched string varies with length of the vibrating string. (5)

  (c) A uniform wire of length 0.8m and mass 2.0×10^{-2}kg is stretched between two fixed points so that the tension in the wire is 200N. If the wire is plucked in the middle, calculate the:

   (i) speed of the transverse wave produced. (3)

   (ii) frequency of the fundamental note. (2)

  (d) (i) What is Doppler effect? (1)

   (ii) state two applications of Beats. (2)

   (iii) A car sounds its horn as it travels at a steady speed of 15 ms^{-1} along a straight road between two stationary observers A and B. The observer A hears a frequency of 538 Hz while B hears a lower frequency. Calculate the frequency heard by B, assuming the speed of sound in air is 340 ms^{-1}. (4)

SECTION C

5 (a) What is meant by

(i) magnetic meridian? (1)

(ii) angle of dip? (1)

(b) Describe an experiment to determine the horizontal component of the earth's magnetic flux density. (5)

(c) A circular coil of 50 turns each of radius 12.0cm is placed vertical with its plane perpendicular to the magnetic meridian. The earth's field intensity at the location is 52.8Am^{-1}, and the angle of dip is 72.4^0. Find the

(i) magnetic flux linkage with the coil. (4)

(ii) Torque on the coil when a current of 3.0A is passed through it. (3)
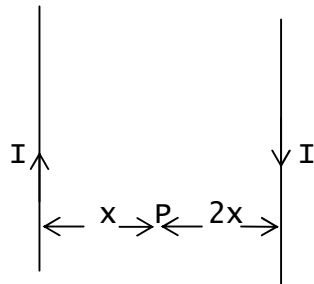
(d)

I↑   ↓I

← x →P← 2x →

Figure 1

Figure 1 shows two parallel straight wires, a distance x apart, carrying current of I in air.

(i) Show that the magnetic flux density at point P is $\dfrac{3I}{x}x\,10^{-7}$T (3)

(ii) Find the expression for the force per metre acting on the wires. (3)

6 (a)   X   Y
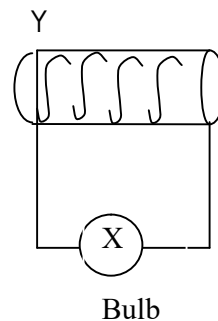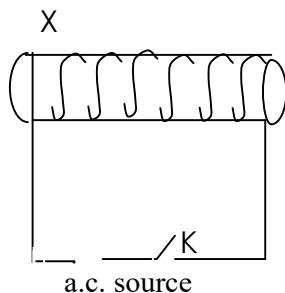
K

a.c. source

X

Bulb

Figure 2

Figure 2 shows two coils, X which is soft iron cored and Y which is air cored. When switch k is closed, bulb lights. Explain what would be observed when,

(i) soft iron rods are placed in coil Y   (3)

(ii) the a.c source is replaced by d.c source and then switch k is closed.   (3)

(b) (i)A metal disc of radius a is placed in a uniform magnetic field of flux density B, with its plane perpendicular to the magnetic field. The disc is rotated with uniform angular frequency, f. Derive the expression for the *e.m.f* induced between the rim and axle of the disc.   (4)

(ii) A circular aluminium disc of radius 30cm is mounted inside a long solenoid of 2000 turns per metre carrying current of 15A, such that its axis is along the axis of the solenoid. If the disc is rotated about its axis at 40 revolutions per minute, find the *e.m.f* induced.   (5)

(c) With the aid of a diagram describe the mode of action of a full wave rectifier.   (4)

7 (a) Define

(i) root mean square value of an alternating voltage.   (1)

(ii) reactance of a capacitor.   (1)

(b) A sinusoidal alternating voltage of V= 8sin 120πt volts is connected across a resistor of 6Ω. Find the mean power dissipated in the resistor. Hence deduce the *r.m.s* value of the current.   (4)

(c) Describe, with the aid of a diagram, a hot wire ammeter works.   (5)

(d) A capacitor of capacitance C is connected across a source of alternating voltage,

V= V_o sin ωt.

(i) Find the current which flows in the circuit.   (3)

(ii) Sketch using the same axes, the voltage across the capacitor and current which flows in the circuit, with time.   (2)

(iii) Explain why power dissipated in a capacitor is zero.   (4)

SECTION D

8 (a) (i) Derive the expression for the effective resistance of three resistors in parallel.

(ii) Explain why a wire heats up when current flows through it. (3)

(iii) Consider a portion of copper wire of length L and area of cross section, A, through which current, I, flows for a time t, Show that the drift speed of the electron is given by

$$V = \frac{I}{nAe}$$ (3marks)

(b) (i) Describe how a metre bridge can be used to measure resistivity of a wire (6)

c) A battery of *emf* $10V$, and negligible internal resistance is connected in the circuit as shown below.
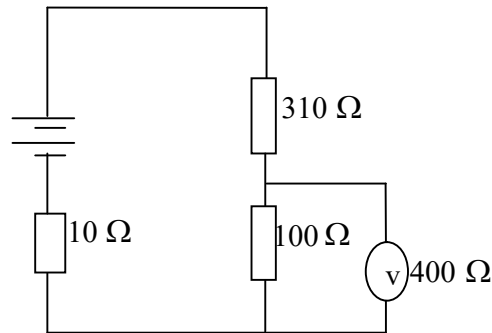
i) Find the reading of the voltmeter. (3marks)
ii) Calculate the power dissipated in the $100V$ resistor. (2marks)

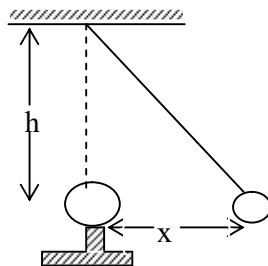9 (a)(i) State Coulomb's law of electrostatics. (1)

(ii)

Figure above shows two identical metal balls of mass, m, in air. One is fixed on an insulating stand while the other is suspended by a silk thread a height, h, above the fixed ball. When the balls are given identical charge of q, they repel. In equilibrium, the balls are a distance x, apart. Show that,

$$q = \sqrt{\frac{4\pi\varepsilon_0 mgx^3}{h}}$$

(b) Describe an experiment to show that when two dissimilar insulators are rubbed together, they acquire equal and opposite charge. (5)

(c) (i) Explain how a charged material attracts an uncharged conductor. (3)

(ii) Explain why the surface of a conductor is always an equipotential Surface. (3)
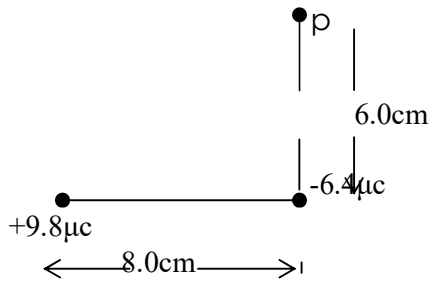
Two charges of +9.8µC and -6.4µC are placed as in figure above, in air. Find the potential energy of a charge of +2.5µC placed at a point P. (4)

10. (a) (i) Define dielectric strength and state its unit. (2)

(ii) Describe an experiment to show the effect of placing a dielectric between the plates of a capacitor on capacitance of a capacitor. (4)

(b) Two capacitors of capacitances C_1 and C_2 connected across a voltage source, carry charge of Q, when fully charged. Show that charge Q_1 stored on capacitor of capacitance C_1 is given by

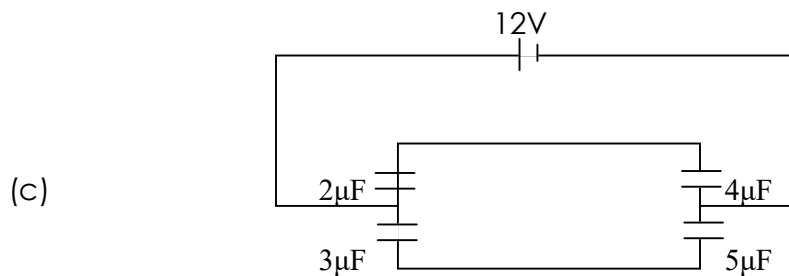$$Q_1 = \frac{C_1 Q}{C_1 + C_2}$$ (4)

(c)

Figure 6

Figure 6 shows a net work of capacitors connected across a battery of e.m.f 12V. Calculate:

(i) The total charge stored on the capacitors. (4)

(ii) the energy stored in the network. (2)