THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/2

PHYSICS 2
(For Both School and Private Candidates)

Time: 2 Hours 30 Minutes **2006 February, 20 Monday a.m.**

INSTRUCTIONS

1. This paper consists of **ten (10)** questions in sections A, B and C.
2. Answer **four (4)** questions from section A and **three (3)** questions from each of sections B and C.
3. All questions carry equal marks.
4. Mathematical tables and non programmable calculators may be used.
5. Cellular phones are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. The following information may be useful.

(a)	Universal gravitation Constant	G	=	6.67×10^{-11} Nm^2 kg^{-2}
(b)	Mass of earth	M_E	=	6×10^{24} kg.
(c)	Density of hydrogen at STP		=	0.09 kgm^{-3}
(d)	Planck's constant	h	=	6.63×10^{-34} Js
(e)	Velocity of em waves	c	=	3×10^{8} ms^{-1}
(f)	Mass of an electron	m_e	=	9.1×10^{-31} kg
(g)	Moment of inertia of a sphere about a diameter	I	=	$0.4\ MR^2$
(h)	Mass of deuterium nucleus		=	3.345×10^{-27} kg
(i)	Mass of helium – 3 nucleus		=	5.008×10^{-27} kg
(j)	Mass of Neutron		=	1.675×10^{-27} kg.

ACS

This paper consists of 7 printed pages

SECTION A (40 marks)

Answer four (4) questions from this section.

1. (a) (i) State Newton's law of gravitation and show that the speed v of a particle in an orbit of radius r around a planet of mass M is given by $v = \left(\frac{GM}{r}\right)^{\frac{1}{2}}$.

(ii) Define gravitational field strength and gravitational potential at a point on the earth's gravitational field. How are they related?

(iii) Given a graph of the variation of gravitational potential with distance away from the earth, how could the graph of gravitational field strength with distance be derived?

(b) (i) At one point on a line between the earth and the moon the gravitational field caused by the two bodies is zero. Explain briefly why this is so.

(ii) The mass of moon is $\frac{1}{81}$ the mass of earth and its radius is $\frac{1}{4}$th that of the earth. If the acceleration due to gravity at the surface of the earth is 9.8 ms^{-2}, what is its value at the surface of the moon?

(c) The Apollo 11 space craft on its journey from the earth to the moon had a velocity of 5374 m/s when 26,306 km from the center of the earth. What would have been its velocity at 50,000 km from the earth's center if the space craft did not fire its motors during the journey?

2. (a) (i) What is meant by the moment of inertia of a body?

(ii) State the perpendicular axes theorem for moment of inertia of a rigid body.

Deduce an expression for the moment of inertia of a disc about an axis at its rim perpendicular to the axis through its centre if the moment of inertia of this disc about a diameter is $I = \frac{1}{4}Md^2$.

(b) (i) Define radius of gyration.

(ii) Calculate the radius of gyration about a tangent of a sphere of radius 0.5 m parallel to the axis through its center.

(iii) A ballet dancer spins with 30 $revs^{-1}$ with arms outstretched, when the moment of inertia about the axis of rotation is I. With her arms folded the moment of inertia is 75 % of I. What is the new angular velocity? State any assumptions made.

(c) A solid cylinder of mass M and radius r whose moment of inertia $I = Mk^2$ (k being its radius of gyration) rolls down an inclined plane of angle α to the horizontal, having a length ℓ and height, h. Find its final velocity v when at the bottom in terms of

(i) h, k, r and g.

(ii) α, ℓ, k, g and r.

What assumptions have you made?

3. (a) (i) What is an ideal gas?

(ii) Derive the perfect gas equation for a unit mass of a gas assuming Boyle's and Charles' laws.

(b) (i) How was Boyle's law modified in deriving the gas equation for real gases?

(ii) What is the absolute temperature of a gas moving at a speed (rms) of 500 ms^{-1} if the average mass of the molecule is 8×10^{-26} kg.

(c) A flask of 10^{-3} m^3 contains hydrogen gas at a pressure of 10^{-3} mmHg and a temperature of 27 °C. Calculate the:

(i) root mean square speed of the molecules.

(ii) number of molecules present in the flask.

(iii) number of impacts per sec per unit area on the wall of the flask.

4. (a) State the first law of thermodynamics, defining all the terms involved.

(b) An ideal gas is kept in thermal contact with a very large body of constant temperature T and undergoes an isothermal expansion in which its volume changes from V_1 to V_2. Derive an equation for the work done by the gas.

(c) A heat engine carries 1 mole of an ideal gas around a cycle as shown in figure 1. Process 1 – 2 is at constant volume, process 2 – 3 is adiabatic and process 3 – 1 is at a constant pressure of 1 atm. The value of γ for this gas is 5/3. Find the:

(i) pressure and volume at points 1, 2 and 3.

(ii) net work done by the gas in the cycle.

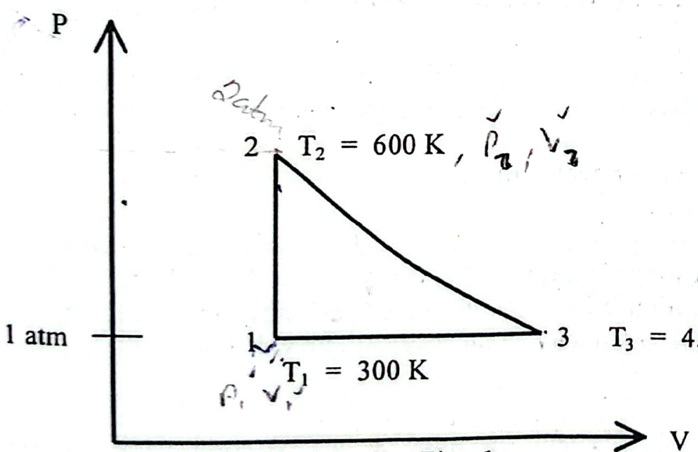


Fig. 1

(d) The door of a working refrigerator is left open. What effect will this have on the temperature of the room in which the refrigerator is kept? Explain.

SECTION B (30 marks)

Answer **three (3)** questions from this section.

5. (a) (i) In a Young's double slit experiment, interference occurs when diffraction of light takes place at each of the two slits. Explain with the aid a diagram the meaning of interference and diffraction in this case.

(ii) In the double slit experiment using light of wavelength 6.0×10^{-7} m, the slits were 0.40 mm apart and the distance of the slits to the screen was 1.20 m. Find the separation of the fringes and the angles subtended by a central pair of the bright fringes at the slits.

(b) Determine the slit separation if the distance between the centre of the interference pattern and the tenth bright fringe on either side is 3.44 cm and the distance between the slits and the screen is 2.0 m. The wavelength of the incident light is 5.89×10^{-7} m.

(c) Two waves of equal frequency and amplitude travel in opposite directions in a medium. What is the resultant wave?

(d) State **two (2)** differences between a stationary and a progressive wave.

6. (a) (i) Explain briefly the phenomena observed when an electric discharge passes through a gas at very low pressure. Illustrate your answer using a labelled diagram.

(ii) Draw a sketch graph showing clearly the **breakdown potential**. Hence define breakdown potential.

(b) (i) What is lightning?

Explain two ways in which lightning may be harmful.

(ii) The main discharge in lightning produces a current of 10^5A for a short duration of 10^{-4} s. If the potential difference between cloud and ground is 10^8 V, calculate the amount of energy produced by the discharge.

(iii) If some of the energy in 6.(b)(ii) above is converted into heat when lightning strikes a tree having a resistance of $10^4\ \Omega$, how much heat will be produced in 10^{-4} s?

(c) (i) State Faraday's laws of electrolysis.

(ii) Calculate the mass of copper deposited in 30 minutes in a copper voltameter when a constant current of 2 A flows (take M/Q = 3.3×10^{-8} kg C^{-1}). How much silver will be deposited on the other cathode if the same current flows for the same time through a copper sulphate voltameter and a silver nitrate voltameter, if 0.1 g of copper is deposited at one cathode?

[Atomic masses of Cu and Ag are 63.5 and 108 respectively, valence of Cu in Cu_2SO_4 is 2 and of silver ions in the nitrate solution is 1].

7. (a) Explain what is meant by:

(i) self inductance.

(ii) mutual inductance.

(b) (i) Define the terms impedance, inductive and capacitive reactance.

(ii) Using a phasor diagram show that the impendance of a R-L-C series circuit is given by

$$Z = \sqrt{R^2 + (X_L - X_C)^2}.$$

(iii) Calculate the maximum potential difference across a R – L – C series circuit having a resistance of 10 Ω when a current of 4.5 A is flowing through.

(c) (i) A series circuit has a resistance of 75 Ω and an impedance of 150 Ω. What power is consumed in the circuit when a potential difference of 120 V is applied across it?

(ii) How much energy is stored in the magnetic field of the coil in 7.(c)(i) above in 10 seconds if the inductance of the coil is 2 H?

SECTION C (30 marks)

Answer **three (3)** questions from this section.

8. (a) Show how an operational amplifier may be arranged to be used as:

(i) an inverting amplifier.

(ii) a non-inverting amplifier.

How is the amplification calculated in each case?

(b) An ideal operational amplifier is used in the circuit as shown in figure 2 below with a constant input of 0.50 V and power supplies of +6.0V and –6.0V.

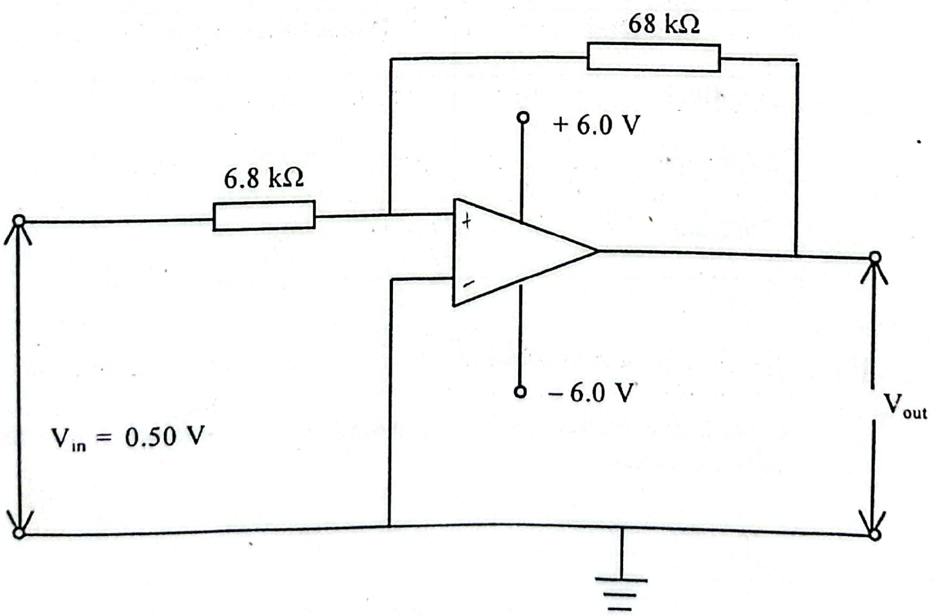


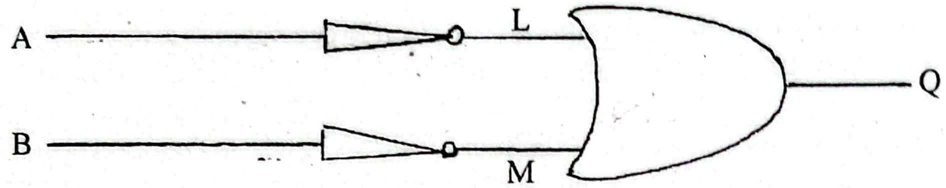
Fig. 2

(i) Calculate the gain of the amplifier circuit.

(ii) What is the output voltage V_{out}?

(iii) If the constant input is then changed from 0.5 V to a sinusoidal alternating voltage of 0.5 V_{rms}, calculate the peak value of the input voltage and the maximum and minimum values of the output voltage if the power supply remains as indicated.

(c) Produce a truth table for the gate combination shown below. Hence show that it behaves as a NAND gate.



9. (a) (i) The work function of potassium is 3.52×10^{-19} J. What does the statement mean?

(ii) Yellow light has a wavelength of 6×10^{-7} m. How many photons are emitted per second by a yellow lamp rated 15 W?

(b) (i) When radiation of a suitable frequency falls on a potassium surface, photoelectrons are emitted. Calculate the minimum frequency for this to occur.

(ii) Calculate the maximum speed of the photoelectrons emitted when radiation of wavelength 4.0×10^{-7} m is incident on a potassium surface.

(c) (i) Which one of the metals listed in the table below would be suitable for use in a photocell to detect red light of wavelength 6.6×10^{-7}m? Justify your answer.

Metal	Work function/eV
Beryllium	3.9
Potassium	2.2
Caesium	1.8

(ii) What is a photoemissive cell?

Explain how photoemissive cell works. Give **two (2)** examples for which photoemissive cells are useful.

10. (a) (i) What is the difference between natural and artificial radioactivity?

(ii) Name **three (3)** applications of artificial radioactivity.

(b) (i) State **two) (2)** conditions for stability of nuclides referring to light nuclides and heavy nuclides.

(ii) Sketch a graph showing how binding energy per nucleon varies with mass number.

Relate the graph to nuclear fission and nuclear fusion.

(c) (i) Calculate the energy available when two nuclei of deuterium fuse together as shown

$$^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}He + ^{1}_{0}n$$

(ii) Given that 2 kg of deuterium contains 6×10^{26} deuterium nuclei, calculate the energy released per kilogram by the fusion reaction.

In a fission reactor 1.9×10^{16} J of energy are released when 6×10^{26} uranium nuclei (mass 240 kg) disintegrate. Compare the energy released per kilogram by the two processes and comment on your answer