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, March 07, 2005 p.m.***

Instructions

1. This paper consists of sections A, B and C.
2. Answer ten (10) questions choosing ***Four (4)*** from section A and ***three (3)*** 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	$g = 9.8\ m/s^2$
(b)	Mean sun-earth distance	$= 1.5 \times 10^8$ km
(c)	Tanzania total surface area	$= 945{,}000\ km^2$
(d)	Density of water	$\rho_w = 1 \times 10^3\ kg\ m^{-3}$
(e)	Density of glycerine	$\rho_g = 1.2 \times 10^3\ kg\ m^{-3}$
(f)	Coefficient of surface tension of mercury	$\gamma_{Hg} = 0.472$
(g)	Specific heat capacity of water	$C_w = 4.2 \times 10^3\ Jkg^{-1}\ K^{-1}$
(h)	Planck's constant	$h = 6.6 \times 10^{-34}$ JS
(i)	Charge to mass ratio	$\frac{e}{m_e} = 1.8 \times 10^{11}\ C\ kg^{-1}$
(j)		$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9$
(k)	Speed of light in vacuo	$C = 3 \times 10^8\ ms^{-1}$
(l)	Speed of sound in air	$v = 340\ ms^{-1}$
(m)	Avogadro's number	$N_A = 6 \times 10^{23}\ mol^{-1}$
(n)	Threshold wavelength of potassium	$\lambda_o = 5.5 \times 10^{-7}$ m
(o)	Pie	$\pi = \frac{22}{7}$.

This paper consists of 5 printed pages.

SECTION A (40 Marks)

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

1. (a) (i) What is the meaning of the terms "precision" and "accuracy" as used in experimental physics? **(02 marks)**

(ii) In an experiment to determine the volume of glass in a length of glass tubing the following readings were recorded

length $\ell = (40 \pm 1)$ mm

external diameter $D = (12.0 \pm 0.2)$ mm

internal diameter $d = (10.0 \pm 0.2)$ mm

If the volume of glass is calculated using the relation $V = \frac{1}{4}\pi\ell\,(D^2 - d^2)$

determine the numerical value for the volume V. **(03 marks)**

(b) (i) Distinguish between derived quantities and fundamental quantities. **(02 marks)**

(ii) A small liquid drop is disturbed from its spherical shape and thus set oscillating. The frequency f of oscillation is given by $f^2 \rho r^3 = k\gamma$, where

ρ is the density of the liquid drop
r is its radius
γ is the surface tension of the liquid.

Show by dimensional analysis that k is a dimensionless constant. **(03 marks)**

2. (a) Show that the trajectory of a body projected with an initial velocity V_o at an angle θ to the horizontal is a parabola. **(03 marks)**

(b) While standing on an open truck moving at a velocity of 35 ms^{-1} a man sees a duck flying directly overhead. The man shoots an arrow at the duck and misses it. The arrow leaves the bow with a vertical velocity of 98.0 ms^{-1}. The truck accelerates to a constant speed of 40 ms^{-1} in the same direction just after the man has shot at the duck. If the truck open board at which the man is standing is 2.0 m above the ground:

(i) How long will the arrow remain in air before hitting the ground? **(05 marks)**

(ii) Where will the arrow land in relation to the position of the truck? **(02 marks)**

3. (a) (i) Explain why a coiled water hose-pipe tend to straighten when water flows through it. **(01 mark)**

(ii) If action and reaction are always equal in magnitude and opposite in direction why don't they always cancel each other and leave no net force for acceleration of the body? **(01 mark)**

(iii) State the principle of conservation of linear momentum and show that it can be obtained from Newton's laws. **(03 marks)**

(b) (i) What is an impulse of a force? **(01 marks)**

A rifle of mass 5.0 kg is used to fire a bullet of mass 0.15 kg with a muzzle velocity of 600 ms^{-1}. Calculate the

(ii) velocity with which the rifle starts to recoil. **(02 marks)**

(iii) average force required, if the recoil is to be reduced to zero in a distance of 5.0 cm. **(02 marks)**

4. (a) (i) Define "free surface energy" in relation to the liquid surfaces. **(01 mark)**

(ii) Explain what will happen if two bubbles of unequal radii are joined by a tube without bursting. **(01 mark)**

(iii) A spherical drop of mercury of radius 5.0 mm falls on the ground and breaks into 1000 equal droplets. Calculate the amount of work done in breaking the drop. **(03 marks)**

(b) (i) Two capillary tubes of radii r and R are placed in a beaker containing a liquid of density ρ. Show from first principles, in which tube the liquid will rise highest, given that $r < R$. **(02½ marks)**

(ii) Suppose the xylem tubes in the actively growing outer layer of a tree are uniform cylinders and that the rising of sap is due entirely to capillarity with a contact angle of 45° and surface tension 5×10^{-2} Nm^{-1}. What will the maximum radius of the tubes be for a tree 20 m tall? **(02½ marks)**

5. (a) (i) What is the difference between ice point and triple point of water? **(02 marks)**

(ii) Several cooking utensils for sale are rated at "HIGH" or "LOW" in terms of their thermal efficiency for the following properties:

- thermal conductivity
- specific heat capacity
- coefficient of expansion and
- melting point.

Explain briefly the thermal ratings you would observe with respect to each property in purchasing a cooking utensil. **(04 marks)**

(b) A calorimeter of thermal capacity 30 JK^{-1}, contains 100 cm^3 of glycerine and it cools from 80° C to 70° C in 3.5 min, room temperature being 20° C. When the glycerine is replaced by 100 cm^3 of water, the water cools from 43° C to 33° C in 16.5 min. Determine the specific heat capacity of glycerine. **(04 marks)**

6. (a) (i) How does heat transfer by convection differ from that by conduction? **(01 mark)**

(ii) State Newton's law of cooling and Stefan's law. For each law state one significant limitation. **(03 marks)**

(iii) State and illustrate how an increase in temperature affects the radiation spectrum of a blackbody. **(02 marks)**

(b) Given that the solar constant has a value of 1350 W m^{-2}:

(i) Estimate the total direct solar energy which enters the Tanzanian atmosphere from 06.55 a.m. to 05.05 p.m. on a sunny day. Neglect changes in the solar beam between the earth's atmosphere and the sun-earth midpoint. **(02 marks)**

(ii) What is the total rate at which the sun emits out energy? **(02 marks)**

SECTION B (30 Marks)

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

7. (a) (i) Distinguish between longitudinal and transverse wave motion and give an example of each.

(ii) Show the relationship between the frequency f, wavelength λ and velocity of propagation v, of a wave motion. **(04 marks)**

(b) (i) Draw a sketch diagram showing the positions of nodes and antinodes in the vibrations of an air column in a pipe closed at one end when giving the second overtone. Calculate the frequency of this second overtone if the effective length of the pipe is 72 cm. **(03 marks)**

(ii) A small loud speaker is placed near the open end of a pipe of length 400 mm closed at its other end. The minimum frequency at which the pipe resonates is 215 Hz. Estimate the speed of sound in the pipe and calculate the next highest frequency for resonance. **(03 marks)**

8. (a) (i) State Coulomb's law. **(01 mark)**

(ii) A spherical metal of radius r carries a charge Q. Sketch a graph showing the variation of the electric potential V, with the distance x from the centre of the sphere for points (inside and outside) along a line through the centre of the sphere. Account for the shape of the graph. **(03 marks)**

(b) (i) Name the physical properties of a capacitor that affect its capacitance hence write the relation. **(02 marks)**

(ii) Show that the energy stored per unit volume of a parallel plate capacitor is given by $\frac{1}{2} \varepsilon_o \varepsilon_r E^2$ where the symbols carry their usual meaning. **(04 marks)**

9. (a) (i) Define an equipotential surface. **(01 mark)**

(ii) What is the work done on a test charge when it is moved from one point to another along an equipotential surface? **(01 mark)**

(b) (i) Two small spheres A and B are fixed on the x-axis with their centres at distances $X_A = 4$ cm and $X_B = 12$ cm from and on the same side of the origin. If the charge on A is 20×10^{-19} C and that on B is -12×10^{-19} C, determine the electric potential V and the electric field strength E at the origin. **(05½ marks)**

(ii) A capacitor of capacitance 2.0 μF is charged using 0.4 V from a cell and voltage divider. It then discharges through a meter. The meter gives a charge deflection of 6.4 cm. What is the sensitivity of the meter in mm C^{-1}. **(02½ marks)**

10. (a) (i) Explain why an electric bulb turns on as soon as the switch is closed, though the drift velocity of electrons in a metallic conductor is very small. **(02 marks)**

The current in a wire varies with time as $I = 4 + 2t^2$, where I is in amperes and t in seconds.

(ii) How many charges pass a cross-section of the wire in the interval between t = 5s and t = 10s? **(03 marks)**

(iii) What constant current would transport the same charge in the same time interval? **(02 marks)**

(b) What is the velocity of the charge carriers when a current of 1A passes through a copper wire with a cross-sectional area 1 mm^2. Assume that each copper atom donates one electron for conduction purposes. **(03 marks)**

SECTION C (30 Marks)

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

11. (a) (i) What is a semiconductor? **(01 mark)**

(ii) Write down two physical properties of semiconductors that distinguish them from other types of materials. **(02 marks)**

(iii) Explain briefly the effects of applying a forward bias, and reverse bias to the junction diode. **(02 marks)**

(b) Discuss the mode of action of a light dependent resistor (LDR) and light emitting diode (LED). State **two (2)** uses of each. **(05 marks)**

12. (a) Write down an expression for the forces on an electron when moving perpendicular to

(i) an electric field (ii) a magnetic field. Explain all symbols. **(02 marks)**

(b) An electron in a circular path is travelling at 2.0×10^{6} ms^{-1} at right angles to a magnetic field of flux density 1.2×10^{-5} T. The uniform circular motion of an electron is accompanied by the emission of electromagnetic radiation of the same frequency as that of the circular motion. Calculate the:

(i) Radius of the circle. **(02½ marks)**

(ii) Frequency of the circular motion of the electron. **(02½ marks)**

(iii) Wavelength of the electromagnetic radiation emitted and identify the part of the electromagnetic spectrum in which this radiation lies. How would this wavelength be affected by a decrease in the speed of the electron. **(03 marks)**

13. (a) (i) What is meant by the term work function of a metal? **(01 mark)**

(ii) Write down and explain the equation connecting photon energy, work function of the metal and the maximum K.e of the electron. **(02 marks)**

(b) (i) Light of wavelength 5.9×10^{-7} m is shone onto a potassium surface. Determine if there will be any emission of electrons. **(01 marks)**

(ii) Calculate the work function of potassium. **(02 marks)**

(iii) What will the maximum kinetic energy of the electron emitted be when light of wavelength 5×10^{-7} m is shone onto a potassium surface? **(02 marks)**

(iv) Why, for photons of a given energy, are electrons emitted with a range of velocities? In what circumstances are **no** electrons emitted? **(02 marks)**

14. (a) Define the following terms:

(i) Epicentral distance (ii) Body wave (iii) Seismograph. **(03 marks)**

(b) (i) Explain the meaning of reflection seismology and state its application. **(02 marks)**

(ii) Show how the magnetic field within the atmosphere is generated? **(02 marks)**

(c) (i) Name the lowest layers of the atmosphere and the ionosphere.

(ii) State their importance. **(03 marks)**