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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 ½ Hours **16 May 2001 a.m.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer **FIVE (5)** questions choosing at least ONE (1) question from each of the sections A, B and C.
3. Write your examination number on every page of your answer booklet.
4. Marks for each question or part thereof are given beside each question.
5. Mathematical tables and calculators may be used.
6. The following information may be useful.

(a) Density of oxygen at Stp	ρ	$= 1.43\ kgm^{-3}$
(b) Molar mass of oxygen	M_m	$= 32 \times 10^{-3}\ kgmol^{-1}$
(c) Mass of mercury	M_{Hg}	$= 200 \times 10^{-3}\ kg$
(d) Mass of krypton	M_{Kr}	$= 84 \times 10^{-3}\ kg$
(e) Ratio of specific heat capacities	Cp/Cv	$= 1.4$
(f) 1 atomosphere		$= 1.01 \times 10^{5}\ Pa$
(g) Universal gas constant	R	$= 8.31\ Jmol^{-1}K^{-1}$
(h) Planck's constant	h	$= 6.63 \times 10^{-34}\ Js$
(i) Permeability of free space	μ_o	$= 4\pi \times 10^{-7}\ Hm^{-1}$
(j) 1 a.m.u		$= 931\ MeV$
(k) Charge of electron	e	$= 1.6 \times 10^{-19}\ C$
(l) Mass of electron	M_e	$= 9.1 \times 10^{-31}\ kg.$
(m) Pie	π	$= 3.14$

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SECTION A

Answer at least **ONE (1)** question from this section.

1. (a) What do you understand by

(i) gravitational intensity (2 marks)
(ii) gravitational potential (2 marks)
How are gravitational intesity and gravitational potential related? (2 marks)

(b) Taking the earth to be a uniform sphere of radius 6,400 km, and the value of g at the surface to be $9.8\ ms^{-2}$, calculate the total energy needed to raise a satellite of mass 2,000 kg into orbit at an altitude of 8,000 km. (6 marks)

(c) (i) Explain the term "parking orbit" of a satellite. (3 marks)
(ii) Explain briefly how the satellite is sent into orbit when the intended altitude has been reached. What would happen if this procedure of putting a satellite in an orbit failed to come into effect? (5 marks)

2. (a) Write down the formula for the viscous drag force on a sphere falling in a fluid as stated by Stokes. Explain the symbols used. (2 marks)

(b) (i) When a sphere in a liquid starts to move from rest, what are the magnitudes and directions of the forces acting on it? (5 marks)
(ii) Why does the sphere in (i) above has an initial acceleration? (2 marks)
(iii) How do the forces change as the velocity of the sphere increases? (3 marks)

(c) A horizontal tube consists of two parts joined together end to end. One part is 100 mm long and has a radius of 1.00 mm. The other part is 140 mm long with a radius of 0.5 mm. When water, equivalent to that due to 120 mm of water, flows between the tube ends, what are the pressure differences across each of the component tubes? (Give your answer in terms of mm of water). (8 marks)

3. (a) (i) What is the difference between an isothermal and an adiabatic process? (2 marks)

(ii) Show that an adiabatic change follows an adiabatic equation

$$pV^{\gamma} = \text{a constant.}$$ (4 marks)

(b) (i) Distinguish between the specific heat capacity and the molar heat capacity. Give the units of each. (3 marks)
(ii) Calculate the two principal molar heat capacities of oxygen and explain why the specific heat capacity of the gas at constant pressure is greater than that at constant volume. (6 marks)

(c) (i) What is a reversible change? State the condition for a reversible change to occur. (2 marks)
(ii) A litre of air at 10^5 Pa pressure expands adiabatically and reversibly to twice its volume. Calculate the work done by the gas. (3 marks)

4. (a) (i) What do you understand by an ideal gas? (2 marks)

(ii) Derive the expression $P = \frac{1}{3}\rho\overline{c^2}$ for an ideal gas where

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P = pressure of the gas
ρ = density of the gas
$\overline{c^2}$ = mean square speed.

(4 marks)

(iii) What is the reasoning which leads to the assertion that the temperature of an ideal monatomic gas is proportional to the mean kinetic energy of its molecules?

(4 marks)

(b) The Doppler broadening of a spectral line is proportional to the root mean speed (r.m.s.) of the atoms emitting light. Which source has less Doppler broadening; a mercury lamp at 300 K or krypton lamp at 77 K? (Mathematical treatment of your answer is required)

(10 marks)

SECTION B

Answer at least **ONE** (1) question from this section.

5. (a) (i) What is a Brewster angle? (1 mark)

(ii) Name one effect which could not be explained by Huygen's wave theory. (1 mark)

(b) (i) Why is it necessary to use satellites for long distance TV transmission? (1 mark)

(ii) Why does a thin film of oil on the surface of water appear coloured? (4 marks)

(c) In a Young's slit experiment, the distance of the screen from the two slits is 1.0 m. When light of wavelength 6000 °A is allowed to fall on the slits, the width of the fringes obtained on a screen is 2.0 mm.
Determine
(i) the distance between the slits (4 marks)
(ii) the width of the fringes if the wavelength of the incident light is 4800 °A. (2 marks)

(d) The wavelength of a particular line in the emission of distant star is measured as 600.80 nm. The true wavelength is 600.00 nm.
(i) Is the star moving away from or towards the observer? (3 marks)
(ii) Calculate the speed of the star. (4 marks)

6. (a) (i) What is meant by 'specific charge' of an ion?
Give the SI units of specific charge. (2 marks)

(ii) An accumulator battery of emf 50 V and internal resistance 2 Ω is charged on a 100 V d.c. source.
What series resistance will be required to give a charging current of 2 A? (3 marks)

(2 marks)

(b) (i) State the laws of electrolysis.
(ii) If an electric current passes through a copper voltameter and a water voltameter in series, calculate the volume of hydrogen gas that will be liberated in the water voltameter at 25° C and 780 mmHg pressure whilst 5×10^{-5} kg of copper is deposited in the copper voltameter.

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Take
mass of hydrogen deposited per Coulomb = 1.04×10^{-8} kgC^{-1}

mass of copper deposited per Coulomb = 3.3×10^{-7} kgC^{-1}

density of hydrogen at stp = 9×10^{-2} kgm^{-3}
(4 marks)

(c) (i) Briefly explain line spectra and how they are produced. (3 marks)

(ii) Draw an I-V characteristic for electric conduction in gases. Does it obey Ohm's law? Why? (2 marks)

(iii) Mention and explain the applications of line gaseous spectra. (4 marks)

7. (a) State the law of force acting on a conductor of length ℓ carrying an electric current in a magnetic field. (2 marks)

(b) What is the magnetic field induction at the centre of a solenoid? (1 mark)

(c) It is desired to design a solenoid that will produce a magnetic field of 0.1 T at the centre. The radius of the solenoid is 5.0 cm, its length is 50 cm and carries a current of 10 A. Calculate

(i) the number of turns per unit length that this solenoid could have. (2 marks)

(ii) the total length of the wire required. (2 marks)

(d) (i) State the Biot and Savart law. (1 mark)

(ii) In a hydrogen atom, an electron keeps moving around its nucleus with a constant speed of 2.18×10^{6} ms^{-1}. Assuming the orbit to be circular of radius 5.3×10^{-11} m, determine the magnetic flux density B it produces at the site of a proton on the nucleus. (4 marks)

(iii) A circular loop of 200 turns and radius 0.15 m carries a current of 12 A. Find the magnetic flux density B at its centre and the flux density at a point on the axis of the coil 0.4 m away from the centre. (5 marks)

(e) A capacitor of capacitance 10^{-6} F is used in a radio circuit. If the frequency of the circuit is 10^{3} Hz and the current flowing in it is 2 mA r.m.s., calculate the voltage across the capacitor. (3 marks)

SECTION C

Answer at least **ONE (1)** question from this section.

8. (a) The circuit below is designed to switch on a light emitting diode (LED) when darkness falls. The circuit uses light dependent resistor (LDR) which has a resistance greater than 1 MΩ in the dark but less than 1 kΩ when illuminated.

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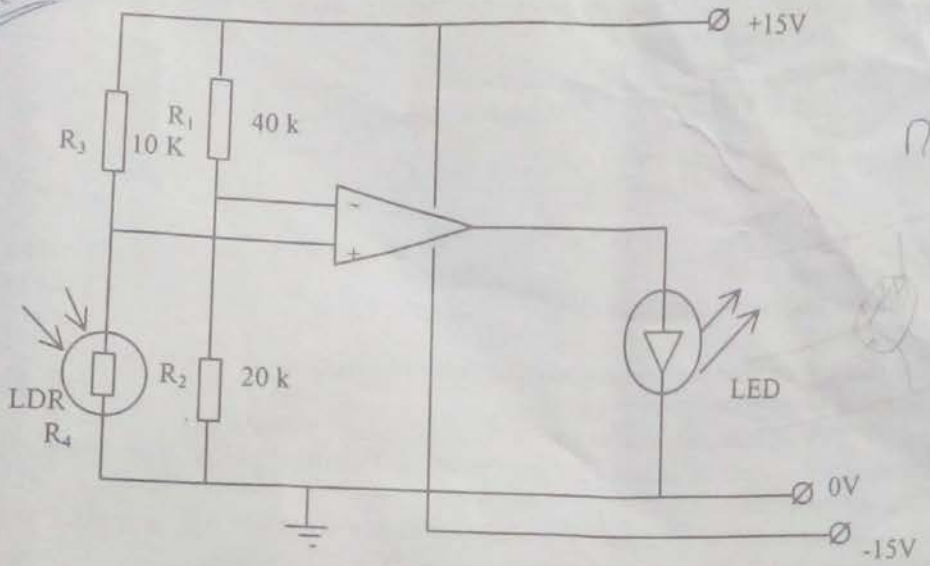


(i) Calculate the potential at the inverting input. (3 marks)

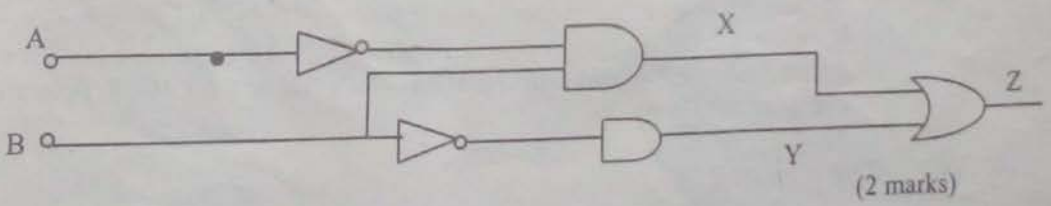
(ii) Calculate the approximate potential of the non-inverting input when the LDR is in the dark and when in the light. (3 marks)

(iii) Why does the LED light when darkness falls? (2 marks)

(b) (i) Define a transistor and explain how it is made. (2 marks)

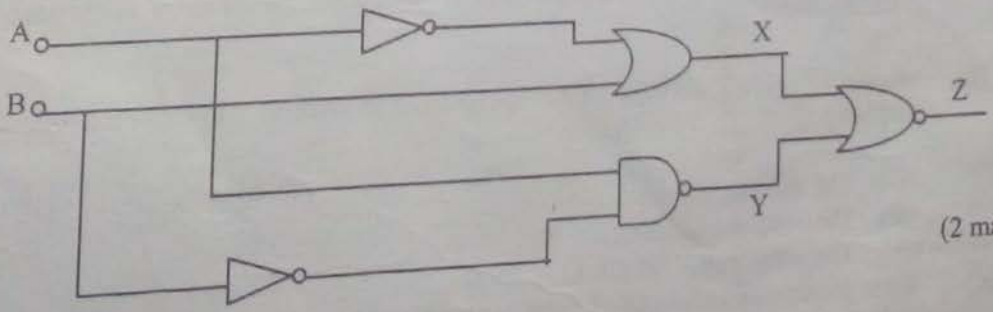
(ii) Mention three uses of a transistor and the three different modes in which a transistor can be connected in the circuit by using the emitter (E), base (B) and collector (C). (3 marks)

(c) (i) Develop truth tables showing the output X,Y and Z for the following figures.



(2 marks)

(ii)



(2 marks)

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(ii) Design a circuit using the minimum number of logic gates which gives the truth table shown below.

INPUT	A	0	0	1	1
	B	0	1	0	1
OUTPUT	C	1	0	1	1

(3 marks)

9. (a) (i) What are cathode rays? (1 marks)
(ii) Mention six properties of cathode rays. (3 marks)

(b) (i) Define thermionic emission and explain why nowadays oxide coated metal is preferred to tungsten as emitting material. (2 marks)
(ii) A p.d of 2 kV is maintained between a heated thermionic cathode and a collector electrode in a vacuum, the latter being more positive. Calculate the speed of the electrons striking the collector.
What is the initial rate of temperature rise of the collector when the p.d. is applied, if the electron current is 0.105 mA and the thermal capacity is $2.1\ JK^{-1}$? [$e/_m = -1.76 \times 10^{11}\ Ckg^{-1}$] (4 marks)
(iii) A beam of electrons enters into a field of potential 10^5 volts. Determine the velocity of the electrons accelerated through the potential. (1 mark)

(c) (i) Protons are made to rotate in a circular orbit of radius r at the moment they enter into a uniform magnetic field of flux density 0.8 T. If the charge-mass ratio of a proton is $1.0 \times 10^8\ Ckg^{-1}$, show that the number of revolutions per second of these protons do not depend on the radius (r) of the orbit and hence determine the frequency (f) of the proton in this field. (4 marks)
(ii) In an experiment to determine the specific charge of an electron using Thomson's method, the stream of electrons from the cathode is accelerated through a p.d. of 1.5 kV and passes undeflected through both electric and magnetic fields which are perpendicular to one another to hit a fluorescent screen at the end of the tube.
If the electric field is provided by 2 parallel plates 2 cm apart joined to p.d. of 400 V and the magnetic field provided by the Helmholtz's coil is 8.6×10^{-4} T, determine the specific charge of the electrons. (5 marks)

10. (a) What is meant by
(i) quantization of energy
(ii) wave-particle duality? (2 marks)

(b) Define de-Broglie wavelength and find its value when the speed v is $10^5\ ms^{-1}$. (3 marks)

(c) Figure 10 below shows the X-ray spectrum of an element. How can the following be explained?
(i) The line spectrum A, (2 marks)
(ii) The continuous spectrum B (2 marks)
(iii) The wavelength cut off C. (2 marks)

(d) What information was gained from Moseley's experiments on the wavelengths of the x-ray line spectra of elements? (2 marks)

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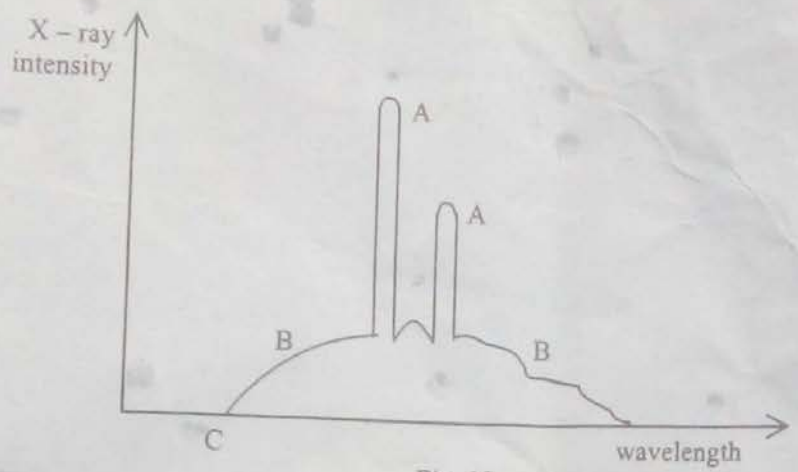

Fig. 10

(e) (i) What is the difference between fusion and fission ? (2 marks)

(ii) Write down a nuclear reaction for the fission of $^{235}_{92}U$ into lanthanum and bromine. Calculate the total energy released by the fission of 1 kg of $^{235}_{92}U$

(5 marks)

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