

Students Name:
School Name..... Index Number

P510/2
PHYSICS
PAPER 2
2 $\frac{1}{2}$ HOURS
JUNE/JULY 2025



HES MOCK EXAMINATIONS 2025

UGANDA ADVANCED CERTIFICATE OF EDUCATION
PHYSICS

PAPER 2
2 $\frac{1}{2}$ HOURS

INSTRUCTIONS

- Answer **five** questions, including at least **one** from each section, but **not more** than **one** from any of the sections A and B.
- Where necessary assume the following constants:

Acceleration due to gravity,	g	=	9.81ms^{-2}
Speed of light in vacuum,	c	=	$3.0 \times 10^8\text{ms}^{-1}$
Speed of sound in air	v	=	340ms^{-1}
Electronic Charge,	e	=	$1.6 \times 10^{-19}\text{C}$
Electronic mass,	m_e	=	$9.1 \times 10^{-31}\text{kg}$
Permeability of free space,	μ_0	=	$4.0\pi \times 10^{-7}\text{Hm}^{-1}$
Permittivity of free space,	ϵ_0	=	$8.85 \times 10^{-12} \text{Fm}^{-1}$
The Constant,	$\frac{1}{4\pi\epsilon_0}$	=	$9.0 \times 10^9\text{F}^{-1}\text{m}$

SECTION A

1.
 - a) Define the term principal focus of a biconcave lens.
 - b) A converging lens of focal length f_1 and a diverging lens of focal length f_2 are placed in contact with each other. Derive an expression for the power of the lens combination.
 - c)
 - i) Define absolute refractive index of an optical material.
 - ii) When monochromatic Light is incident on a prism of refractive index 1.52 at an angle of incidence 36° , the imaginary makes an angle 54.3° with the normal on the opposite face. Find the angle of incidence for minimum deviation.
 - d)
 - i) Define the terms Eye ring and angular magnification as applied to the optical instruments.
 - ii) A telescope has an objective lens of focal length f_1 and an eye piece of focal length f_2 . If it is in a normal adjustment, show that:
Angular magnification $= \frac{\text{Diameter of objective}}{\text{Diameter of eye piece}}$.
 - e) A simple astronomical telescope has an objective of focal length 250 cm and an eyepiece of focal length 8 cm. The eyepiece is adjusted so that a real image of the sun is formed on a screen placed for 24 cm from the eyepiece. If the sun's image on the screen has a circumference of 32 cm, calculate the angle subtended by the sun at the objective.
2.
 - a) When light is incident at an interface of a pair of optical media of different optical densities it bends. State the laws that govern that phenomenon.
 - b)
 - i) Draw a diagram to show how a thin converging lens forms a virtual image of a real finite object.
 - ii) Use the ray diagram in (i) above to derive the mirror formula.
 - c) A diverging lens of focal length 30 cm is placed 10 cm from a point object. A converging lens of focal length, 20 cm is placed 12.5 cm from the diverging lens on the side remote of the object.
 - i) Find the position, nature and magnification of the final image.
 - ii) Sketch a ray diagram to show the formation of the final image.
 - d) Describe an experiment to determine the focal length of a converging lens using Newton's relation $xy = f^2$.
 - e) List two conditions under which a convex lens may not form an image.

SECTION B

3. a) What is meant by the following as applied to light waves.
- i) Diffraction (1mark)
 - ii) Polarization (1mark)
- b) A diffraction grating of space, d is illuminated normally with light of Wavelength λ .
- i) Derive the condition of occurrence of diffraction maxima. (3 marks)
 - ii) Describe briefly the intensity distribution on a screen placed beyond the grating. (2marks)
 - iii) What is the effect on the diffraction pattern when a grating with a large number of lines is used? (2marks)
- c) Light of wavelength 5.8×10^{-7} is incident on a diffraction grating of 500 lines per mm. Find the;
- i) Diffraction angle for the 2nd order image (3marks)
 - ii) Maximum number of images formed (2marks)
- d) i) Describe how polarized light can be produced by reflection. (4marks)
- ii) List any 2 uses of polarized light.
4. a) Distinguish between free oscillations and forced oscillations. (2marks)
- b) Define the terms as applied to musical organs. (2marks)
- i) Harmonics
 - ii) Overtones
- c) Two tuning forks with the same frequency 512 Hz are sounded near the open end of two tubes A and B of the same diameter but of different lengths. Tube A is closed at only one end while tube B is open at both ends. If both tubes are made to sound at their first resonance. Determine
- i) The ratio of length of tube A to the length of tube B (3marks)
 - ii) The value of end correction of tube A if its length is 16.0 cm. (3marks)
- d) i) Explain the occurrence of beats. (2marks)
- ii) Describe an experiment to determine the speed of sound in the dust-tube method. (4marks)
- e) A stretched wire of length 0.75m radius 1.36mm and density 1.380kgm^{-3} is clamped at its both ends and plucked in the middle. The fundamental note produced by the wire resonates with the first overtone of a closed pipe of length 0.15m. Calculate the tension in the wire. (4marks)

SECTION C

5. a) Define the term magnetic field. (1mark)
- b) A strip of metal 1.2cm wide and 1.5×10^{-3} cm thick carries a current of 0.5A along its length, and the metal contains 5×10^{22} free electrons per cm^3 . If the stripe is placed normal to the magnetic field of flux density 0.5T, a p.d is developed across the foil.
- i) Explain why a p.d is developed across the stripe. (3marks)
- ii) Calculate the mean drift velocity of the electrons. (2marks)
- iii) Find the value of maximum p.d across the stripe. (2marks)
- c) Describe an experiment to show the variation of magnetic flux density at the centre of a circular coil with current through it. (5marks)
- d) A rectangular coil of 50 turns and dimensions 5cm x 2cm hangs vertically inside a solenoid which carries a current of 4A and has 2000 turns per meter. (2marks)
- i) Calculate the magnetic flux density of the solenoid.
- ii) If the plane of the rectangular coil was initially at 60° to the axis of the solenoid, find the value of current that must be passed through the rectangular coil such that the initial torque on the coil is 3.0×10^{-8} Nm. (3marks)
- e) Explain the orientation of a freely suspended bar magnet at a position in southern hemisphere. (2marks)
6. a) Define root mean square (r.m.s) value and peak value of an alternating current. (2marks)
- ii) A sinusoidal alternating current $I = 4\sin(120\pi)$ amperes flows through a resistor of resistance 3Ω , find the mean power dissipated in the resistor. (3marks)
- b) With the aid of a diagram describe how a repulsion type ammeter works. (5marks)
- c i) An alternating voltage is applied across a capacitor of capacitance C. Show that the current leads the voltage by phase angle $\pi / 2$. (3marks)
- ii) Find the expression for the capacitive reactance in terms of frequency, f, and capacitance, C.
- d) A transformer designed to step down voltage to 12V, is 80% 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. (5marks)

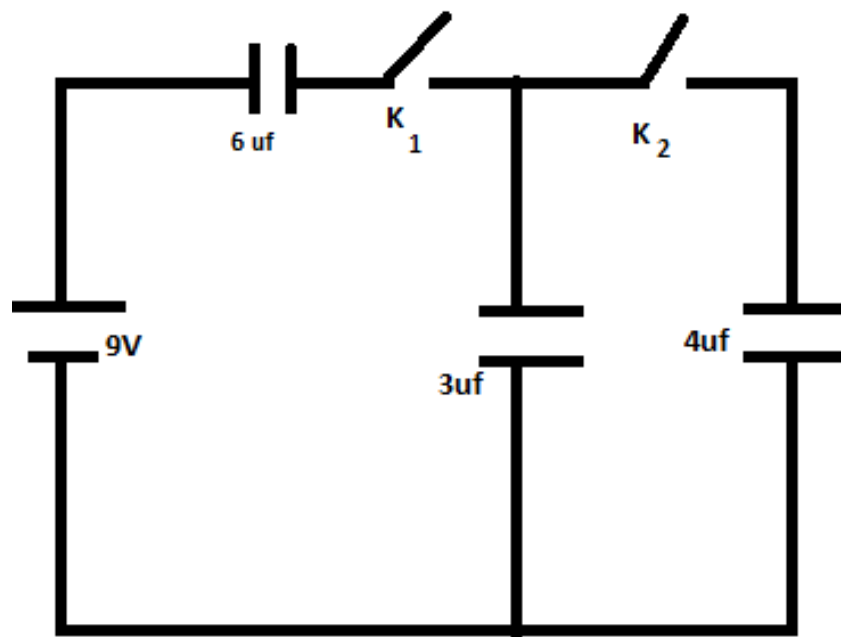
7. a) State the laws of electromagnetic induction. (2marks)
- b) A circular coil of 150 turns and cross-sectional area 0.3m^2 is placed with its plane perpendicular to a horizontal magnetic field of flux density $1.2 \times 10^{-2}\text{ T}$. The coil is rotated about a vertical axis so that it turns through 70° in 2s.
Calculate the:
- i) initial flux linkage through the coil (2marks)
- ii) E.M.F induced in the coil q (3marks)
- c) i) Explain how back e.m.f is produced in a coil in an electric motor. (2marks)
- iii) A metal aircraft with a wingspan of 40m flies with ground speed of 100kmh^{-1} in the direction due east at a constant altitude a region where the horizontal component of the earth's field is 1.6×10^{-5} and the angle of dip is 71.6° . Find the potential difference that exists between the wing tips. (5marks)
- d) With the aid of a diagram, describe how a simple a.c generator works. (5marks)

SECTION D

8. a i) What is a super conductor? (1mark)
- ii) Suggest what could be the importance of superconductors in domestic electrical installations. (2marks)
- b i) Derive the expression for the effective resistance R of the resistance R_1 , R_2 , and R_3 arranged in parallels. (4marks)
- ii) Why is it easier to start a car engine on a hot day than a cold day? (2marks)
- c) An aluminium cable is made from 50 strands round a central wire of steel of resistance is 0.8Ω .
- i) Explain the use of steel in the cable axis. (1mark)
- ii) Calculate the rate of heat dissipation in the cable when a current of 50A flows through it. (4marks)
- d) A source of e.m.f E and internal resistance r drives current one I through a resistor of resistance R connected across it.

- i) Derive the expression for the efficiency of the circuit above. (4marks)
 ii) Sketch a graph showing the variation of the current I that flows with increasing values of R . (2marks)

9. a) Distinguish between the dielectric constant and the dielectric field strength. (2marks)
 b) Describe an experiment to determine the dielectric constant of a plastic material. (6marks)
 c) Two charged capacitor plates A and B are such that A is connected to the cap of earthed gold leaf electroscope, while B is earthed. Why are both B and the gold leaf electroscope earthed? (1mark)
 d)

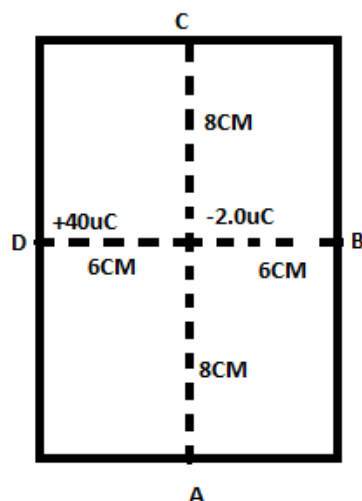


In the circuit above, initially K_1 is closed and K_2 open.

- i) What are the charges on each capacitor? (3marks)
 ii) Switch K_1 is now opened and K_2 closed. Find the energy stored on the $4\mu\text{F}$ cap. (3marks)
 C i) Explain how the effect of a dielectric material on capacitance of a capacitor is determined. (4marks)
 ii) Give one property of a good dielectric. (1mark)

- 10.a) Distinguish between electric potential and electric potential difference. (2marks)
 b) Derive the relationship between the electric potential V at a point a distance, X from charge, Q placed in a vacuum and the electric field strength. (4marks)

c) Two point charges of magnitude $+4.0\mu\text{C}$ and $-2.0\mu\text{C}$ are placed at points D and B as shown in the figure below.



Find the

- i) electric field intensity at point C (4marks)
- ii) work done to move a charge of $-3.0\mu\text{C}$ from A to O. (5marks)
- d) Describe how you would distinguish a conductor and an insulator using an electroscope. (3marks)
- e) Show that lines of force from a charged conductor are at right angles to the conductor. (2marks)

END