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

131/1

PHYSICS 1
(For Both School and Private Candidates)

Time: 2 Hours 30 Minutes

2006 February, 06 Monday, p.m.

INSTRUCTIONS

1. This paper consists of **fourteen (14)** 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. Mathematical tables and non-programmable calculators may be used.
4. Cellular phones are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).
6. The following may be useful:

(a)	Acceleration due to gravity	$g = 9.8\ ms^{-2}$
(b)	Specific heat capacity of water	$C_W = 4200\ Jkg^{-1}K^{-1}$
(c)	Universal gas constant,	$R = 8.3\ J\ mol^{-1}\ °C^{-1}$
(d)	Permitivity of free space	$\varepsilon_o = 8.85 \times 10^{-12}\ F_M^{-1}$
(e)	Electronic charge	$e \doteq 1.6 \times 10^{-19}\ C$
(f)	Speed of light in vacuum	$C = 3.0 \times 10^{8}\ ms^{-1}$
(g)	Plank's constant	$h = 6.63 \times 10^{-34}\ Js.$

SECTION A (40 marks)

Answer **four (4)** questions from this section.

1. (a) The viscosity η of a liquid, flowing through a capillary tube of length L and radius r is given by the equation $\frac{v}{t} = \frac{\pi(P_1 - P_2)}{8 \eta L} r^4$ where P_1 and P_2 are pressures existing at the ends of the tube. t = time taken by liquid of volume v to pass through the tube.

(i) Find an expression for the fractional error in η.

(1 mark)

(ii) Calculate the percentage error in η using the following experimental results:
Length, L = 26.00 ± 0.10 cm, radius r = (0.65 ± 0.01) × 10^{-3} m
Pressure, P_1= (8.10 ± 0.05) × 10^3 Nm^{-2}
Pressure, P_2 = (5.40 ± 0.05) × 10^3 Nm^{-2}
Volume, V = 3.23 ± 0.02 cm^3
Time, t = 60.00 ± 0.20 sec.

(2 marks)

(iii) Write the experimental value of η (including the order of accuracy).

(3 marks)

(b) (i) Distinguish between fundamental physical quantities and derived physical quantities giving one example for each.

(2 marks)

(ii) An equation showing a body that is accelerating vertically upwards is given by $S = at^2 - bt^3$ where S and t are measured in metres and seconds respectively. Determine the dimensions and units of a and b.

(2 marks)

2. (a) (i) Discuss the meaning of the statement "during rocket propulsion both the rocket and the hot gases emitted gain kinetic energy and momentum".

(2 marks)

(ii) The mass per second of a gas emitted from the rear of a toy rocket is initially 0.1 kgs^{-1}. If the speed of the gas relative to the rocket is 50 ms^{-1} and the mass of the rocket is 2 kg, what is the initial acceleration of the rocket?

(3 marks)

(b) Two blocks connected to a string over a small frictionless pulley rest on frictionless planes as shown in figure 1 below.

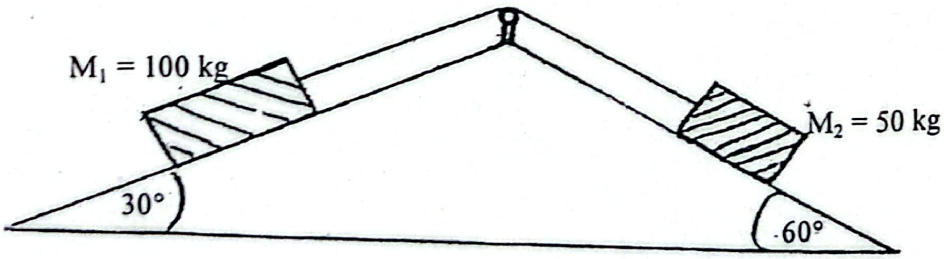


Fig. 1

Calculate the:

(i) acceleration of the block system.

(3 marks)

(ii) tension of the string.

(2 marks)

3. (a) (i) Explain what is meant by angular velocity and centripetal acceleration.

(2 marks)

(ii) Why does a motorbike rider bend while going around a corner?

(3 marks)

(b) (i) What is the maximum speed at which a car can safely go round a circular curve of radius 48 metres on a horizontal road if the coefficient of static friction between tyres and the road is 0.8?

(3 marks)

(ii) Will the car overturn or skid if it just exceeds the speed stated in 3. (b) (i) above? Assume the width between the wheels is 1.5 metres and the centre of gravity of the car is 0.6 metres above the road.

(2 marks)

4. (a) (i) What is the criterion for an object to execute simple harmonic motion?

(1 mark)

(ii) A body executing simple harmonic motion is associated with the accelerating force acting on it, its velocity and its acceleration. Which of the three physical quantities are in phase?

(1 mark)

(b) (i) Suppose a tunnel is dug through the earth from one side to the other along a diameter. Show that the motion of a particle dropped into the tunnel is simple harmonic. You may assume the density, γ, of the earth to be uniform.

(4 marks)

(ii) A simple pendulum has a period of 1 second in city A, where the acceleration due to gravity is 9.66 ms^{-1}. It is taken to city B where it is found to lose 20 seconds per day. Calculate the value of acceleration due to gravity in city B.

(4 marks)

5. (a) (i) Describe how mercury in glass thermometer could be made sensitive.

(1 mark)

(ii) A sensitive thermometer can be used to investigate the difference in temperature between the top and bottom of the waterfall. Calculate the temperature difference of the waterfall 50 m high.

(4 marks)

(b) (i) Platinum resistance thermometer and constant volume gas thermometer are based on different thermometric properties but they are calibrated using the same fixed points. To what extent are the thermometers likely to agree when used to measure temperature near the ice point and near the steam point?

(1 mark)

(ii) The resistance of the element of a platinum resistance thermometer is 2.0 Ω at ice point and 2.73 Ω at steam point. What temperature on the platinum resistance scale would correspond to a resistance value of 8.34 Ω and when measured on the gas scale the same temperature will correspond to a value of 1020 °C? Explain the discrepancy.

(4 marks)

6. (a) (i) Why is heat needed to change liquid water into vapour? What amount of energy is needed?

(2 marks)

(ii) The molar heat capacity of hydrogen at constant volume is 20.2 J mol^{-1} $°C^{-1}$. What is the molar heat capacity at constant pressure?

(3 marks)

(b) (i) In an industrial refrigerator, ammonia is vaporised in the cooling unit to produce a low temperature. Why should the evaporation of ammonia reduce the temperature in the refrigerator?

(2 marks)

(ii) How much energy is needed to convert 150 g of water at 20 °C into steam at 100 °C?

(3 marks)

SECTION B (30 marks)

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

7. (a) (i) What is meant by the terms wave motion and wavelength?

(2 marks)

(ii) If the speed of sound in air is 340 ms^{-1}, calculate the wavelength of sound when its frequency is 256 Hz.

(1 mark)

(b) Given that the velocity v of transverse waves along a stretched string is related to tension T and mass per unit length μ,

(i) derive an equation in terms of T and μ. Hence deduce an expression for natural frequencies of a string of length ℓ when fixed at both ends.

(5 marks)

(ii) calculate the tension in the string along which waves move with speed of 8 cm s^{-1} if its mass per unit length is 0.05 kg per metre and constant of proportionality is 2.

(2 marks)

8. (a) State Kirchhoff 's laws of electrical network.

(2 marks)

(b) Study the circuit diagram in figure 2 below and answer the questions that follow:

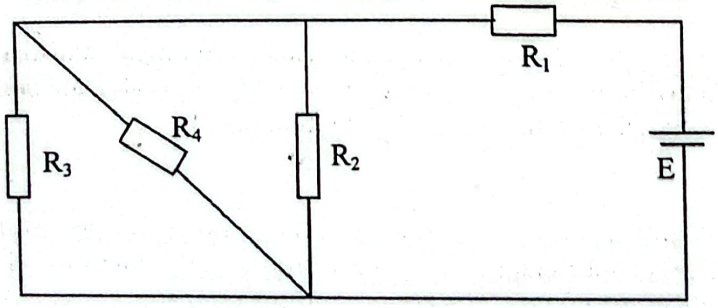


Fig. 2

Where $R_1 = 100\ \Omega$, $R_2 = R_3 = 50\ \Omega$, $R_4 = 75\ \Omega$ and E = 6.0 V.

$\frac{1}{T_1} = 0.048$ $\frac{4}{T} = 0.06$

(i) Determine the equivalent resistance of the network diagram in figure 2.

(2 marks)

(ii) Determine the current that flows through R_4.

(3 marks)

(c) A voltmeter, connected across the terminals of a battery, shows a potential difference of 1.3 V when the current taken from the battery is 0.2 A and 1.0 V when it is 0.4 A. Find the:

(i) e.m.f.

(2 marks)

(ii) internal resistance of the battery.

(1 mark)

9. (a) What is an inductor? Give the expression of the energy stored in an inductor.

(2 marks)

(b) (i) Calculate the inductance of a toroid having 200 turns and length 20 cm, that is uniformly wound over an iron alloy core of 1.0 cm^2 cross-section area and permeability 1.0×10^{-2} Hm^{-1}.

(4 marks)

(ii) What would the self-induced e.m.f. be when the current in the toroid is changing at 1.0 As^{-1}?

(2 marks)

(iii) How much energy is stored by the inductor when it carries a current of 100 mA?

(2 marks)

10. (a) (i) What is meant by transistor biasing?

(1 mark)

(ii) List **three (3)** different ways of transistor biasing.

(3 marks)

(iii) Why is the base region of a transistor made thin?

(2 marks)

(b) (i) Draw a circuit diagram representing a bridge rectifier.

(2 marks)

(ii) List down **two (2)** advantages and **two (2)** disadvantages of using bridge rectifiers.

(2 marks)

$1.3 = 0.2R$ — (i)

$1.0 = 0.4R$ — (i)

SECTION C (30 marks)

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

11. (a) (i) Define capacitance.

(1 mark)

(ii) The capacitor C_1 in figure 3 initially has a charge Q_o and a voltage V_o across its plates while capacitor C_2 is uncharged. After closing the switches S_1 and S_2, the voltage across the plates of each capacitor is found to be V.

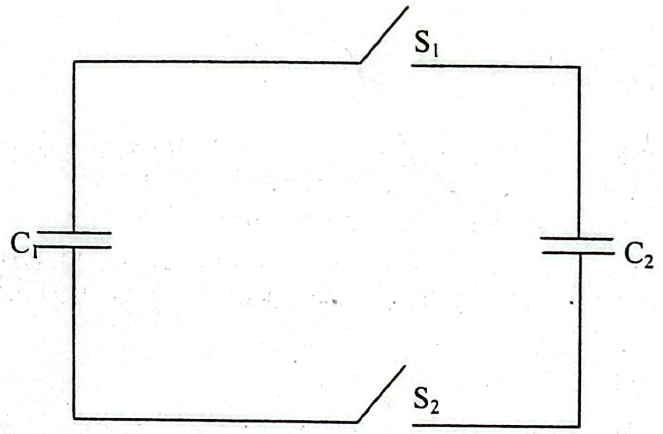


Fig. 3

Evaluate the ratio $\frac{V_o}{V}$.

(4 marks)

(b) A charge of +2 μ C is placed at one corner of an equilateral triangle and a charge of −2 μ C at another corner. The sides of the triangle are 1.5 m long.

(i) What is the size of the electric field and electric potential at the corner of the triangle without a charge?

(4 marks)

(ii) Calculate the potential difference which could be applied between two parallel plates 3.0 mm apart to cause the same electric field as that in 11. (b) (i).

(1 marks)

12. (a) (i) State Faraday's laws of electrolysis .

(2 marks)

(ii) Define back e.m.f. with reference to electrolysis.

(1 mark)

(iii) Briefly explain the conduction of electricity in gases.

(2 marks)

(b) Chromium is deposited on steel by electrolysis, when making car hubcaps. The reaction at the cathode is represented by $Cr^{3+}_{(aq)} + 3e^- \rightarrow Cr_{(s)}$.

(i) Calculate the mass of chromium deposited when a current of 150 A is used for ten hours.

(3 marks)

(ii) Calculate the average thickness of chromium deposited if the hub has a surface area of 2000 cm^2.

Given that:

- Coulombs = ampere × seconds
- Density of chromium $\rho = 6.4\ g\ cm^{-3}$
- 52 g of chromium is deposited by 289500 coulombs.

(2 marks)

13. (a) What is the work function of a metal?

(1 mark)

(b) Radiation of wavelength 360 nm incident on the emitter of a photocell produces photoelectrons which are prevented from reaching the collector when the potential difference of –2 V is applied across the photocell. Calculate the:

(i) maximum KE of the photoelectrons.

(1 mark)

(ii) work function, ω_o of the emitter.

(2 marks)

(c) A proton and an α-particle are accelerated through the same potential difference before entering a region where the magnetic field B is at right angles to their direction of motion. If the radius of the proton's circular path is 15 cm, what is the radius of the α-particles?

(6 marks)

14. (a) (i) State **two (2)** ways by which seismic waves may be produced.

(2 marks)

(ii) What is seismic prospecting?

(2 marks)

(b) (i) Discuss briefly the importance of the lowest layer of the atmosphere and the ionosphere.

(2 marks)

(ii) Sketch the temperature against altitude curve for the atmosphere indicating the important atmospheric layers.

(2 marks)

(iii) The average velocity of P-waves through the earths solid core is 8 km s^{-1}. If the average density of the earth's rock is 5.5×10^3 kg m^{-3}, find the average bulk modulus of the earth's rock.

(2 marks)