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

131/2

PHYSICS PAPER 2
(For Both School and Private Candidates)

TIME: 2½ Hours

03 June 1999 A.M.

INSTRUCTIONS

1. This paper consists of sections A, B and C.
2. Answer FIVE (5) questions in the answer booklet provided including at least ONE (1) question from each of the Sections A, B and C.
3. The marks beside each question indicate the relative credit given to each part of the question.
4. Remember to write your Index Number on every page of your answer booklet provided.
5. Mathematical tables, calculators and slide rules may be used. Graph papers are provided.
6. Unless stated otherwise in the question, the following constants may be useful.
   - Acceleration due to the earth's gravity, $g = 9.8 ms^{-2}$
   - Newton's universal gravitational constant, $G = 6.67 \times 10^{-11} \frac{Nm^2}{Kg^2}$
   - Mass of the Earth, $M_E = 6.0 \times 10^{24}$ kg
   - Radius of the Earth, $R_E = 6.5 \times 10^6$ m
   - Avogadro's Number, $N_A = 6.0 \times 10^{23} Mol^{-1}$
   - Density of Helium at S.T.P., $p = 1.785 \times 10^{-1}$ kg m^{-3}
   - 1 atmosphere, $P_o = 1.0 \times 10^5$ Pa
   - Permittivity constant of free space, $\epsilon_o = 8.85 \frac{pF}{m}$
   - Vertical component of Earth's Magnetic flux density, $B_E = 4.0 \times 10^{-5}$ Tesla
   - Half life of Radium -226, $T½ = 1600$ years
   - Boltzmann constant, $k = 1.38 \times 10^{-23} JK^{-1}$

SECTION A

Attempt at least one question from this section.

1. (a) Define "Young's Modulus" of a material and give its SI units.

[02 Marks]

(b) With the aid of a sketch graph, explain what happens when a steel wire is stretched gradually by an increasing load until it breaks.

[06 Marks]

(c) A force F is applied to a long steel wire of length L and cross-sectional area A.

(i) Show that if the wire is considered to be a spring, the force constant k is given by: $k = \frac{AY}{L}$, where Y is Young's Modulus of the wire. [02 Marks]

(ii) Show that the energy stored in the wire is $U = \frac{1}{2} F \Delta L$, where ΔL is the extension of the wire. [04 Marks]

(d) The period T of vibrations of a tuning fork may be expected to depend on the density D, Young's Modulus Y of the material of which it is made and the length a of its prongs. Using dimensional analysis deduce an expression for T in terms of D, Y and a. [06 Marks]

2. (a) Explain the meaning of the following terms:

(i) Gravitational Potential of the Earth. [02 Marks]

(ii) Gravitational Field Strength of the Earth. [01 Mark]

How are the above quantities in (i) and (ii) related? [01 Mark]

(b) Show that the total energy of a satellite in a circular orbit equals half its potential energy. [05 Marks]

(c) Calculate the height above the Earth's surface for a satellite in a parking orbit. [06 Marks]

(d) What would be the length of a day if the rate of rotation of the Earth were such that the acceleration of gravity g = 0 at the equator? [05 Marks]

3. (a) What do you understand by the term "moments of inertia" of a rigid body? [02 Marks]

(b) (i) State the perpendicular axes theorem of moments of inertia for a body in the form of a lamina [02 Marks]

(ii) Calculate the moments of inertia of a thin circular disc of radius 50cm and mass 2 kg about an axis along a diameter of the disc. [08 Marks]

(c) A wheel mounted on an axle that is not frictionless is initially at rest. A constant external torque of 50 Nm is applied to the wheel for 20 s. At the end of the 20 s, the wheel has an angular velocity of 600 rev/min. The external torque is then removed, and the wheel comes to rest after 120 s more.

(i) Determine the moments of inertia of the wheel. [06 Marks]

(ii) Calculate the frictional torque which is assumed to be constant. [02 Marks]

4. (a) State the main assumptions of the "kinetic theory" of gases. [05 Marks]

(b) Derive an expression for the pressure exerted by an ideal gas on the walls of its container. [08 Marks]

(c) How does the average translational kinetic energy of a molecule of an ideal gas change if:

(i) the pressure is doubled while the volume is kept constant? [02 Marks]

(ii) the volume is doubled while the pressure is kept constant? [02 Marks]

(d) Calculate the value of the root mean-square speed of molecules of helium at 0°C. [03 Marks]

SECTION B

Attempt at least one question from this section.

5. (a) (i) What is "capacitance"? [02 Marks]
(ii) List three factors that govern the capacitance of a parallel plate capacitor. [03 Marks]

(b) Show that the energy per unit volume stored in a parallel plate capacitor is given by:

$U = \frac{1}{2}\epsilon E^2$ and define all the symbols in this equation. [08 Marks]

(c) Given that the distance of separation between the parallel plates of a capacitor is 5mm, and the plates have an area of $5m^2$. A potential difference of 10 kV is applied across the capacitor which is parallel in vacuum.

Compute:

(i) the capacitance [02 Mark]

(ii) the electric intensity in the space between the plates [01 Mark]

(iii) the change in the stored energy if the separation of the plates is increased from 5mm to 5.5mm. [04 Marks]

6. (a) With the help of illustrative diagrams explain the action of a choke in a circuit. [04 Marks]

(b) When an impedance consisting of an inductance L and a resistance R in series is connected across a 12V, 50Hz power supply, a current of 0.050A flows, which differs in phase from that of the applied potential difference by 60°.

(i) Find the value of R and L. [07 Marks]

(ii) Find the capacitance of the capacitor which, when connected in series in the above circuit, has the effect of bringing the current into phase with the applied voltage. [02 Marks]

(c) An inductance of 4 mH is connected in series with a resistance of 20Ω together with a battery:

(i) Determine how the current will vary with time in this circuit. [04 Marks]

(ii) Sketch the current of (i) above against time [01 Mark]

(iii) Calculate the inductive time constant [02 Marks]

7. (a) State the laws of electromagnetic induction and describe briefly experiments (one in each case) which can be used to demonstrate them. [08 Marks]

(b) A flat coil of 100 turns and mean radius 5.0cm is lying on a horizontal surface and is turned over in 0.20 sec. against the vertical component of the Earth's magnetic field. Calculate the average e.m.f. induced. [04 Marks]

(d) With the help of clear diagrams, explain briefly how you would convert a sensitive galvanometer into:
(i) an ammeter [04 Marks]
(ii) a voltmeter [04 Marks]

SECTION C

Attempt at least one question from this section.

8. (a) State Bohr's postulates of the atomic model. [06 Marks]

(b) Show that for an electron in a hydrogen atom, the possible radii of an electron orbit are given by:

$$r_n = a_o n^2, \quad n = 1, 2, 3, \ldots.$$ [06 Marks]

(c) (i) Show that the possible energy levels (in Joules) for the hydrogen atom are given by the formula:

$$E_n = \frac{-me^4}{8h^2\epsilon_o^2}\,\frac{1}{n^2}$$

where m = mass of the electron

e = electronic charge

h = Planck's constant

ϵ_o = permittivity constant of vacuum [06 Marks]

(ii) What does the negative sign signify in the formula for E_n in (i) above? [02 Marks]

9. (a) Define the term "binding energy" of a nuclide. [02 Marks]

(b) Distinguish between:

(i) β^- decay and β^+ decay. [03 Marks]

(ii) nuclear fission and nuclear fusion. [03 Marks]

(iii) activity and half-life of a radioactive material. [03 Marks]

(iv) Taking the half-life of Radium - 226 to be 1600 years, what fraction of a given sample remains after 4800 years? [02 Marks]

(c) An experiment was conducted to investigate the absorption by aluminium of the radiation from a radioactive source by inserting aluminium plates of different thicknesses between the source and a Geiger tube connected to a ratemeter (or scales). The observations are summarized in table 1.

TABLE 1

Thickness of Aluminium (cm)	2.3	6.9	11.4	16.0
Mean Count rate (min^{-1})	1326	802	496	300

Use these data to plot a graph and hence determine for this radiation in aluminium, the linear absorption coefficient μ, defined by $\mu = -{}^{dI}/_{I}\ {}^{1}/_{dx}$ where I is the intensity of the incident radiation and dI is the part of the incident radiation absorbed in the thickness dz. [07 Marks]

10. (a) Briefly describe the major factors that you would consider when designing a voltage amplifier.

[05 Marks]

(b) (i) Explain the term "thermal run away" as regards a transistor amplifier. [03 Marks]

(ii) With the help of clear diagrams, explain how you would overcome thermal run away in a voltage amplifier. [05 Marks]

(c) Figure (1) shows a junction transistor voltage amplifier circuit. If $R_1 = 100k\Omega$, $R_2 = 1k\Omega$, $V_{cc}=6.0V$, $V_{BE} = 0.6$ and $h_{FE} = 60$; calculate:

(i) The voltage across R_1 [02 Marks]

(ii) The value of I_B [01 Mark]

(iii) The value of I_c [01 Mark]

(iv) The voltage across R_2 [02 Marks]

(v) The collector - emitter voltage [02 Marks]

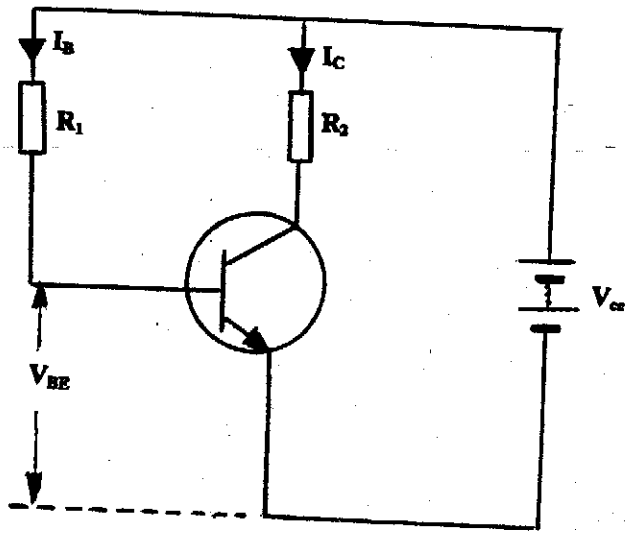

Figure 1