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, 9th February 2010 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) Thermal conductivity of copper = 400 $Wm^{-1}K^{-1}$
   (b) Acceleration due to gravity g = $10m/s^2$
   (c) Stefan's constant $\sigma = 5.7 \times 10^{-8}Wm^{-2}K^{-4}$
   (d) Exponential constant e = 2.7
   (e) Electronic charge e = $1.6 \times 10^{-19}C$
   (f) Temperature coefficient of resistance for nichrome = $8.0 \times 10^{-5}K^{-1}$
   (g) Resistivity of nichrome at 373K = $1.08 \times 10^{-6}\ \Omega m$

This paper consists of 6 printed pages

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SECTION A (40 marks)

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

1. (a) Mention two uses of dimensional analysis. **(1 mark)**

(b) The critical velocity of a liquid flowing in a certain pipe is $3ms^{-1}$. Assuming that the critical velocity v depends on the density ρ of the liquid, its viscosity η, and the diameter d, of the pipe.

(i) Use the method of dimensional analysis to derive the equation of the critical velocity of the liquid in a pipe of half the diameter. **(2 marks)**

(ii) Calculate the value of critical velocity. **(2 marks)**

(c) (i) Define an error. **(1 mark)**

(ii) In an experiment to determine the acceleration due to gravity g, a small ball bearing is timed while falling freely from rest through a measured vertical height. The following data were obtained: vertical height h = (600 ± 1) mm, time taken t = (350 ± 1)ms. Calculate the numerical value of g from the experimental data, clearly specify the errors. **(4 marks)**

2. (a) (i) Mention two examples of projectile motion. **(2 marks)**

(ii) Define the trajectory. **(1 mark)**

(b) (i) Mention two uses of projectile motion. **(2 marks)**

(ii) Find the velocity and angle of projection of a particle which passes in a horizontal direction just over the top of a wall which is 12m high and 32m away. **(5 marks)**

3. (a) What is the origin of centripetal force for:

(i) a satellite orbiting around the Earth. **(1 mark)**

(ii) an electron in the hydrogen atom? **(1 mark)**

(b) A small mass of 0.15kg is suspended from a fixed point by a thread of a fixed length. The mass is given a push so that it moves along a circular path of radius 1.82m in a horizontal plane at a steady speed, taking 18.0s to make 10 complete revolutions. Calculate:

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

(ii) the centripetal acceleration. **(3 marks)**

(iii) the tension in the thread. **(3 marks)**

4. (a) (i) State surface tension in terms of energy. **(1 mark)**

(ii) The surface tension of water at $20^{o}C$ is $7.28 \times 10^{-2}Nm^{-1}$. The vapor pressure of water at this temperature is $2.33 \times 10^{3}Pa$. Determine

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the radius of smallest spherical water droplet which it can form without evaporating **(3 marks)**

(b) A circular ring of thin wire 3cm in radius is suspended with its plane horizontal by a thread passing through the 10cm mark of a metre rule pivoted at its centre and is balanced by 8g weight suspended at the 80cm mark. When the ring is just brought in contact with the surface of a liquid, the 8g weight has to be moved to the 90cm mark to just detach the ring from the liquid. Find the surface tension of the liquid (assume zero angle of contact.) **(6 marks)**

5. (a) (i) Define thermal convection. **(1 mark)**

(ii) In a special type thermometer a fixed mass of a gas has a volume of $100cm^3$ at a pressure of 81.6cmHg at the ice point and volume of $124cm^3$ and pressure of 90cmHg at steam point. Determine the temperature if its volume is $120cm^3$ and pressure of 85cmHg. **(2.5 marks)**

(iii) What value does the scale of this thermometer give for absolute zero? **(1.5 marks)**

(b) (i) State Stefan's law of thermal radiation. **(1 mark)**

(ii) A solid copper sphere cools at the rate of 2.8°C/min when its temperature is 127°C. At what rate will a solid copper sphere of twice the radius cool when its temperature is 227°C? In both cases the surroundings are kept at 27°C and conditions are such that Stefan's law may be applied. **(4 marks)**

6. (a) (i) State Newton's law of cooling. **(1 mark)**

(ii) Explain the observation that a piece of wire when steadily heated up appears reddish in color before turning bluish. **(2 marks)**

(b) (i) A glass disc of radius 5cm and uniform thickness of 2mm had one of its sides maintained at 100°C while copper block in good thermal contact with this side was found to be 70°C. The copper block weighs 0.75kg. The cooling of copper was studied over a range of temperature and the rate of cooling at 70°C was found to be 16.5K/min. Determine the thermal conductivity of glass. **(4 marks)**

(ii) A cylindrical element of 1kW electric fire is 30cm long and 1.0cm in diameter. If the temperature of the surroundings is 20°C, estimate the working temperature of the element. **(3 marks)**

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SECTION B (30 marks)

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

7. (a) Distinguish between stationary waves and progressive waves. **(2 marks)**

(b) A wave is represented by the equation $y = 10\sin 0.4\pi (60t-x)$, where the distance parameters are measured in metres and the time in seconds.

(i) State whether the wave is stationary or progressive. **(1 mark)**

(ii) Determine the wavelength and frequency of the wave. **(4 marks)**

(iii) What will be the phase difference between two points which are 40cm apart? . **(2 marks)**

(iv) Calculate the period and amplitude of the wave. **(1 mark)**

8. (a) (i) Distinguish between magnetic flux density and magnetic induction. . **(1 mark)**

(ii) Describe using a sketch graph how magnetic flux density varies with the axis (both inside and at the ends) of a long solenoid carrying current. . **(3 marks)**

(b) A solenoid 80m long has a cross-sectional area of $16cm^2$ and a total of 3500 turns closely wound. If the coil is filled with air and carries a current of 3A, Calculate:

(i) Magnetic field density B at the middle of the coil. **(2 marks)**

(ii) Magnetic flux inside the coil. **(1 mark)**

(iii) Magnetic force H at the centre of the coil. **(2 marks)**

(iv) Magnetic induction at the end of the coil. **(0.5mark)**

(v) Magnetic field intensity at the middle of the coil. **(0.5 mark)**

9. (a) (i) Define the temperature coefficient of resistance. **(1 mark)**

(ii) Briefly describe an experiment to measure temperature coefficient of a wire. **(4 marks)**

(b) A heating coil is made of a nichrome wire which will operate on a 12V supply and will have a power of 36W when immersed in water at 373K. The wire available has a cross-sectional area of $0.10mm^2$. What length of the wire will be required? **(5 marks)**

10. (a) Briefly explain why a P-N junction is referred as a junction diode. **(2 marks)**

(b) Study carefully Figure 1 where x and y are identical junction diodes with s an internal resistance of $2k\Omega$ each.

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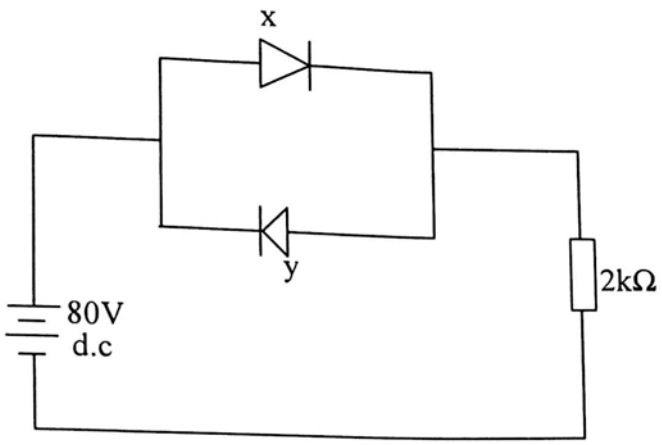


Figure 1

Determine the current drawn from the source when:

(i) Connections are as shown in Figure 1. **(2 marks)**

(ii) Terminals connected to junction diode x are reversed. **(2 marks)**

(iii) Terminals connected to junction diode x is restored but those to junction diode y are reversed. **(2 marks)**

(iv) All connections are as shown in Figure 1, but the polarities of the source are reversed. **(2 marks)**

SECTION C (30 marks)

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

11. (a) (i) State Coulomb's law for charged particles. **(1 mark)**

(ii) Does the coulomb force that one charge exert on another charge change when a third charge is brought nearby? Explain. **(2 marks)**

(b) (i) Describe the action of dielectric in a capacitor. **(2 marks)**

(ii) The electric field intensity inside a capacitor is E. What is the work done in displacing a charge q over a closed rectangular surface? **(2 marks)**

(iii) A capacitor of $12\,\mu F$ is connected in series with a resistor of $0.7M\Omega$ across a 250V d.c supply. Calculate the initial charging current and p.d across the capacitor after 4.2 seconds. **(3 marks)**

12. (a) Explain the following observation:

(i) A dressing table mirror becomes dusty when wiped with a dry cloth on a warm day. **(2 marks)**

(ii) A charged metal ball comes into contact with an uncharged identical ball. (Illustrate your answer by using diagrams). **(2 marks)**

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(b) (i) Show that the unit of CR (time constant) is seconds and prove that for a discharging capacitor it is the time taken for the charge to fall by 37%. **(0 marks)**

(ii) The variable radio capacitor can be charged from 50pF to 950pF by turning the dial from 0^o to 180^o. With the dial at 180^o, the capacitor is connected to a 400V battery. After charging the capacitor is disconnected from the battery and the dial is turned to 0^o. What is the charge on the capacitor? What is the p.d across the capacitor when the dial reads 0^o and the work done required to turn the dial to 0^o? (Neglect frictional effects). **(3 marks)**

13. (a) (i) Without giving any experimental or theoretical detail explain how the results of Millikan's experiment led to the idea that charge comes in 'packets', the size of the smallest packet being carried by an electron. **(1 mark)**

(ii) In the form of Millikan's experiment, an oil drop was observed to fall with a constant velocity of $2.5 \times 10^{-4} ms^{-1}$ in the absence of an electric field. When a p.d of 1000V was applied between the plates 10mm apart, the drop remained stationary between them. If the density of oil is $9 \times 10^2 kgm^{-3}$, density of air is $1.2 kgm^{-3}$ and viscosity of air is $1.8 \times 10^{-5} Nsm^{-2}$. Calculate the radius of the oil drop and the number of electric charges it carries. **(4 marks)**

(b) Show that the path of an electron moving in an electric field is a parabola. **(5 marks)**

14. (a) (i) Explain the following terms: Earthquake, Earthquake focus and Epicenter. **(3 marks)**

(ii) Describe clearly how P and S waves are used to ascertain that the outer core of the Earth is in liquid form. **(3 marks)**

(b) (i) Define the ionosphere and give one basic use of it. **(3 marks)**

(ii) Why is the ionosphere obstacle to radio astronomy? **(1 mark)**

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