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

131/1 **PHYSICS 1**
(For Both School and Private Candidates)

Time: 3 Hours **Tuesday, 03rd May 2016 a.m.**

Instructions

1. This paper consists of sections A, B and C.

2. Answer **ten (10)** questions choosing **four (4)** questions from section A and **three (3)** questions from each of sections B and C.

3. Marks for each question or part thereof are indicated.

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) Acceleration due to gravity $g = 9.8\text{m/s}^2$
   (b) Density of water $\varrho = 1000\text{kg/m}^3$
   (c) Radius of the earth = $6.37\times10^6 m$
   (d) Mass of the earth = $6.0\times10^{24}\text{kg}$
   (e) Universal gravitational constant = $6.67\times10^{-11}\text{Nm}^2\text{kg}^{-2}$
   (f) Stefan Boltzmann constant = $5.67\times10^{-8} Wm^{-2}K^{-4}$
   (g) Heat of vaporization of water = $2256\times10^3 Jkg^{-1}$
   (h) Pi, $\pi = 3.14$

SECTION A (40 Marks)

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

1. (a) (i) Define the term dimension of a physical quantity. **(1 mark)**

(ii) The number of particles n crossing a unit area perpendicular to *x-axis* in a unit time is given as $n = -D\frac{(n_2-n_1)}{(x_2-x_1)}$ where n_1 and n_2 are the number of particles per unit volume for the values of x_1 and x_2 respectively. What are the dimensions of diffusion constant D? **(1 mark)**

(b) (i) Give two basic rules of dimensional analysis. **(1 mark)**

(ii) The frequency, f of a vibrating string depends upon the force applied, F the length, l of the string and the mass per unit length, μ. Using dimension show how f is related to F, l and μ. **(2.5 marks)**

(c) (i) What is meant by least count of a measurement? **(1 mark)**

(ii) The period of oscillation of a simple pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$ where by 100 vibrations were taken to measure 200 seconds. If the least count for the time and length of a pendulum of 1m are 0.1sec and 1mm respectively, calculate the maximum percentage error in the measurement of g. **(2.5 marks)**

2. (a) (i) Mention two characteristics of projectile motion. **(1 mark)**

(ii) If the range of the projectile is 120m and its time of flight is 4sec, determine the angle of projection and its initial velocity of projection assuming that the acceleration due to gravity $g = 10ms^{-2}$. **(3 marks)**

(b) (i) State the principles on which the rocket propulsion is based. **(1 mark)**

(ii) A jet engine on a test bed takes in 40kg of air per second at a velocity of 100ms^{-1} and burns 0.80kg of fuel per second. After compression and heating the exhaust gases are ejected at 600ms^{-1} relative to the aircraft. Calculate the thrust of the engine. **(2 marks)**

(c) An object of mass 2kg is attached to the hook of a spring balance which is suspended vertically to the roof of a lift. What is the reading on the spring balance when the lift is:

(i) going up with the rate of 0.2ms^{-2} **(1 mark)**

(ii) going down with an acceleration of 0.1ms^{-2} **(1 mark)**

(iii) ascending with uniform velocity of 0.15ms^{-1} **(1 mark)**

3. (a) (i) Define the term inertia. **(1 mark)**

(ii) Why is Newton's first law of motion called the law of inertia? **(1 mark)**

(b) A jet of water from a fire hose is capable of reaching a height of 20m. If the cross sectional area of the hose outlet is $4.0\times10^{-4}m^2$, calculate the

(i) Minimum speed of water from the hose. **(1 mark)**

(ii) Mass of water leaving the hose each second. **(2 marks)**

(iii) Force on the hose due to the water jet. **(2 marks)**

(c) A boy ties a string around a stone of mass $0.15kg$ and then whirls it in a horizontal circle at constant speed. If the period of rotation of the stone is 0.4sec and the length between the stone and the boy's hand is $0.50m$;

(i) Calculate the tension in the string. **(2.5 marks)**

(ii) State one assumption taken to reach the answer in 3 (c) (i) **(0.5 mark)**

4. (a) What do you understand by the following terms:

(i) Damped oscillations. **(1 mark)**

(ii) Undamped oscillations. **(1 mark)**

(b) (i) Sketch the waveform diagrams to represent the terms in 4 (a) (i). **(2 marks)**

(ii) Show that the total energy of a body executing S.H.M. is independent of time. **(2 marks)**

(c) A mass of $0.5kg$ connected to a light spring of force constant $20Nm^{-1}$ oscillates on a horizontal frictionless surface. If the amplitude of the motion is $3.0cm$, calculate the;

(i) Maximum speed of the mass. **(2 marks)**

(ii) Kinetic energy of the system when the displacement is $2.0cm$. **(2 marks)**

5. (a) (i) What is meant by moment of inertia of a body? **(1 mark)**

(ii) List two factors on which the moment of inertia of a body depends. **(1 mark)**

(b) A thin sheet of aluminium of mass $0.032kg$ has the length of $0.25m$ and width of $0.1m$. Find its moment of inertia on the plane about an axis parallel to the;

(i) Length and passing through its centre of mass m. **(2 marks)**

(ii) Width and passing through the centre of mass m in its own plane. **(2 marks)**

(c) (i) Define the term angular momentum. **(1 mark)**

(ii) A thin circular ring of mass M and radius r is rotating about its axis with constant angular velocity ω_1. If two objects each of mass m are attached gently at the ring, what will be the angular velocity of the rotating wheel? **(3 marks)**

6. (a) (i) Mention one application of parking orbit. **(1 mark)**

(ii) Briefly explain how parking orbit of a satellite is achieved? **(1.5 marks)**

(b) The earth satellite revolves in a circular orbit at a height of $300km$ above the earth's surface. Find the;

(i) Velocity of the satellite. **(2 marks)**

(ii) Period of the satellite. **(1.5 marks)**

(c) (i) Why are space rockets usually launched from west to east? **(1.5 marks)**

(ii) A spaceship is launched into a circular orbit close to the earth's surface. What additional velocity has to be imparted to the spaceship in order to overcome the gravitational pull? **(2.5 marks)**

SECTION B (30 Marks)

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

7. (a) Briefly explain why:
   (i) A body with large reflectivity is a poor emitter. **(1 mark)**
   (ii) The earth without its atmosphere would be too cold to live. **(1 mark)**

   (b) (i) Identify two factors on which the coefficient of thermal conductivity of a material depends. **(1 mark)**
   (ii) A brass boiler of base area $1.50\times10^{-1}m^2$ and thickness of $1.0cm$ boils water at the rate of $6.0kg$/min when placed on a gas stove. Estimate the temperature of the part of the flame in contact with the boiler. **(2.5 marks)**

   (c) (i) Briefly describe the working principle of a thermocouple. **(2 marks)**
   (ii) In a certain thermocouple thermometer the e.m.f. Is given by $E = a\theta + \frac{1}{2} b\theta^2$ where θ is the temperature of hot junction. If $a = 10mV°C^{-2}$, $b = -\frac{1}{20} mV°C^{-1}$ and the cold junction is at $0°C$, calculate the neutral temperature. **(2.5 marks)**

8. (a) (i) What is meant by thermal radiation? **(1 mark)**
   (ii) Briefly explain why forced convection is necessary for excess temperature less than $20K$? **(1.5 marks)**

   (b) (i) Why is the energy of thermal radiation less than that of visible light? **(1.5 marks)**
   (ii) A body with a surface area of $5.0cm^2$ and a temperature of $727°C$ radiates 300 joules of energy in one minute. Calculate its emissivity. **(2 marks)**

   (c) (i) State Newton's law of cooling. **(1 mark)**
   (ii) A body cools from $70°C$ to $40°C$ in 5 minutes. If the temperature of the surroundings is $10°C$, Calculate the time it takes to cool from $50°C$ to $20°C$. **(3 marks)**

9. (a) (i) Define the term junction as applied in electrical networks. **(1 mark)**
   (ii) What is the physical significance of Kirchhoff's first law? **(1 mark)**

   (b) (i) Why is Kirchhoff's second law sometimes referred to as the voltage law? **(1 mark)**
   (ii) List down five points to be considered when applying Kirchhoff's second law in formulating analytical problems or equations. **(2.5 marks)**

(c) Study the circuit diagram in Figure 1 then answer the questions that follow:

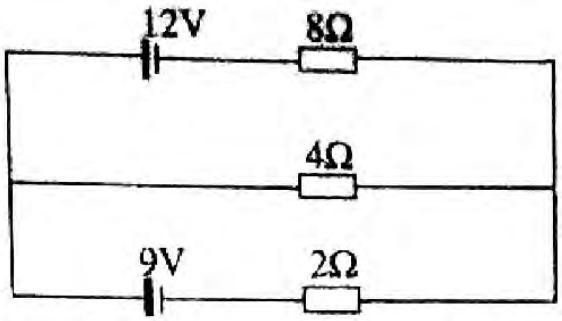


Figure 1

(i) How many loops are there in the circuit? **(0.5 mark)**
(ii) Find the current flowing through 2Ω, 4Ω and 8Ω resistors **(4 marks)**

10. (a) What is meant by the following terms:
(i) Phase of alternating e.m.f. **(1 mark)**
(ii) Root mean square (r.m.s.) value of alternating e.m.f. **(1 mark)**

(b) An a.c. circuit consisting of a pure resistance of 10Ω is connected across an a.c. supply of $230V$,$50Hz$. Calculate the;
(i) Current flowing in the circuit. **(1.5 marks)**
(ii) Power dissipated. **(1.5 marks)**

(c) A 25 μF capacitor, a $0.10H$ inductor and a 25Ω resistor are connected in series with an a.c. source whose e.m.f. Is given by $E = 310\sin 314t$ volt. Determine the;
(i) Frequency of the e.m.f. **(1.5 marks)**
(ii) Net reactance of the circuit. **(3.5 marks)**

SECTION C (30 Marks)

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

11. (a) (i) What is the importance of doping as applied to semiconductors? **(1 mark)**
(ii) Distinguish between *n–type* and *p–type* semiconductors. Give three points. **(3 marks)**

(b) (i) Why are transistors mostly used in common emitter arrangement? **(1 mark)**
(ii) When does a transistor amplifier work as an oscillator? **(1 mark)**

(c) (i) Explain the use of an op-amp as a summing amplifier. **(1.5 marks)**
(ii) Figure 2 is an operational amplifier circuit where $R_1 = 39k\Omega$, $R_2 = 4.7k\Omega$, $R_3 = 10k\Omega$ and $R_4 = 2.7k\Omega$.

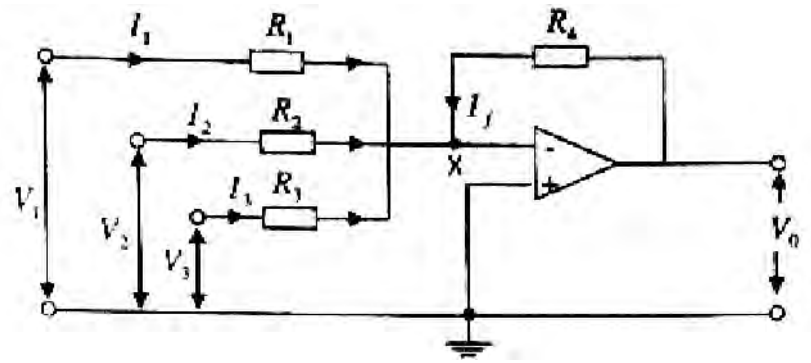


Figure 2

Calculate the output potential V_0 given that the input voltage $V_1 = 4.0V$, $V_2 = -2.5V$ and $V_3 = 1.5V$ **(2.5 marks)**

12. (a) Name three electronic circuits in which multivibrators can be constructed. **(1.5 marks)**

    (b) (i) List down three types of multivibrators. **(1.5 marks)**
    (ii) Briefly explain the applications of multivibrators listed in 12 (b) (i) **(4.5 marks)**

    (c) (i) Mention two characteristics of op-amps. **(1 mark)**
    (ii) Briefly explain why op-amps are sometimes called differential amplifiers? **(1.5 marks)**

13. (a) Discuss the mode of action of each of the following sensors:
    (i) Thermistor (TH). **(1.5 marks)**
    (ii) Light Dependent Resistor (LDR). **(1.5 marks)**

    (b) Give symbols, expressions and truth tables for each of the following logic gates:
    (i) NAND gate. **(1.5 marks)**
    (ii) Exclusive NOR gate. **(1.5 marks)**

    (c) (i) Why is NAND gate considered as a basic building block for a variety of logic circuits? **(1 mark)**
    (ii) Produce a truth table for the gate shown in Figure 3 hence show that it behaves as AND gate. **(3 marks)**

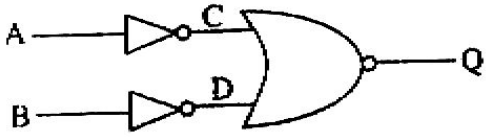


Figure 3

14. (a) (i) What is meant by aerial environment? Give two examples. **(2 marks)**
    (ii) Describe three ways at which the aerial environment is threatened **(3 marks)**

    (b) (i) Briefly explain three major concepts on solar wind. **(3 marks)**
    (ii) How do soil environmental components influence plant growth? Give four points. **(2 marks)**