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 *Monday 11th February 2008 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 constants may be useful:

(a)	Pie,	$\pi = 3.14$
(b)	Acceleration due to gravity,	$g = 9.81\ m/s^2$
(c)	Thermal conductivity of brass,	$k_b = 109\ Jm^{-1}s^{-1}K^{-1}$
(d)	Latent heat of vapourization of water,	$L = 2.25 \times 10^6\ J/kg$
(e)	Thermal conductivity of glass,	$k_g = 2 \times 10^{-4}\ Jm^{-1}s^{-1}K^{-1}$
(f)	Boltzmann's constant,	$K_b = 1.38 \times 10^{-23}\ JK^{-1}$
(g)	Permitivity of free pace,	$\varepsilon_o = 8.85 \times 10^{-12} Fm^{-1}$
(h)	Mass of an electron,	$Me = 9.1 \times 10^{-31}\ kg$
(i)	Velocity of sound in air,	$= 340\ m/s$
(j)	Electronic change,	$e = 1.6 \times 10^{-19} C$
(k)	Stefan's constant,	$\sigma = 5.7 \times 10^{-8}\ Wm^{-2}K^{-4}$
(l)	Specific heat capacity of water,	$c_w = 4.2 \times 10^3\ Jkg^{-1}K^{-1}$
(m)	Specific heat capacity of copper,	$c_{cu} = 4 \times 10^2\ Jkg^{-1}K^{-1}$

This paper consists of 8 printed pages.

SECTION A (40 marks)

Answer four (4) questions from this section.

1. (a) Differentiate between an error and a mistake. **(02 marks)**

(b) In determining the resistivity 'ρ' of a certain wire, the following measurements were taken.

Resistance R of the wire = $(2.06 \pm 0.01)\ \Omega$.

Diameter d of the wire = (0.57 ± 0.01) mm.

length L of the wire = (105.6 ± 0.1) mm.

Use the formula $\rho = \frac{\pi d^2 R}{4L}$ to find the relative error in resistivity, ρ.

(02½ marks)

(c) (i) Give **three (3)** limitations of dimensional analysis. **(01½ marks)**

(ii) After being deformed, a spherical drop of liquid will excute periodic vibrations about its sphere. The frequency (f) of vibrations of the drop will depend on the surface tension (γ) of the drop, its density (ρ) and on the radius (r) of the drop. Using the method of dimensions, obtain an expression for the frequency of these vibrations in terms of the related physical quantities.

(04 marks)

2. (a) (i) Can a body have energy without momentum? Explain. **(01 marks)**

(ii) Two masses m_1 = 10 kg and m_2 = 250 g are acted upon by a force of 10 N and 5 N, respectively in opposite direction. After a certain instant the two masses collide and coalesce. If the force remains the same both before and after colliding, calculate the relative acceleration before collision and their acceleration after collision.

(04 marks)

(b) Rain falls vertically on a plane roof, 1.5 m square, which is inclined to the horizontal at angle of 30°. The raindrops strike the roof with a velocity of 3 m/s and a volume of 2.5×10^{-2} m^3 of water is collected from the roof in one minute. Assuming that the conditions are steady and that the velocity of the raindrops after impact is zero, calculate the

(i) vertical force exerted on the roof by the impact of the falling rain.

(02½marks)

(ii) pressure exerted, normal to the roof due to the impact of the rain.

(02½ marks)

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3. (a) (i) Distinguish uniform circular motion from non –uniform circular motion. **(01 mark)**

(ii) A racing car (figure 1) goes around a circular curve as fast as it can without skidding. The radius of the curve is 50 m and the road is banked at 20° to allow faster speed. If the coefficient of static friction between the road and the tyres is 0.80, resolve the forces into horizontal and vertical components and apply Newton's laws of motion and the equation for maximum frictional force to determine the maximum speed of the car.

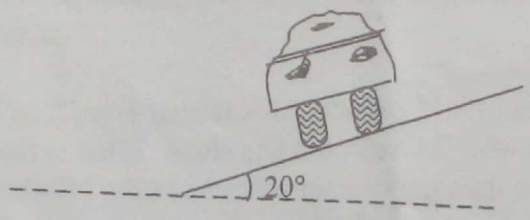


Figure 1.

(04 marks)

(b) Two soap bubbles have radii in the ratio 2:3.

(i) Compare excess pressure inside these bubbles.

(ii) Show that the ratio of the work done in blowing these bubbles is $\frac{4}{9}$.

(05 marks)

4. (a) (i) Give **two (2)** practical examples of oscillatory motion, which approximate to simple harmonic motion. **(01 mark)**

(ii) What factors determine the restoring force on a body performing simple harmonic motion? **(02 marks)**

(iii) A person is swinging on a swing in the sitting position. How will the period change if the person stands up? **(02 marks)**

(b) (i) A body of mass M is performing simple harmonic motion whose amplitude is A. Sketch, on the same axes, a plot of both the kinetic energy and the potential energy of the body against time. **(03 marks)**

(ii) A uniform spring has a certain mass suspended from it and its period for vertical oscillation is T_1. The spring is now cut into two equal halves and the same mass is suspended from one of the halves. The period of vertical oscillation is now T_2. Calculate T_2/T_1. **(02 marks)**

5. (a) (i) What is meant by reference temperature as applied to thermocouples? **(01 mark)**

(ii) The e.m.f. (in microvolts) in a lead iron thermocouple, one junction of which is at 0 °C is given by $V = 1784t - 2.4t^2$, where t is the temperature of the hot junction in °C. Calculate the neutral temperature. **(02½ marks)**

(iii) When a particular temperature is measured on scales based on different properties, it has different numerical values on each scale except at certain points. Explain why and state at what points the values agree. **(2½marks)**

(b) A brass boiler has a base area of 0.15 m^2 and thickness of 1cm. It boils water at the rate of 6 kg/min when placed on a gas stove. What is the temperature of the part of the flame in contact with the boiler? **(04 marks)**

6. (a) (i) Distinguish between forced and natural convection and state the laws governing these processes. **(02 marks)**

(ii) A piece of copper of mass 50 g is heated to 100 °C and then transferred to a well insulated copper calorimeter of mass 25 g containing 100 g of water at 10 °C. Neglecting heat loss, calculate the final steady temperature of water after it has been well stirred. **(04 marks)**

(b) A blackened sphere of radius 2 cm is contained within a hollow evacuated enclosure the wall of which are maintained at 27 °C. Assuming that the sphere radiates like a blackbody, calculate the rate at which the sphere looses heat when its temperature is 227 °C. **(04 marks)**

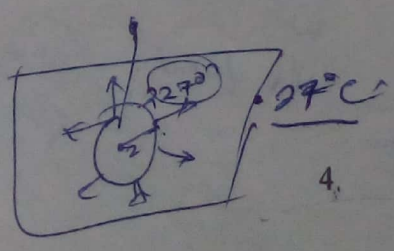
SECTION B (30 marks)

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

7. (a) (i) What is a *stationary wave*? **(01 mark)**

(ii) In one set of axes draw graphs showing critical damped, overdamped and underdamped oscillations. **(02 marks)**

(b) Plane sound waves of frequency 100 Hz fall normally on a smooth wall. At what distances from the wall will the air particles have maximum and minimum amplitude of vibration? Give reasons for your answer. **(04 marks)**



(c) A stationary wave is given by $y = 5\sin\frac{\pi x}{3}\cos 40\pi t$, where x and y are in cm and t is in seconds. What are the equations of the component waves whose superposition gives rise to the above wave? **(03 marks)**

8. (a) (i) What is a potentiometer? **(01 mark)**

(ii) A student sets up a potentiometer and finds that no matter where along the potentiometer wire contact is made, the galvanometer deflection is always in the same direction and it is impossible to obtain a zero current reading. Give reasons for this phenomenon. **(02 marks)**

(b) Define the following terms:

(i) Resistivity. **(01 mark)**

(ii) Temperature coefficient of resistance. **(01 mark)**

(c) Calculate the steady temperature attained by a copper wire carrying a current of 5A, using the following data:
Temperature of the surrounding air = 10 ° C, diameter of wire = 1 mm, emmissivity of surface of wire = 9.22 $Jm^{-2} K^{-1}s^{-1}$; resistivity of copper = 1.8×10^{-8} ohm – metre; temperature coefficient of resistance of copper = 0.0043 K^{-1}.
(05 marks)

9. (a) (i) What is a magnetic field? **(01 mark)**

(ii) State **four (4)** factors upon which the magnetic induction, B, at any point of magnetic field depends. **(02 marks)**

(b) Derive an expression for the flux density B at the centre of circular coil of radius r and N turns placed in air carrying a current I. **(03 marks)**

(c) The diameter of a 20 turn circular coil is 8.0 cm and it has a current of 3.0 A.

(i) Find the magnetic moment of the coil. **(02 marks)**

(ii) If the coil is suspended in a uniform magnetic field of 0.5 Weber/m^2, such that its plane is parallel to the direction of the field, calculate the moment of the couple acting on it. **(02 marks)**

10. (a) (i) Distinguish between zero bias and contact potential as applied to P – N junction diode. **(01 mark)**

(ii) A close examination of current-voltage characteristic of a diode shows that current varies exponentially with applied voltage (V_a) according to the equation $I_D = I_S \exp\left(\frac{eV_a}{KT}\right)$, where I_S is the fiddle factor called saturation current, e is the charge on an electron, I_D is the diode current and K is the Boltzmann constant. Calculate the resistance of the diode at the temperature T = 25 °C (298 K) if the ammeter reading is 10^{-5} Amps. **(02 marks)**

(b) (i) Describe basic logic gates. **(01½ marks)**

(ii) A driver must wear a seat belt(s) when he/she is driving (D) unless he/she is reversing (R). Convert this conditional statement into a logic gate system. **(01 mark)**

(c) Study the common emitter circuit in figure 2 and answer the questions which follows.

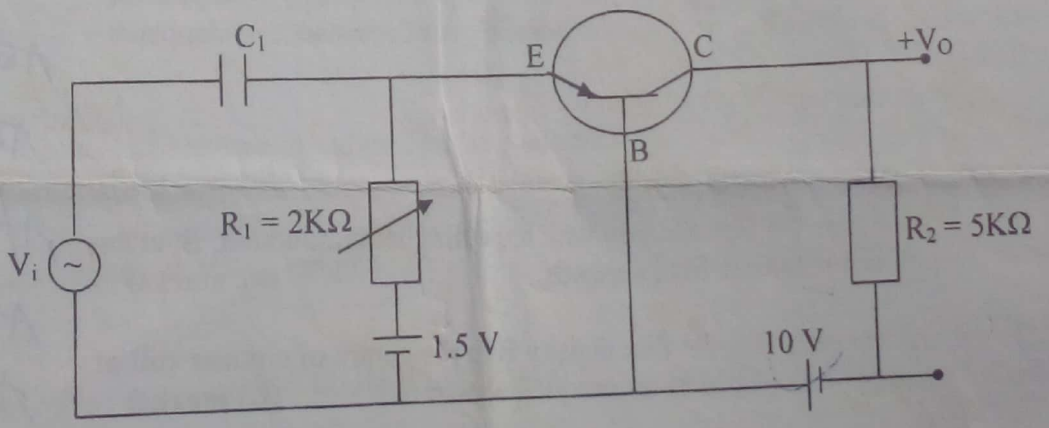


Fig. 2

(i) What is the function of R_1, 1.5 V and 10 V supply? **(01½ marks)**

(ii) Explain the role played by capacitor C_1. **(01 mark)**

(iii) Given that $I_E = 1.0$ mA and $I_B = 0.02$ mA, calculate the voltage amplification of the circuit if $V_i = 10$ mV and input resistance is 50 Ω. **(02 marks)**

SECTION C (30 marks)

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

11. (a) Define the following terms as applied in capacitors.

(i) Time constant. **(01 mark)**

(ii) Dielectric constant. **(01 mark)**

(b) State the relationship between the capacitance of a capacitor and the following:

(i) Distance between plates. **(01 mark)**

(ii) Area between plates. **(01 mark)**

(c) In a vibrating reed experiment, two parallel plates capacitors with area 0.4 m^2 are separated by 3 mm of a dielectric. The battery of 200 V, charges and discharges the capacitor at frequency of 60 Hz and a current of 40 μA is produced.

(i) Calculate the value of dielectric constant ε_r. **(03 marks)**

(ii) What will be the new capacitance if half of the dielectric is withdrawn from the plates? **(03 marks)**

12 (a) (i) What is thermionic emission? **(01 mark)**

(ii) Explain the action of the deflecting system in a cathode ray oscilloscope (C.R.O.). **(01 mark)**

(b) An electron beam passes through a parallel plate capacitor with a velocity of 10^7 m/s. The length of each plate is 10 cm while the distance between the plates is 5 cm. Calculate the deflection angle of the beam if the electric intensity between the plates is 20 V cm^{-1}. **(04 marks)**

(c) An oil drop of diameter 10^{-5} cm carrying two electronic charges remains suspended between charged parallel plates capacitor 10 mm apart. If the density of oil is 1.8 g/cm^3, calculate the potential difference between the two plates. **(04 marks)**

13. (a) What is meant by

(i) an electric field? **(01 mark)**

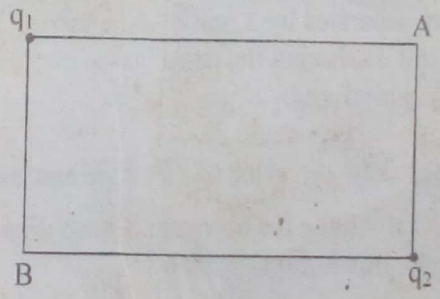
(ii) a magnetic field? **(01 mark)**

(b) (i) Define electric potential. **(01 mark)**

(ii) Eight charged water droplets, each with a radius of 1 mm and a charge of 10^{-10}C coalesce to form a single drop. Calculate the potential of the bigger drop. **(03 marks)**

(c) (i) What is an electric line of force? **(01 mark)**

(ii) In figure 3 below, $q_1 = -5 \times 10^{-5}$ C and $q_2 = +2 \times 10^{-6}$ C. Calculate the work done in moving a third charge $q_3 = 3 \times 10^{-6}$ from B to A along the diagonal of the rectangle.



(03 marks)

Fig. 3

14. (a) Define the following terms:

(i) Earthquake. **(01 mark)**

(ii) Atmosphere. **(01 mark)**

(b) Distinguish between body waves and surface waves that are produced by an earthquake. **(04 marks)**

(c) (i) Define the terms epicentre and focus as applied to earthquake. **(02 marks)**

(ii) Draw a well labelled diagram which shows the interior structure of the earth. **(02 marks)**