P510/1
PHYSICS
Paper 1
July/August 2025
2½ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*Answer **five** questions, including **at least one,** but not more than **two** from each of the Sections **A, B** and **C**.*

*Any additional question(s) answered will **not** be marked.*

Non programmable silent scientific calculators may be used.

Assume where necessary:

Acceleration due to gravity	g	=	$9.81\ ms^{-2}$
Electron charge	e	=	$1.6 \times 10^{-19}\ C$
Electron mass		=	$9.11 \times 10^{-31}\ kg$
Mass of earth		=	$5.97 \times 10^{24}\ kg$
Planck's constant,	h	=	$6.6 \times 10^{-34}\ Js$
Stefan – Boltzmann's constant,	σ	=	$5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
Radius of the earth		=	$6.4 \times 10^{6}\ m$
Radius of the sun		=	$7.0 \times 10^{8}\ m$
Radius of earth's orbit about the sun		=	$1.5 \times 10^{11}\ m$
Speed of light in a vacuum		=	$3.0 \times 10^{8}\ ms^{-1}$
Specific heat capacity of water		=	$4,200 Jkg^{-1}K^{-1}$
Specific latent heat of fusion of ice		=	$3.34 \times 10^{5}\ Jkg^{-1}$
Universal gravitational constant,	G	=	$6.67 \times 10^{-11}\ Nm^{2}kg^{-2}$
Avogadro's number	N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Density of mercury		=	$13.6 \times 10^{3}\ kgm^{-3}$
The constant $\frac{1}{4\pi\varepsilon_0}$		=	$9.0 \times 10^{9}\ F^{-1}m$
Density of water		=	$1000\ kgm^{-3}$
Gas constant	R	=	$8.31 Jmol^{-1}K^{-1}$
Wien's displacement constant		=	$2.90 \times 10^{-3}\ m\ K$
Surface tension of soap solution		=	$2.0 \times 10^{-2}\ Nm^{-1}$
Electron charge to mass ratio, e/m		=	$1.8 \times 10^{11}\ C\ kg^{-1}$
Specific latent heat of vaporation of water		=	$2.23 \times 10^{6}\ J\ kg^{-1}$

Turn Over

SECTION A

1. (a) What is meant by the following terms?
   (i) **Free fall** (01 mark)
   (ii) **Terminal velocity** (01 mark)

   (b) The weight of a body is measured using a spring balance which is suspended to the roof of a lift.
   Explain the reading obtained when the lift is accelerating.
   (i) Downwards (02 marks)
   (ii) Upwards (02 marks)

   (c) (i) Derive an expression relating the distance, initial velocity, time and acceleration for a particle moving with uniform acceleration. (02 marks)
   (ii) Show that the expression in (b) (i) is dimensionally consistent. (02 marks)

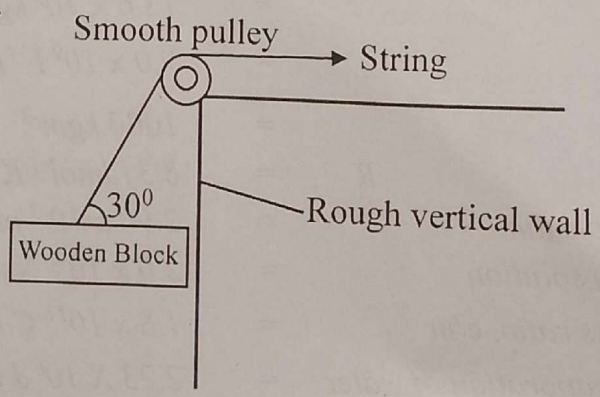
   (d) A car of mass 1.5 tonnes and tractive pull of 3.5 KN climbs a track which is inclined at an angle of 30^0 to the horizontal. The velocity of the car at the bottom of the incline is 20 ms^{-1} and the coefficient of sliding friction is 0.25. Calculate the;
   (i) distance travelled along the incline before the car comes to a halt. (03 marks)
   (ii) time taken travelling along the incline before the car comes to a halt. (02 marks)
   (iii) Potential energy gained by the car at the time it comes to rest. (02 marks)

   (e) Explain the use of a seat belt in a car. (03 marks)

2. (a) Define the following terms.
   (i) **Moment of a force.** (01 mark)
   (ii) **Torque.** (01 mark)

   (b) State the conditions for a rigid body to be in equilibrium. (02 marks)

   (c) (i) What is meant by **limiting equilibrium.** (01 mark)
   (ii) State the **laws of solid friction** and explain them using molecular theory. (06 marks)
   (iii)



The figure above shows a wooden block of mass 1.5 kg being held at rest against a rough vertical wall by a string passing over a smooth pulley.
If the force in the string of 15 N is just enough to prevent the block from sliding down, calculate the coefficient of limiting friction on the wall. (04 marks)

(d) (i) State the law of **conservation of energy.** (01 mark)

(ii) A particle is projected at an angle to the horizontal. Assuming no air resistance, show that the mechanical energy of the particle is conserved throughout its motion. (04 marks)

3. (a) (i) What is meant by **co-efficient of viscosity of a fluid?** (01 mark)

(ii) Explain the effect of temperature on viscosity of air. (03 marks)

(b) (i) Write down Poiseuille's formula of fluid flow. (02 marks)

(ii) Describe with the aid of labeled diagram how you can determine the co-efficient of viscosity of a liquid. (05 marks)

(c) A liquid of negligible viscosity flows steadily through a pipe whose cross sectional area at one point is 15 cm^2 at a velocity of 0.5 ms^{-1}.
Find the pressure difference between this point and another point whose cross sectional area is 3.0 cm^2. (Density of liquid 800 kgm^{-3}) (03 marks)

(d) (i) Derive the expression for pressure difference across a soap bubble. (03marks)

(ii) Two soap bubbles of radii 1.5 cm and 3.0 cm respectively coalesce to form a single bubble under isothermal conditions.
Calculate the excess pressure of the resulting soap bubble. (03marks)

4. (a) (i) Define **simple Harmonic motion.** (01 mark)

(ii) State the characteristics of simple harmonic motion. (02 marks)

(b) A liquid of density ρ and length L is placed in a U-tube of uniform cross sectional area A.

(i) If the liquid is displaced, show that it performs simple harmonic motion. (04 marks)

(ii) Show that the period of oscillation of the liquid in the tube is given by; $T = 2\pi\sqrt{\frac{l}{2g}}$. (04 marks)

(c) (i) Define the term **angular velocity.** (01 mark)

(ii) A car of widith, C and whose centre of gravity is at a height, h, above the ground goes round a bend of radius, r.

Show that it will overturn if its speed exceeds $\sqrt{\frac{cgr}{2h}}$ (05 marks)

(iii) A bucket of water is swung at constant tangential speed in a vertical circle of radius 0.5 m in such a way that the bucket is upside down when it is at the top of the circle. Find the minimum speed that the bucket may have if the water is to remain in it. (03 marks)

SECTION B

5. (a) Define the following terms as used in the thermometry.
   (i) **Kelvin** (01 mark)
   (ii) **Absolute zero** (01 mark)

   (b) (i) Describe the steps taken when setting up a thermodynamic scale of temperature based on a thermo couple. (03 marks)
   (ii) The e.m.f of a thermo couple at the tripple point of water is 3.25 mV, calculate the e.m.f that corresponds to a temperature of 100^0C. (02 marks)

   (c) (i) Define **specific latent heat of vapourisation.** (01 mark)
   (ii) With the aid of a well labeled diagram, describe how the specific latent heat of vaporization can be determined by the method of mixtures. (06 marks)

   (d) (i) Explain why the specific latent heat of vaporization is greater than the specific latent heat of fusion for the same substance. (02 marks)

   (ii) A well lagged copper calorimeter of mass 0.10 kg contains 0.20 kg of water and 0.05 kg of ice at 0^0C. Steam at 100^0C, containing condensed water at the same temperature is passed into the mixture until the temperature of the calorimeter and its contents is 30.0^0C. If the increase in the mass of calorimeter and its contents is 0.025 kg, calculate the percentage of condensed water in wet steam. (04 marks)

6. (a) (i) State the **first law of thermodynamics.** (01 mark)
   (ii) Use the above law to distinguish between an **isothermal change** and an **adiabatic change.** (03 marks)

   (b) State and explain the conditions for adiabatic process. (04 marks)

   (c) A vessel contains 2.5×10^{-3} m^3 of an ideal gas at a pressure of 8.5×10^4 pa and a temperature of 45^0C. The gas is compressed isothermally to a volume of 1.25×10^{-3} m^3. It is then allowed to expand adiabatically to the original volume.
   Calculate the;
   (i) final temperature and pressure of the gas. (04 marks)
   (ii) total work done during the two processes. (04 marks)

   (d) (i) State **Dalton's law of partial pressures.** (01 mark)
   (ii) Deduce Avogadro's hypothesis from the kinetic theory of gases. (03 marks)

7. (a) (i) What is meant by **black body radiation?** (01 mark)

(ii) Sketch a graph of intensity against wave length for two different temperatures of a black body and explain the features of the graph. (03 marks)

(b) (i) State the **laws of black body radiation.** (03 marks)

(ii) The total power output of the sun is 4.0×10^{26} W. Given that the mass of the sun is 1.97×10^{30} kg and its density is 1.4×10^{3} kgm^{-3}, estimate the temperature of the sun. (04 marks)

(c) Explain why metals are better conductors of heat than insulators. (03marks)

(d) (i) Define **co-efficient of thermal conductivity** of a conductor. (01 mark)

(ii) Describe an experiment to determine thermal conductivity of Aluminum. (05 marks)

SECTION C

8. (a) (i) State **Bohr's postulates of the hydrogen atom.** (02 marks)

(ii) Use Bohr's postulates to derive an expression for the radius of the n^{th} orbit of a hydrogen atom. (04 marks)

(b) (i) What is meant by a **line spectrum?** (01 mark)

(ii) Explain how a line spectrum is produced in a gas. (04 marks)

(c) (i) Define the terms unified atomic mass unit and binding energy per nucleon. (02 marks)

(ii) Calculate the binding energy per nucleon for $^{202}_{80}Hg$ given the following information

Mass of $^{202}_{80}Hg$ = 201. 971U

Mass of a neutron = 1.009U

Mass of hydrogen = 1.008U

Mass of electron = $5.45^{4} \times 10^{-4}$U

1U = 931 MeV (03 marks)

(d) In a head on collision between an alpha particle and a gold nucleus, the minimum distance of approach is 5×10^{-4} m. Calculate the energy of the alpha particle in (MeV).
(Atomic number of gold = 79) (04 marks)

9. (a) Define the terms;

(i) **Decay constant** (01 mark)

(ii) **Half-life.** (01 mark)

(b) (i) Derive the relationship between half-life and decay constant. (03 marks)

(ii) The half – life of Polonium-30 is 2.5 minutes. Calculate the mass of polonium – 30 which has an activity of 1.0×10^{15} disintegrations per second. (04 marks)

(c) Describe how Geiger Muller tube (G.M.T) can be used to distinguish between radiations. (05 marks)

(d) Explain the following observations as applied to a Geiger – Muller tube
(i) The anode is made thin. (01 mark)
(ii) The cathode is made cylindrical. (01 mark)

(e) (i) What are **radio isotopes?** (01 mark)
(ii) State two industrial uses of radio isotopes. (01mark)
(iii) Mention any two safety measures taken when handling radioactive substances. (02 marks)

(a) (i) What are **X – rays?** (01 mark)

(ii) Draw a sketch graph showing a typical X – ray energy spectrum. (02 marks)

(iii) Explain the occurrence of minimum wave length of X – rays emitted in an X – ray tube. (02 marks)

(b) An X – ray tube is operated at 10 kV. Calculate:
(i) the minimum possible wavelength of the X – rays produced. (03 marks)

(ii) the energy gained by an X – ray photon when the operating voltage is raised to 100 kV. (03 marks)

(c) With aid of a diagram describe how Millikan's experiment can be used to determine the radius of an oil drop. (05 marks)

(d) A particle of charge 2.6×10^{-19} C is accelerated from rest through a potential difference of 20 kV connected to the electro gun system. It enters a region of uniform magnetic field of flux density 0.5 T. The particle describes a circular path of radius 0.0804 m. Find the mass of the particle. (04 marks)

END