P510/1
PHYSICS
Paper 1
August 2016
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 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		=	$9.11 \times 10^{-31}\ kg$
Planck's constant,	h	=	$6.6 \times 10^{-34}\ Js$
Speed of light in vacuum,	c	=	$3.0 \times 10^{8}\ ms^{-1}$
Stefan's – Boltzmann's constant,	σ	=	$5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
Avogadro's number	N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Gas constant,	R	=	$8.31\ J\ mol^{-1}K^{-1}$
Charge to mass ratio,	e/m	=	$1.8 \times 10^{11} Ckg^{-1}$
The constant $1/4\pi\varepsilon_0$		=	$9.0 \times 10^{9}\ F^{-1}m$

SECTION A

1. (a) State **Newton's laws** of motion. (3 marks)

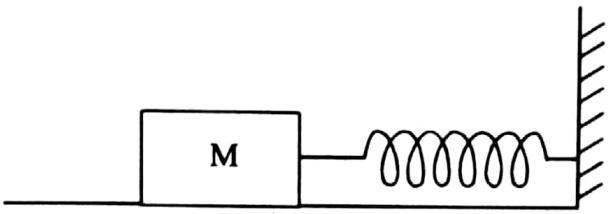
(b) (i) State the principle of conservation of **linear momentum.** (1 mark)

(ii) A body explodes and produces **two** fragments of masses m_1 and m_2. If the velocities of the fragments are μ_1 and μ_2 respectively, show that the mass of the second fragment is given by $m_2 = \alpha m_1$ Where α is the ratio of the kinetic energies of the fragments. (4 marks)

(c) (i) What is meant by a **non - conservative force?** (1 mark)

(ii) Give **two** examples of non - conservative forces. (1 mark)

(d)



The figure above shows a wooden block M of mass 990g resting on a rough horizontal surface and attached to a spring of force constant $50Nm^{-1}$. When a sharp nail of mass 10g is shot at close range into the block, the spring is compressed by a distance of 2.0cm. If the work done against friction is $9 \times 10^{-2}J$, find the speed of the nail just after collision with the block. (6 marks)

(e) Use molecular theory to explain the origin of solid friction. (4 marks)

2. (a) (i) Distinguish between **laminar** and turbulent flow. (2 marks)

(ii) Briefly explain the origin of viscosity in liquids. (2 marks)

(iii) Explain the temperature dependence of viscosity of a liquid. (3 marks)

(b) (i) State **Bernoulli's principle.** (1 mark)

(ii) Explain why a person standing near the road is easily sucked towards the road when a fast- moving truck passes by. (3 marks)

(c) (i) State **Archimedes' principle.** (1 mark)

(ii) Describe an experiment to determine the relative density of an irregular solid which floats on water. (4 marks)

(iii) A block of wood floats at an interface between oil and water, with one quarter of its volume submerged in water. If the density of the wood is $0.8gcm^{-3}$, find the density of the oil in Kgm^{-3}. (4 marks)

3. (a) What is meant by the following?

(i) Moment of a force (1 mark)

(ii) A uniform body (1 mark)

(b) State the conditions for a body to be in equilibrium. (2 marks)

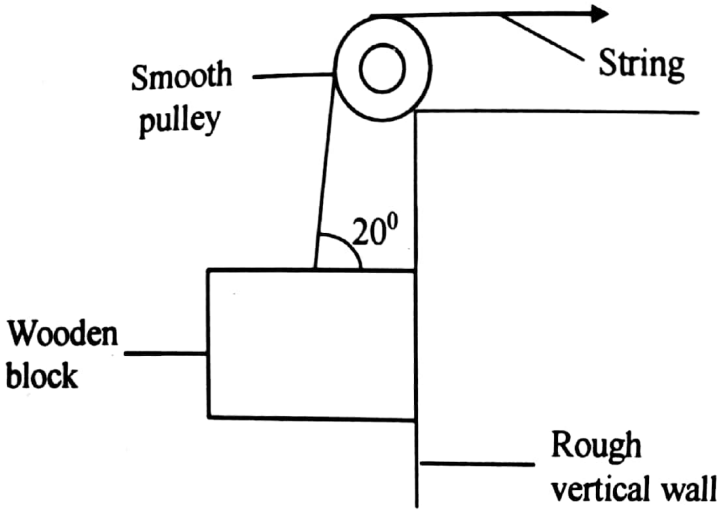
(c) A pole rests at an angle of 50^0 to the horizontal against a smooth vertical wall on rough ground. If the pole is 6m long and weighs 8kg,

(i) Draw a sketch diagram to show the forces acting on the pole, if its centre of gravity is one – quarter from the bottom of the pole. (2marks)

(ii) Calculate the reaction of the ground on the pole. (4marks)

(d) (i) What is meant by **limiting friction?** (1 mark)

(ii) Using molecular theory, explain the laws of solid friction. (6 marks)



The figure above shows a wooden block of mass 1.2kg being held at rest against a rough vertical wall by a string passing over a smooth pulley. If the force in the string of 15N is just enough to prevent the block from sliding down,
Calculate the coefficient of limiting friction of the rough wall. (3 marks)

4. (a) Define **Young's modulus** and derive its dimensions. (3 marks)

(b) (i) Draw a stress – strain curve for a metal wire. (2 marks)

(ii) Explain briefly the main features of the curve. (3 marks)

(c) (i) Outline the measurements to be made in an experiment to determine Young's modulus of steel. (2 marks)

(ii) State and explain any precautions to be taken in the above experiment. (3 marks)

(d) The free ends of a steel wire of diameter 0.25mm are fixed at two rigid supports such that it has its original length. If the wire is cooled from 24^0C to O°C find the:

(i) Strain in the wire. (2 marks)

(ii) tension in the wire. (3 marks)

(Young's modulus of steel = 2.0×10^{11}Pa, coefficient of linear expansion of steel = $1.1 \times 10^{-5}K^{-1}$).

(e) (i) What is a **perfectly plastic** material? (1 mark)

(ii) Give **one** example of a perfectly plastic material. (1 mark)

SECTION B

(a) Define the following terms:

(i) **Specific heat capacity** (1 mark)

(ii) **Specific latent heat.** (1 mark)

(b) (i) Account for the fact that specific latent heat of fusion of a substance is less than the specific latent heat of vaporisation of the same substance at the same pressure. (4 marks)

(ii) Explain briefly why the temperature of a solid remains constant when it is melting. (2 marks)

(c) An experiment was performed to determine the specific latent heat of vaporisation of a liquid at its boiling point. The following table summarises the results:

Voltage across heater (V)	Current through heat (A)	Mass of liquid evaporated in 400s (g)
10.0	2.00	14.6
11.2	2.50	30.6

Calculate the heat lost to the surroundings in 400s (5 marks)

(d) (i) State **Newton's law** of cooling. (1 mark)

(ii) Describe an experiment to verify Newton's law of cooling. (6 marks)

(a) (i) State the assumptions made in the derivation of the Kinetic theory expression for the pressure of an ideal gas. (2 marks)

(ii) The equation of state for one mole of a real gas is given by the expression;

$$\left(p + {}^{a}/_{v^2}\right)(v-b) = RT$$

Account for the terms ${}^{a}/_{v^2}$ and b. (3 marks)

(b) A total mass of 5.0kg of a certain gas is confined in a vessel of volume $10m^3$ and pressure of 2 atmospheres.
Calculate the total kinetic energy of the molecules of the gas. (4 marks)

(c) Explain the following observations using **Kinetic theory;**

(i) The pressure of a fixed mass of gas falls when its temperature is decreased at constant volume. (2 marks)

(ii) A gas fills any container in which it is placed and exerts a pressure on its walls. (3 marks)

(d) (i) Distinguish between **saturated** and **unsaturated** vapours. (2 marks)

(ii) A horizontal tube of uniform bore, closed at one end, has some air trapped by a water index. If the length of the trapped air is 20cm at 15^0C, find the new length of the trapped air if the temperature is raised to 40^0C.
(Take atmospheric pressure to be 760mmHg, saturated vapour pressure of water at 15^0C and 40^0C is 11.0mmHg and 50.0mmHg respectively). (4 marks)

7. (a) (i) What is meant by a **black body?** (1 mark)

(ii) State why black body radiation is also referred to as temperature radiation. (1 mark)

(iii) With the aid of sketch graphs, explain the salient features of the spectral distribution of black body radiation. (4 marks)

(b) (i) Explain briefly why the centre of a fire appears white. (2 marks)

(ii) With the aid of a labelled diagram, describe how the temperature of the inside of a furnace can be measured using the filament – disappearing pyrometer. (5 marks)

(c) 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}Kg^{-3}, estimate the temperature of the sun. (4 marks)

(d) Briefly account for the fact that metals are better conductors of heat than insulators. (3 marks)

SECTION C

8. (a) Define the terms;

(i) **decay constant.** (1 mark)

(ii) **half-life.** (1 mark)

(b) (i) Derive the relationship between **half life** and **decay constant.** (3 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} disintergrations per second. (4 marks)

(c) (i) What is meant by **binding energy per nucleon?** (1 mark)

(ii) Sketch a graph of binding energy per nucleon against mass number, and use it to explain liberation of energy by nuclear fusion and nuclear fission. (6 marks)

(d) (i) What are **radioisotopes?** (1 mark)

(ii) State **two** industrial uses of radioisotopes. (1 mark)

(iii) Mention any **two** safety measures taken when handling radioactive substances. (2 marks)

9. (a) What is meant by the following terms?

(i) **work function.** (1 mark)

(ii) **threshold frequency.** (1 mark)

(b) (i) Explain, using **quantum theory,** the experimental observations on photoelectric effect. (6 marks)

(ii) When light of wavelength 500nm falls on a certain metal, electrons of maximum Kinetic energy of 0.80 eV are emitted.
Find the threshold frequency for the metal. (4 marks)

(c) (i) What are **x – rays?** (1 mark)

(ii) Explain the physical processes in an x-ray tube that account for the cut-off wavelength. (3 marks)

(d) (i) State **Bragg's law** of x – ray diffraction. (1 mark)

(ii) A beam of x-rays of wavelength 9.0×10^{-11}m is incident on a sodium chloride crystal of interplanar separation of 2.50×10^{-10} m. Calculate the first order diffraction angle. (3 marks)

10. (a) (i) What are energy levels? (1 mark)

(ii) Briefly describe **Bohr's model** of an atom. (3 marks)

(b) (i) Explain the observations made in **Rutherford's** α - particles scattering experiment. (3 marks)

(ii) State why this experiment is carried out in a vacuum. (1 mark)

(c) Distinguish between **excitation** and **ionisation** energies of an atom. (2 marks)

(d) In a simple model of the hydrogen atom, an electron of mass m and charge - **e** moves in a circular orbit about the nucleus. Given that the angular momentum of the electron is $\frac{nh}{2\pi}$, show that the total energy of the electron is given by

$E=\frac{me^4}{8\varepsilon_0^2 h^2 n^2}$ where h is Planck's constant, n is an integer and ε_0 is permittivity of free space. (6 marks)

(e) The diagram below shows some energy levels of the mercury atom in eV.

OeV _____ n = ∞

-2.71eV _____ n = 6

-3.74eV _____ n = 5

-4.98eV _____ n = 4

-5.55eV _____ n = 3

-5.77eV _____ n = 2

-10.44eV _____ n = 1

Calculate the speed of the electrons which can ionise the atom. (4 marks)

END