P510/2
PHYSICS
Paper 2
July/August, 2024
2 ½ hours

ACHOLI SECONDARY SCHOOLS EXAMINATIONS COMMITTEE

Uganda Advanced Certificate of Education

Joint Mock Examinations, 2024

PHYSICS

Paper 2

2 HOURS 30 MINUTES

INSTRUCTIONS TO 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) answered will NOT be marked.
- ✓ Assume where necessary:

Acceleration due to gravity	$g = 9.81 ms^{-2}$
Speed of light in a vacuum	$c = 3.0 \times 10^8 ms^{-1}$
Speed of sound in air	$= 340 ms^{-1}$
Electron charge	$e = 1.6 \times 10^{-19} C$
Electronic mass	$m_e = 9.11 \times 10^{-31} kg$
Permeability of free space	$\mu_o = 4.0\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space,	$\varepsilon_o = 8.85 \times 10^{12} Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_o}$	$= 9.0 \times 10^9 F^{-1}m$
One electron volt (eV)	$= 1.6 \times 10^{-19} J$

SECTION A

1. (a) (i) Define ***magnifying power*** of a microscope? (01 mark)

(ii) With the aid of a ray diagram describe the action of a compound microscope in normal adjustment. (05 marks)

(iii)Explain why the setup a(ii) is referred to as normal adjustment. (02 marks)

(b) Describe an experiment to determine the focal length of a convex mirror using a plane mirror. (05 marks)

(c) A convex lens of focal length 18cm and a convex mirror of focal length 30cm are arranged coaxially 8cm apart. An object is placed 40.0cm in front of the convex lens on the side remote from the convex mirror. Find the position of the final image. (05 marks)

(d) Explain the importance of a convex mirror in a reflecting telescope. (02 marks)

2. (a) (i) Show that when a ray of light passes through different media separated by parallel boundaries, $n\sin i$ = **constant**. Where n is the refractive index of a medium, and i is the angle that the ray of light makes with the normal in the medium. (04 marks)

(ii) Explain why, when a fish in water is viewed from directly above, it appears bigger than its normal size. (03 marks)

(b) Monochromatic light is incident at an angle of 49^0 on a glass prism of refracting angle 65^0 in air. The emergent light just grazes the other refracting surface of the prism. Find the;

(i) Refractive index of the material. (05 marks)

(ii) Angle of minimum deviation for the prism. (03 marks)

(c) (i) Explain how multiple images are formed in thick mirrors. (03 marks)

(ii) State *two* factors that determine the distance of separation of the images in c(i) above. (02 marks)

SECTION B

3. (a) (i) What is a ***wave*** and ***wave front***? (02 marks)

(ii)Explain how humidity affects the speed of sound in air. (03 marks)

(iii) Explain why open pipes are preferred to stopped pipes as musical instruments. (02 marks)

(b) Describe an experiment to investigate how frequency of the fundamental note produced by a stretched string varies with tension in the string. (05 marks)

(c) A wire of length 0.5m and mass 8g is stretched between two fixed points so that the tension in the wire is 150N. When the wire is plucked in the middle, its third harmonic resonates with the fundamental frequency in a closed pipe of length 28cm. Find the end correction for the pipe. (05 marks)

(d) (i) What is ***pitch*** of a sound note? (01 mark)

(ii) Explain what is meant by ***timbre*** as applied to a musical note. (02 marks)

4. (a) (i) What is ***polarized*** **light?** (01 mark)

(ii) Describe how polarized light may be produced by reflection. (04 marks)

(b) Explain:

(i) how two coherent sources are obtained using a bi-prism. (03 marks)

(ii) why thin oil films appear colored when illuminated with white light. (03 marks)

(c) (i) Two thin glass slides of length, L, are placed in contact at one end and separated at the other by a thin wire of thickness, t, to form an air wedge. Derive the expression for the width of the interference fringes formed, when the wedge is illuminated almost normally by light of wave length. (04 marks)

(ii) Explain what would be observed when the air in the wedge is replaced with water. (02 marks)

(d) Light of wave length 5.8×10^{-7}m is incident on a diffraction grating with 500 lines per mm. Find the angular deviation for the 2nd order image. (03 marks)

SECTION C

5. (a) (i) Define ***one tesla*** and ***magnetic flux linkage***. (02 marks)

(ii) Write the expression for the force on an electron moving with velocity, **u** , at right angles to a magnetic flux density, **B**. Hence deduce the force on a wire of length, **l**, in which current of, **I**, flows, when the wire is placed perpendicular to the field. (03 marks)

(b) Describe a simple experiment to investigate the variation of magnetic flux density at the centre of a coil, with the current flowing through it. (05 marks)

(c) A plane circular coil of 50 turns and mean radius 3.0cm is suspended on a torsion wire at the centre of a long solenoid of 750 turns per metre and connected in series with the solenoid. If the coil is placed such that the normal to its plane makes an angle of 20^0 with the axis of the solenoid and a current of 5.0A is passed through the system, find:

(i) the magnetic flux density at the centre of the solenoid. (03 marks)

(ii) the initial torque experienced by the coil. (03 marks)

(d) (i) What is meant by ***angle of dip*** and ***magnetic meridian***, as applied to the earth's magnetic field? (02 marks)

(ii) Draw the resultant magnetic field pattern due to a bar magnet placed in the earth's magnetic field with its north pole facing the earth's south pole. (02 marks)

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

(ii) With the aid of a diagram describe an experiment to verify Faraday's law of electromagnetic induction. (05 marks)

(b)

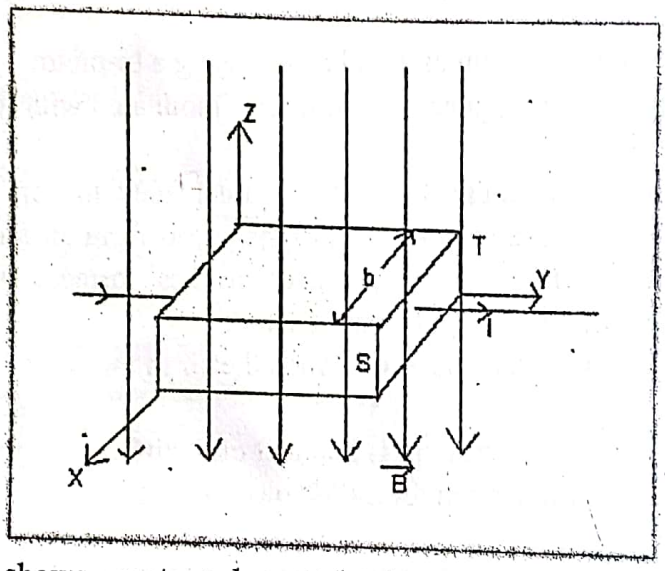


Figure above shows a rectangular metal strip of width, **b**, carrying current of, **I**, in a direction perpendicular to a uniform magnetic field of flux density, **B**.

(i) Explain why a p.d develops between faces **S** and **T**. (03 marks)

(ii) Derive the expression for the p.d induced. (03 marks)

(c)

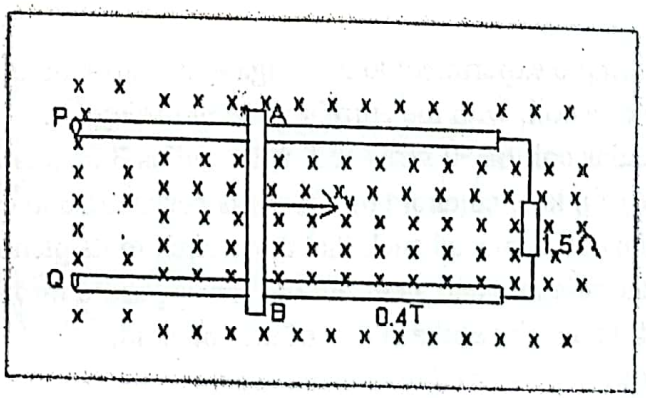


Figure above shows two horizontal conducting rails **P Q** joined through a resistor of resistance 1.5Ω. Ametal rod **A B** of length $50cm$, is pulled over the rails with a velocity of $9ms^{-1}$ in a direction perpendicular to a uniform magnetic field of flux density $0.4T$. Find the:

(i) Current induced in the circuit. (04 marks)

(ii) Force pulling the rod **AB**. (03 marks)

7. (a)(i) Define ***root mean square*** **(r.m.s) value** and ***peak*** **value** of an alternating current. (02 marks)

(ii)A sinusoidal alternating current $I = \hat{I}\sin(120\pi t)$ amperes flows through a resistor of resistance 2.5Ω, find the mean power dissipated in the resistor. (03 marks)

(b) With the aid of a diagram, describe how a repulsion type of ammeter works. (05 marks)

(c) (i) An alternating voltage is applied across a capacitor of capacitance, C. Show that the current leads the voltage by phase angle $\frac{\pi}{2}$. (03 marks)

(ii) Find the expression for the capacitive reactance in terms of frequency, f, and capacitance, C. (02 marks)

(d) A transformer designed to step down voltage to 12V, is 90% efficient. It has 3000 turns in the primary and 150 turns in the secondary. Calculate the current in the primary when a load of 3Ω is connected across the secondary. (05 marks)

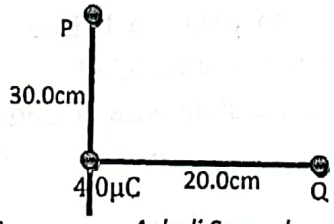
SECTION D

8. (a) State the ***coulomb's law*** of electrostatics. (01 mark)

(b)(i) Describe how a conductor may be positively charged but remains at zero potential. (03 marks)

(ii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere. (03 marks)

(c) In the figure below, point **P** and **Q** are at a distance 30.0cm and 20.0cm from a point charge 4.0μC respectively.



Calculate;

(i) Electric potential difference between **P** and **Q.**
(05 marks)

(ii) Energy required to bring a charge of +1.0μC from infinity to **Q.**
(03 marks)

(d) Describe with the aid of a diagram an experiment to show that excess charge resides only on outside of a hollow conductor.
(05 marks)

9. (a)(i) Define ***capacitance*** of a capacitor and **dielectric constant.** (02 marks)

(ii)Derive the expression for the effective capacitance of three capacitors of C_1, C_2 and C_3 arranged in series.
(04 marks)

(b)

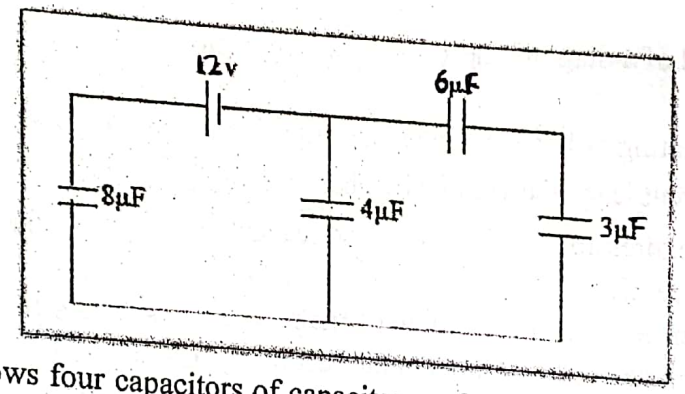


Figure above shows four capacitors of capacitances 3μF, 4μF, 6μF and 8μF connected to a d.c supply source of 12V. Find the;

(i) p.d across the 4μF capacitor
(04 marks)

(ii) Charge stored on the 3μF capacitor.
(03 marks)

(c) Describe an experiment to determine the effect of placing a dielectric between the plates of a capacitor, on capacitance.
(04 marks)

(d) Two capacitors C_1 and C_2 are connected in parallel and charged to a voltage V. When a dielectric is now inserted in C_2, the total energy stored in the network reduces. Explain why.
(03 marks)

10. (a)(i) Explain the principle of the side wire potentiometer.
(03 marks)

(ii) Give two cases when it may not be possible to obtain a balance point in a potentiometer and indicate in each case how the fault can be rectified.
(02 marks)

(b) With the aid of a labeled diagram, describe how a slide wire potentiometer can be used to calibrate an ammeter.
(06 marks)

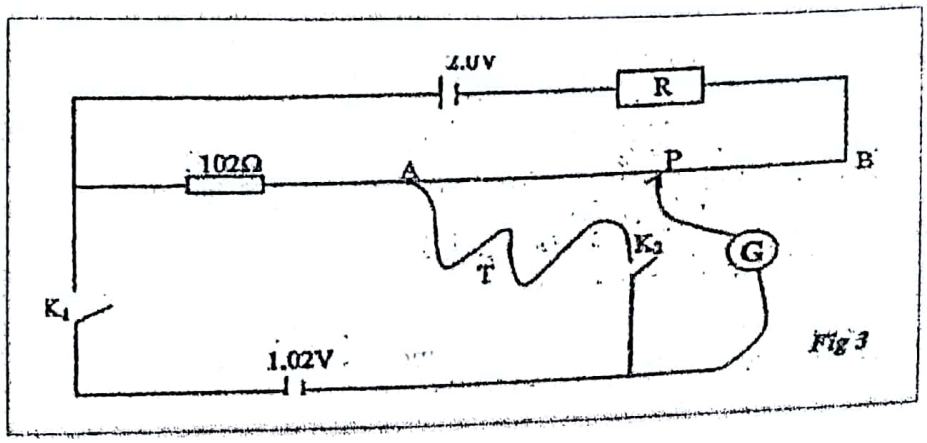


Fig 3

The circuit shown in Figure 3 is being used to measure the e.m.f of a thermal couple***T***. ***AB*** is a uniform wire of length 1.00m and resistance 2.0Ω. With K_1 closed and K_2 open the balance length is 90.0 cm. With K_2 closed and K_1 open balance length is 45.0cm.

Find;

(i) the e.m.f of the thermocouple (03 marks)

(ii) the value of **R**. (03 marks)

(d) What advantages does a potentiometer have over an ordinary voltmeter? (03 marks)

END