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: 2:30 Hours **Tuesday, 12th February 2013 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 questions 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, $g = 9.8\ m/s^2$
   (b) Stefan's constant $\sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
   (c) Surface tension of mercury $\gamma_{Hg} = 0.46\ Nm^{-1}$
   (d) Angle of contact of mercury with glass $\theta = 137^{\circ}$
   (e) Wien's constant $c = 2.9 \times 10^{-3}\ m\ K$
   (f) The reciprocal of $4\pi\varepsilon_o$ i.e $\dfrac{1}{4\pi\varepsilon_o} = 9.0 \times 10^{9}\ mF^{-1}$
   (g) Permeability of free space $\mu_o = 4\pi \times 10^{-7}\ NA^{-2}$
   (h) Electronic charge $e = 1.6 \times 10^{-19}\ C$
   (i) Mass of an electron $M_e = 9.1 \times 10^{-31}\ Kg$
   (j) Velocity of sound in air $v = 340\ m/s$.
   (k) Density of mercury, $\rho_{Hg} = 1.36 \times 10^{4}\ Kgm^{-3}$.
   (l) Thermal radiation from the sun to the earth $= 750\ Wm^{-2}$
   (m) Thermal conductivity of copper, $k_{cu} = 400\ Wm^{-1}K^{-1}$
   (n) Mass of proton $M_P = 9.1 \times 10^{-31} Kg$
   (o) Pie, $\pi = 3.14$

SECTION A (40 marks)

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

1. (a) (i) What is the difference between degree of accuracy and precision. **(2 marks)**

(ii) In an experiment to determine Young's modulus of a wooden material the following measurements were recorded.

length	$l = 80.0 \pm 0.05$ cm
breadth	$b = 28.65 \pm 0.03$ mm
thickness	$t = 6.40 \pm 0.03$ mm and
slope	$G = 0.035 \pm 0.001$ cmgm^{-1}.

Given that the Young's modulus Y is given by

$$Y = \frac{4}{Gb}\left(\frac{l}{t}\right)^3$$

Calculate the maximum percentage error in the value of Y. **(2 marks)**

(b) Using the method of dimensions, indicate which of the following equations are dimensionally correct and which are not, given that, f= frequency, γ = surface tension, ρ = density, r = radius and k = dimensionless constant.

(i) $\rho^2 = k\sqrt{\frac{r^3 f}{\gamma}}$ **(2 marks)**

(ii) $f = \frac{kr^3\sqrt{\gamma}}{\rho^{\frac{1}{2}}}$ **(2 marks)**

(iii) $f = \frac{k\gamma^{\frac{1}{2}}}{\sqrt{\rho} r^{\frac{3}{2}}}$ **(2 marks)**

2. (a) (i) List down two main assumptions in deriving the equation of projectile motion. **(1 mark)**

(ii) Why the horizontal motion of a projectile is constant? **(1 mark)**

(b) A ball is thrown horizontally with a speed of 14.0 ms^{-1} from a point 6.4 m above the ground. Calculate:

(i) The horizontal distance traveled in that time. **(2 marks)**

(ii) Its velocity when it reaches the ground. **(2 marks)**

(c) A man stands in a lift which is being accelerated upwards at 3.2 m/s^2. If the man has a mass of 65 kg, what is the net force exerted on the man by the floor of the lift? **(4 marks)**

3. (a) Why is it technically advised to bank a road at corners? **(2 marks)**

(b) A wheel rotates at a constant rate of 10 revolutions per second. Calculate the centripetal acceleration at a distance of 0.80 m from the centre of the wheel. **(3 marks)**

(c) (i) With the aid of a labeled diagram, sketch the possible orbits for a satellite launched from the earth. **(3 marks)**

(ii) From the diagram in (c) (i) above, write down an expression for the velocity of a satellite corresponding to each orbit. **(2 marks)**

4. (a) (i) Distinguish surface tension from surface energy. **(2 marks)**

(ii) Explain the phenomenon of surface tension in terms of the molecular theory. **(2 marks)**

(b) A clean open ended glass U-tube has vertical limbs one of which has a uniform internal diameter of 4.0 mm and the other of 20.0 mm. Mercury is poured into the tube; and observed that the height of mercury column in the two limbs is different.

(i) Explain this observation. **(2 marks)**

(ii) Calculate the difference in levels. **(4 marks)**

5. (a) Name the temperature of a thermocouple at which the thermo,

(i) e.m.f changes its sign. **(1 mark)**

(ii) electric power becomes zero. **(1 mark)**

(b) (i) A person sitting on a bench on a calm hot summer day is aware of a cool breeze blowing from the sea. Briefly explain why there is a natural convection? **(2 marks)**

(ii) A Nichrome-constantan thermocouple gives about 70 μV for each $1^{0}C$ difference in temperature between the junctions. If 100 such thermocouples are made into a thermopile, what voltage is produced when the junctions are at $20^{0}C$ and $240^{0}C$? **(3 marks)**

(c) A black body of temperature θ is placed in a blackened enclosure maintained at a temperature of $10^{0}C$. When its temperature rises to $30^{0}C$ the net rate of loss of energy from the body was found to be 10 Watts. Find the power generated by the body at $50^{0}C$ if the energy exchange takes place solely by the process of forced convection. **(3 marks)**

6. (a) Compare the law governing the conduction of heat and electricity pointing out the corresponding quantities in each case. **(2 marks)**

(b) (i) Write down three laws governing the black body radiation. **(1.5 marks)**

(ii) A cup of tea kept in a room with temperature of 22^{0}C cools from 66^{0}C to 63^{0}C in 1 minute. How long will the same cup of tea take to cool from the temperature of 43^{0}C to 40^{0}C under the same condition? **(2.5 marks)**

(c) A lagged copper rod is uniformly heated by a passage of an electric current. Show by considering a small section ∂x that the temperature θ varies with distance x along a rod in a way that, $k\left(\frac{d^2T}{dx^2}\right) = -H$, where k is a thermal conductivity and H is the rate of heat generation per unit volume. **(4 marks)**

SECTION B (30 marks)

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

7. (a) (i) Define the term standing wave. **(1 mark)**

(ii) State the position in a stationary wave where a man can hear a louder sound. **(2 marks)**

(b) (i) What is meant by dispersion of waves? **(1 mark)**

(ii) Briefly explain if it is possible for dispersion to take place on a wave whose frequency lie in the audible range. **(2 marks)**

(c) A small speaker emitting a note of frequency 250Hz is placed over the open upper end of a vertical tube which is full of water. When the water is gradually run out of the tube the air column resonates. If the initial and final position of the water surface below the top are 0.31 m and 0.998 m respectively, calculate the speed of sound in air and the end-correction of the tube. **(4 marks)**

8. (a) What is meant by "power rating" as regards to a resistor? **(1.5 marks)**

(b) (i) Mention two distinct velocities of an electron in a wire. **(1.5 marks)**

(ii) A 20 kΩ resistor is to be connected across a potential difference of 300 V. Calculate the required power rating. **(2 marks)**

(c) Explain the following observation:

(i) Light in the bulb comes on once the switch is kept on despite the drift velocity of electrons being very low. **(2.5 marks)**

(ii) The potentiometer is said to be a better device for measuring the potential difference (p.d) than a moving coil voltmeter. **(2.5 marks)**

9. (a) (i) State the laws of electromagnetic induction. **(2 marks)**

(ii) Mention the factors which determine the magnitude and direction of the force experienced by a current-carrying conductor in a magnetic field. **(2 marks)**

(b) (i) Derive the formula for the torque acting on the rectangular current-carrying coil in a magnetic field. **(4 marks)**

(ii) What is the maximum torque on a 400-turns circular coil of radius 0.75 cm that carrying a current of 1.6 mA and resides in a uniform magnetic field of 0.25 T? **(2 marks)**

10. (a) (i) What is band theory? **(1 mark)**

(ii) How does the band theory explain electrical properties of solids? **(1.5 marks)**

(b) In an intrinsic semiconductor, the energy gap E_g is 1.2 eV, and its hole mobility is very much smaller than electron mobility which is independent of temperature. Assuming that the temperature dependence of intrinsic carrier concentration, n_i is expressed as;

$n_i = n_0 \exp\left(\frac{-E_g}{K_B T}\right)$, where, n_0 and K_B are constants, T is temperature and E_g is an energy equal to $\frac{E_g}{2}$.

(i) What is the ratio between conductivity at 600K and that at 300K? **(3 marks)**
(ii) Comment on the result obtained in (b) (i). **(1 mark)**

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

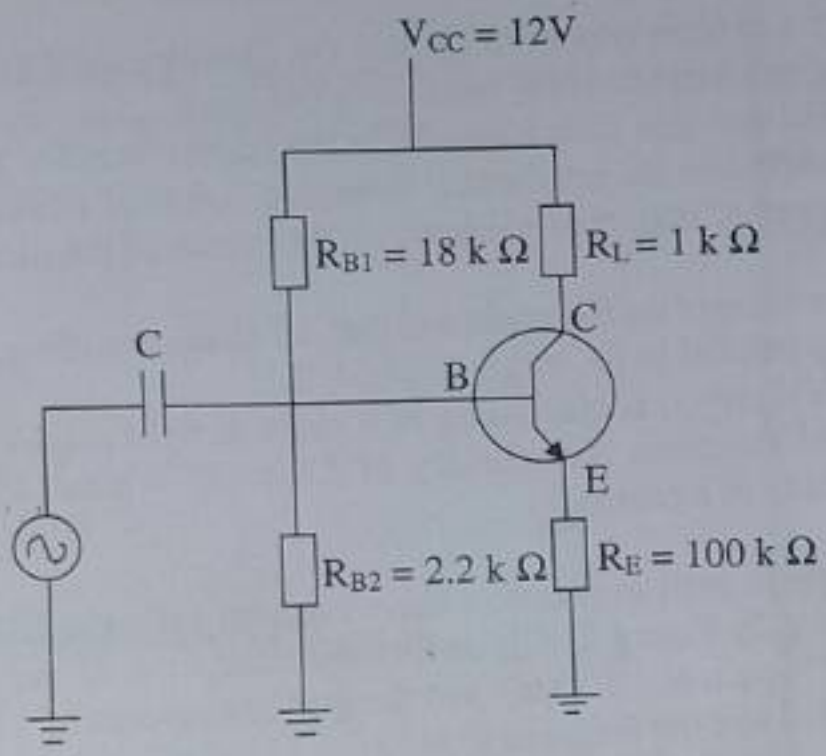

Figure 1

(i) Determine the voltage drop across, R_{B2}. **(2 marks)**
(ii) Calculate the emitter current, I_E. **(1 mark)**
(iii) State the assumption taken to obtain the answer in (c) (ii) above. **(0.5 mark)**

SECTION C (30 marks)

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

11. (a) (i) Describe Coulomb's law and give the dimensions of each quantity. **(3 marks)**
(ii) Briefly explain how you can demonstrate that there are two types of charges in nature. **(2 marks)**

(b) (i) Define electric potential. **(1 mark)**
(ii) A radioactive source in the form of metallic sphere of radius 1.0 cm emits β-particles at the rate of 5.0×10^{10} particles per second. If the source is electrically insulated, how long will it take for its electric potential to be raised by 2.0 Volts? (assuming that 40% of the emitted β-particles escape the source). **(4 marks)**

12. (a) (i) What is an electron microscope? **(1 mark)**

(ii) Outline three disadvantages of electron microscope. **(1.5 marks)**

(b) (i) Draw a schematic diagram of an electron microscope showing its main parts. **(3 marks)**

(ii) Give the order of resolution of electron microscope in (b) (i) above. **(1 mark)**

(c) (i) Briefly explain why Cathode Ray Oscilloscope (C.R.O) is said to be an excellent instrument for measuring the e.m.f. **(1 mark)**

(ii) An electron gun fires electrons at the screen of a TV tube. The electrons start from rest and are accelerated through a potential difference of 30 kV. What is the speed of impact of electrons on the screen of the picture tube? **(2.5 marks)**

13. (a) (i) Give comment on the statement that, an electron suffers no force when it moves parallel to the magnetic field, B. **(1.5 marks)**

(ii) A 10 eV proton is circulating in a plane at right angles to a uniform magnetic field of magnetic flux density of $1.0 \times 10^{-4} Wb/m^2$. Calculate the cyclotron frequency of a proton. **(2.5 marks)**

(b) An oscilloscope is used to measure the waveform across a 500 Ω resistor in an a.c. circuit as shown in Figure 2. Given that the time base of the oscilloscope is set at 5 $mscm^{-1}$, its Y – gain at 0.5 Vcm^{-1} and the grid has squares of 1.0 cm, calculate:

(i) the period and the frequency. **(2 marks)**

(ii) the pick voltage and the r.m.s voltage. **(2 marks)**

(iii) the r.m.s current through the resistor. **(1 mark)**

(iv) the mean power dissipated in the resistor. **(1 mark)**

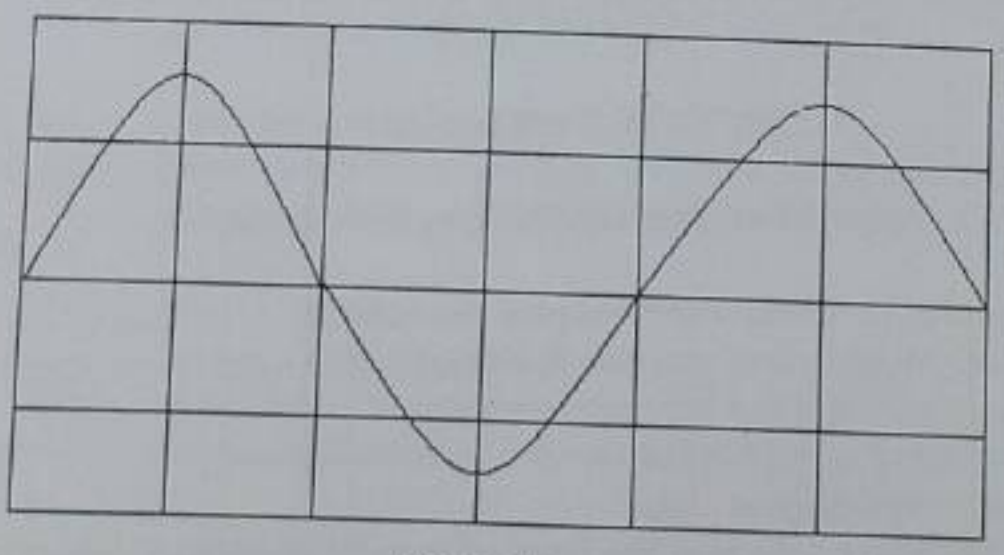

Figure 2

14. (a) (i) The main interior of the earth (core) is believed to be in molten form. What seismic evidence supports this belief? **(1 mark)**

(ii) Explain why the small ozone layer on the top of the stratosphere is crucial for human survival. **(2 marks)**

(b) Electrical properties of the atmosphere are significantly exhibited in the ionosphere.

(i) What is the layer composed of and what do you think is the origin of such constituents. **(2 marks)**

(ii) Mention two uses of the ionosphere. **(2 marks)**

(c) Briefly explain why long distance radio broadcasts make use of short wave bands. **(3 marks)**

15. (a) Briefly explain on the following types of environmental pollution:

(i) Thermal pollution. **(3 marks)**

(ii) Water pollution. **(3 marks)**

(b) Describe the soil temperature with regard to agricultural physics which causes lower crop growth at a particular area. **(4 marks)**