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:

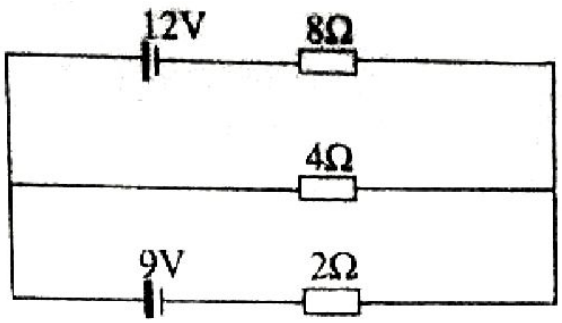

Figure 1

(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 $R_4 = 2.7k\Omega$.

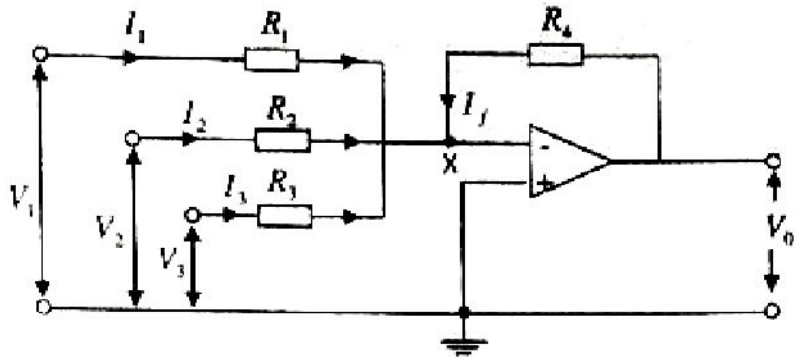

Figure 2

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)**

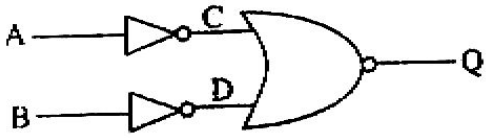

Figure 3

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)**