P510/2
Physics
Paper 2
Jul/Aug. 2024
2½ hours

MATIGO EXAMINATIONS BOARD

MOCK EXAMINATIONS 2024
Uganda Advanced Certificate of Education

PHYSICS
(Theory)
Paper 2
2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*Answer **five** questions, taking at least **one** from each sections* **A, B, C** *and D, but not more than one question should be chosen from either A or B.*
*Any additional questions(s) answered will **not** be marked.*
Mathematical tables and graph paper are provided.
Non- programmable scientific calculators may be used
Assume where necessary:

$Acceleration\ due\ to\ gravity, g$	$= 9.81\text{ms}^{-2}$
$Speed\ of\ light\ in\ vacuum, C$	$= 3.0 \times 10^{8}\text{ms}^{-1}$
$Speed\ of\ sound\ in\ air, v$	$= 340\text{ms}^{-1}$
$Electronic\ Charge, e$	$= 1.6 \times 10^{-19}\text{C}$
$Electronic\ mass,$	$= 9.11 \times 10^{-31}\text{kg}$
$Permeability\ of\ free\ space, \mu_0$	$= 4.0\pi \times 10^{-7}\text{H}m^{-1}$
$Permittivity\ of\ free\ space, \varepsilon_0$	$= 8.85 \times 10^{-12}\ \text{F}m^{-1}$
$The\ Constant\ \frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}F^{-1}\text{m}$
$Resistivity\ of\ Nichrome\ wire\ at\ 25°C$	$= 1.2 \times 10^{-6}\Omega m$
$Specific\ heat\ capacity\ of\ water$	$= 4.2 \times 10^{3}Jkg^{-1}K^{-1}$
$Avogadro's\ number, N_A$	$= 6.02 \times 10^{23}\text{mol}^{-1}$
$One\ election\ volt\ (eV)$	$= 1.6 \times 10^{-19}\text{J}$

Turn Over

SECTION A

1. (a) (i) State the **principle of reversibility of light**. (01 marks)

(ii) Explain the formation of the image in a plane mirror. (03 marks)

(b) Describe an experiment to show that an image in a plane mirror is as far behind the mirror as the object is in front. (05 marks)

(c) (i) Define the term limiting angle as applied in glass prism. (01 mark)

(ii) A glass prism of small angle, A, and refractive index n_g and is completely immersed in a liquid of refractive index n_l. Show that a ray of light passing through the prism at a small angle of incidence suffers a deviation given by; (04 marks)

$$d = \left(\frac{n_g}{n_l} - 1\right) A$$

(d) Explain the necessary adjustments of a spectrometer before it can be used. (06 marks)

2. (a) (i) What is meant by the term **refraction**? (01 mark)

(ii) A converging lens of focal length 30 cm is 20cm away from a diverging lens of focal length 10cm. An object is placed 1.2m distant from the former lens and on the common axis of the system. Determine the position, magnification and nature of the image formed. (05 marks)

(b) Describe the colour effects which you would expect to see in the image of a small source of white light formed on a screen by a lens and how it can be minimised. (04 marks)

(c) (i) Define **angular magnification** of a telescope. (01 mark)

(ii) With the aid of a labeled diagram, describe how a Galilean telescope works when not in normal adjustment. (05 marks)

(d) The deviation, d, by a prism of small angle, A and refractive index, n, is $d = (n-1)A$. Use this to show that the focal length of a thin concave lens of refractive index, n, is given by $\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$.
Where r_1 and r_2 are the radii of curvature of the lens surfaces. (04 marks)

SECTION B

3. (a) (i) What is a **progressive wave**? (01 mark)

(ii) Derive the equation of the progressive wave $y = sin2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$ where y is the vertical displacement, x is the horizontal displacement, T is the period and λ is the wave length (04 marks)

(iii) What is the significance of changing the sign of the term $\frac{x}{\lambda}$ in the equation above? (01 mark)

(c) (i) Describe an experiment to show the variation of diameter and frequency of a vibrating string under tension. (05 marks)

(ii) Alternating current mains is passed through a sonometer wire of length 0.8m, density 8200kgm^{-3} and mean diameter 0.02mm fixed at both ends. Poles of a permanent magnets are placed on either side of the wire so that magnetic field due to it is perpendicular to the wire. A tension of 100N is required to obtain a large amplitude of vibration of the wire with three nodes. Calculate the frequency of the alternating current. (05 marks)

(d) Explain why sound is more audible when wind is blowing towards the observer than when blowing away. (04 marks)

4. (a) (i) State **Huygens' principle** of wave construction. (01 mark)

(ii) Use Huygen's principle to show that the angle of incidence is equal to the angle of reflection of light. (05 marks)

(b) (i) Define **diffraction grating** as applied to wave theory of light. (01 mark)

(ii) Describe an experiment to determine wavelength of light using a diffraction grating and a spectrometer. (06 marks)

(c) Explain why it is not possible to see interference where the light beams from the head lamps of a car overlap. (03 marks)

(d) A lens was placed with a convex surface of radius of curvature 50.0cm in contact with the plane surface such that Newton's rings were observed when the lens was illuminated with monochromatic light. If the radius of the 15th bright ring was 2.13mm; determine the wavelength. (04 marks)

SECTION C

5. (a) Define **magnetic moment**. (01 mark)

(b) The diameter of a 40 turn circular coil is 16cm and it has a current of 5A. Calculate;

(i) magnetic induction at the centre of the coil. (02 marks)

(ii) the magnetic moment of the coil. (02 marks)

(iii) the torque acting on the coil if it is suspended in a uniform magnetic field of 0.76T such that it's plane is parallel to the field. (02 marks)

(c) Describe a simple experiment which demonstrates that a force is experienced by a current carrying conductor in a magnetic field. (05 marks)

(d) (i) Define **Hall voltage**. (01 mark)

(ii) Explain with the aid of a sketch diagram why a large voltage builds up across opposite faces of a metallic slab in a magnetic field when a current is passed through it. (04 marks)

(e) (i) Write down the expression for the magnetic force per metre that is experienced by each of the two straight and infinitely long and thin parallel wires carrying currents $I_1$and I_2 in opposite directions when placed a distance, y metres in a vacuum. (02 marks)

(ii) Use the expression in (i) to define an ampere. (01 marks)

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

(ii) Describe an experiment to verify faraday's law of electromagnetic induction. (06 marks)

(b) A flat coil of 100 turns and mean radius 5.0cm is lying on a horizontal surface and is turned over in 0.20seconds against the vertical component of the earth's magnetic field. Calculate the average emf induced. (04 marks)

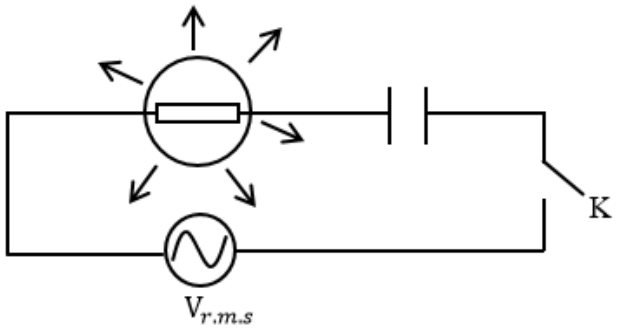
(c) (i) Explain how back emf is produced in a coil in an electric motor. (03 marks)

(ii) A d.c motor of armature resistance 0.75Ω is connected to a 240V supply. When the motor is running freely, the armature current is 2.5A and makes 400 revolution per minute, when a load is connected to the motor in the circuit, the armature increases to 25A. Calculate the speed of rotation.

(05 marks)

7. (a) Define an **impedance** of an a.c circuit? (01 mark)

(b) The figure below shows a $1200\mu F$ capacitor connected in series with a lamp of power rating 0.25A, 2.5V and power supply 50Hz and a switch, K.



Determine;

(i) The root mean square supply voltage, $V_{r.m.s}$ to light up the lamp to its fill brightness when switch K is closed. (02 marks)

(ii) Potential difference across the capacitor and the lamp. (02 marks)

(iii) Verify whether the sum of the p.d across the capacitor and the lamp is equal to the root mean square supply voltage, $V_{r.m.s}$ and comment on the result. (03 marks)

(c) Describe and explain the mode of action of a repulsive type of meter used to measure alternating current. (05 marks)

(d) (i) Distinguish between peak value and root mean square value of an alternating current. (03 marks)

(ii) Derive the relation between the terms in (i) above. (04 marks)

8. (a) (i) What is meant by **capacitance of a capacitor**. (01 mark)

(ii) Describe briefly the energy transformations that take place when charging a capacitor using a dry cell. (03 marks)

(b) (i) Derive an expression for the total capacitance of two capacitors C_1 and C_2 connected in series. (04 marks)

(ii) Two capacitors of 15μF and 20μF are connected in series with a 600V supply. Calculate the charge and potential difference across each capacitor. (04 marks)

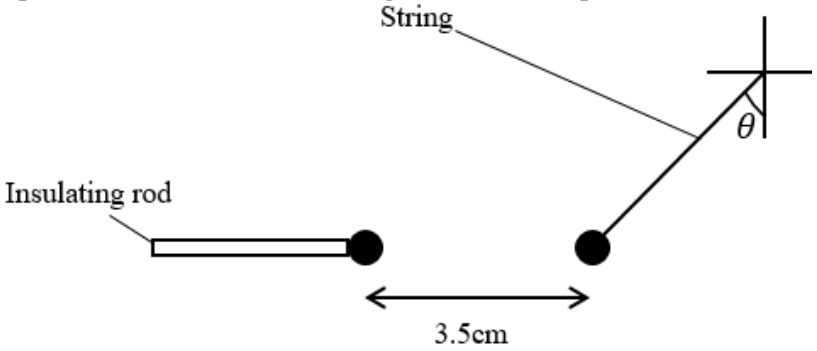
(c) (i) Describe an experiment to compare capacitance of two capacitors. (06 marks)

(ii) State two applications of capacitors. (02 marks)

9. (a) (i) What is **electric potential energy** and **electric field strength**?
(02 marks)

(ii) Sketch graphs showing the variation of electric potential with distance from the centre of a positively charged sphere.
(03 marks)

(b) A charged metal sphere, A is hung from an insulating string. Another charged sphere B, on an insulating rod is then placed close to A as shown.



The charge on sphere A is +5.0nC while that on sphere B is -4.0nC.

(i) Draw the two spheres and show the electric field pattern around them.
(02 marks)

(ii) Determine the magnitude of the electric force between the two spheres.
(03 marks)

(iii) What is the value if the angle θ if sphere A has a mass of 4.5×10^{-5}kg
(03 marks)

(c) (i) Describe the mode of operation of a Van de Graaff generator.
(04 marks)

(ii) Give three ways how the output voltage of a Van de Graaff generator can be increased. (03 marks)

10. (a) Explain why the terminal p.d falls as the current drawn from a source increases. (03 marks)

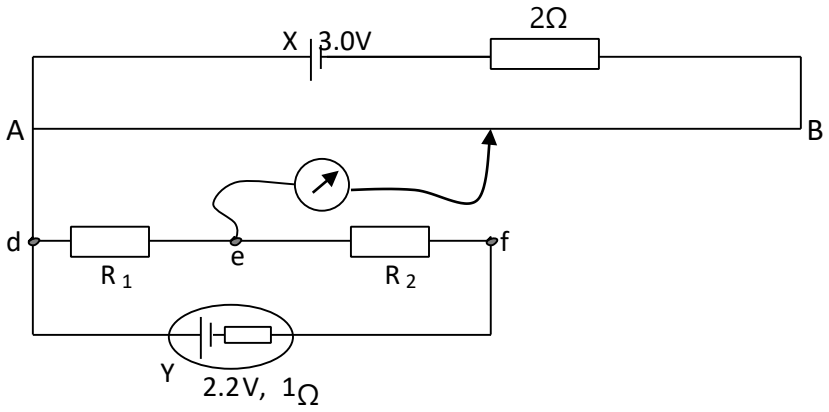
(b) A d.c source of emf 12 V and negligible internal resistance is connected in series with two resistors of 400Ω and R ohms, respectively. When a voltmeter is connected across the 400 Ω resistor, it reads 4 V while it reads 6 V when connected across the resistor of R ohms. Find the:

(i) resistance of the voltmeter. (05 marks)

(ii) value of R (02 marks)

(c) Describe how you would use a slide wire potentiometer to measure the internal resistance of a dry cell. (05 marks)

(d) In the circuit diagram shown below, AB is a slide wire of length 1.0 m and resistance 10 Ω. X is a driver cell of emf 3.0 V and negligible internal resistance. Y is a cell of emf 2.2 V and internal resistance 1.0Ω When the centre-zero galvanometer is connected in turns to points **e** and **f**, the balance lengths obtained are 45.0 cm and 80.0 cm respectively.



Calculate the:

(i) current flowing through R_1 (03 marks)

(ii) resistances of R_1 and R_2. (02 marks)

END

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