RWANDA NATIONAL EXAMINATIONS COUNCIL

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NATIONAL EXAMINATIONS 2002/2003

SUBJECT : PHYSICS II

OPTION : BIOLOGY - CHEMISTRY

DURATION : 3 HOURS

INSTRUCTIONS :

This paper has THREE sections A, B and C.

SECTION A: 15 compulsory questions /55 marks.

SECTION B: 5 questions out of which candidates attempt THREE (3) /30 marks.

SECTION C: TWO (2) questions out of which candidates attempt ONE (1) /15 marks.

Assume where necessary the following:

Acceleration due to gravity	; $g = 10ms^{-2}$
Speed of light in a vacuum	; $c = 3.0 \times 10^{8}ms^{-1}$
Charge on the electron	; $e = 1.6 \times 10^{-19}C$
Plank's constant	; $h = 6.63 \times 10^{-34}Js$
Specific heat capacity of water	; $C_W = 4.2 \times 10^{3}Jkg^{-1}K^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	; $9.00 \times 10^{9}Nm^{2}C^{-1}$
One electron volt	; $eV = 1.6 \times 10^{-19}J$

You may use a non-programmable calculator.
Graph paper is provided.

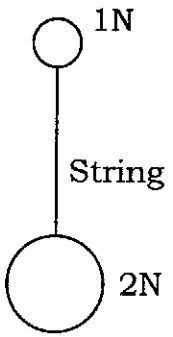
SECTION A: Answer ALL questions in this section /55 Marks.

1. (a) State the relationship between the "mass" and the "weight" of a body on the surface of the earth. **(1mark)**

   (b) State a laboratory instrument which can be used to measure both mass and weight at a given place. **(1mark)**

   (c) Two spheres of weights 1N and 2N are joined by a light inextensible string see figure 1. If they are allowed to fall what is the tension in the string? (ignore air resistance). **(3marks)**

   Figure 1.

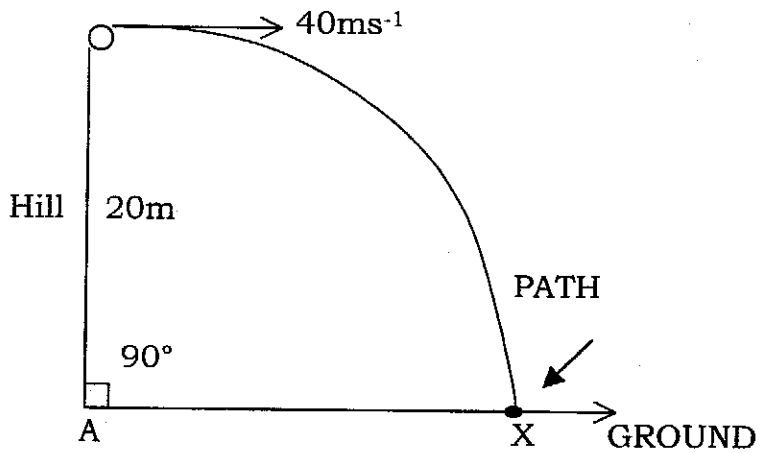


2. (a) Explain briefly what is meant by "Total Internal Reflection" of light. **(2marks)**

   (b) Give one practical example of it. **(1mark)**

3. A stone is projected with a horizontal velocity of $40ms^{-1}$ from the top of a hill 20m high and strikes the ground at a point X away from another point A as shown in the diagram figure 2.

   Figure 2.



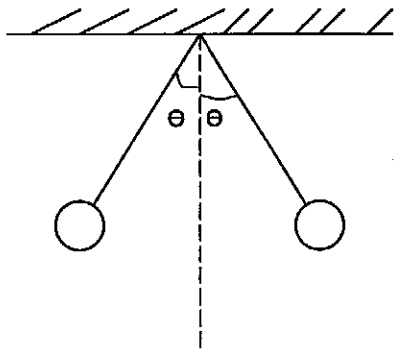
   (i) Calculate the distance A X. **(2marks)**
   (ii) What assumption have you made in the above calculations? **(1mark)**

4. A metal wire has resistance of 2.0Ω, 2.8Ω and 3.0Ω at temperatures of O°C, 100°C and t°C, respectively. What is the value of t on the scale defined by the resistance? **(3marks)**

5. A battery is connected to THREE resistors of value 2Ω, 4Ω and 6Ω in series. The power supplied by the battery is 0.12W. What is the current in the circuit? **(4marks)**

6. Two light conducting balls, suspended on nylon threads, come to rest when the threads make equal angles with the vertical as seen in figure 3.

Figure 3.

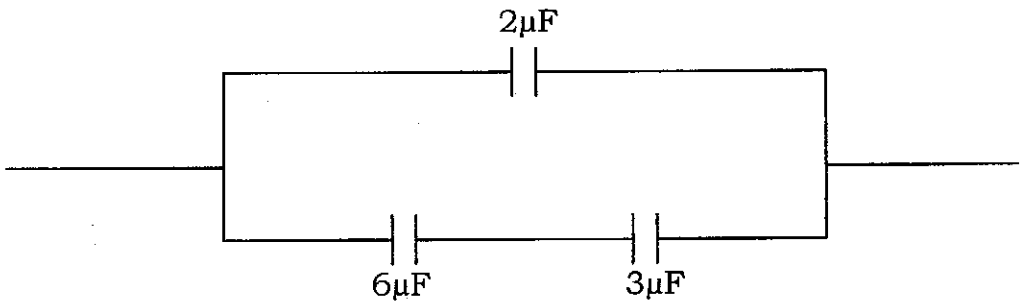


What does this observation tell about the balls? **(2marks)**

7. (a) What is a wave? **(1mark)**
   (b) An organ pipe which is closed at one end has a fundamental or first harmonic of 400Hz. What is
      (i) the frequency of the first overtone? **(1½marks)**

      (ii) the fundamental frequency of a pipe which is open at both ends and of the same length? **(1mark)**

8. (i) What is the total capacitance of the arrangement below shown in the figure. **(2marks)**
   Figure 4.



   (ii) If the combination above is connected to a battery of 4.0V with negligible internal resistance, what is the energy stored by all the capacitors together when fully charged? **(2marks)**

9. (i) Give two <u>different</u> practical examples of simple Harmonic Motion (SHM) **(1mark)**

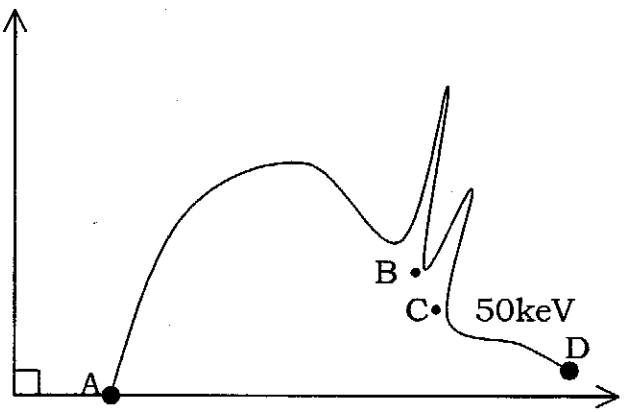
   (ii) State one example where SHM can be converted to circular motion. **(1mark)**

(iii) What is the maximum velocity of a SHM oscillator with amplitude A and period T? **(2marks)**

10. A beam of light from a certain laser has a power of 1.0 mW and a wavelength of 633 nm. How many photons are emitted per second by the laser? **(3marks)**

11. The graph in figure 5, shows a typical x-ray spectrum of energy 50keV.

Figure 5.



By redrawing the diagram;

(a) lable (i) the axes with appropriate units. **(1mark)**
(ii) the marked points A, B,C. **(1½marks)**
(iii) part of the main region ABCD. **(1mark)**

(a) Draw a second graph, on the same diagram as above, to show the spectrum of x-rays with energy 10keV. **(1mark)**

12. A wire that obeys Hooke's law is of length l_1, when it is in equilibrium under a tension F_1 . Its length becomes l_2 when the tension is increased to F_2. What is the energy stored in the wire? **(3marks)**

13. A gun of mass 10.0kg has a bullet of mass 0.1kg inside it. The bullet leaves the gun when fired at a velocity of 200ms^{-1} what is the value of: $\frac{\text{Kinetic energy of bullet}}{\text{Kinetic energy of gun}}$
(Assume there is free movement of both the bullet and the gun) **(4marks)**

14. A straight wire 2,0m long carrying a current of 20m A lies 30° to the earth's magnetic field of magnitude 5 x 10^{-5}T.
Determine the force on the wire. **(4marks)**

15. (i) State THREE <u>different</u> ways in which energy can be obtained from the sun. **(1½marks)**

(ii) Mention TWO sources of Geothermal energy. **(1mark)**

(iii) How much energy in Joules is supplied by the following.

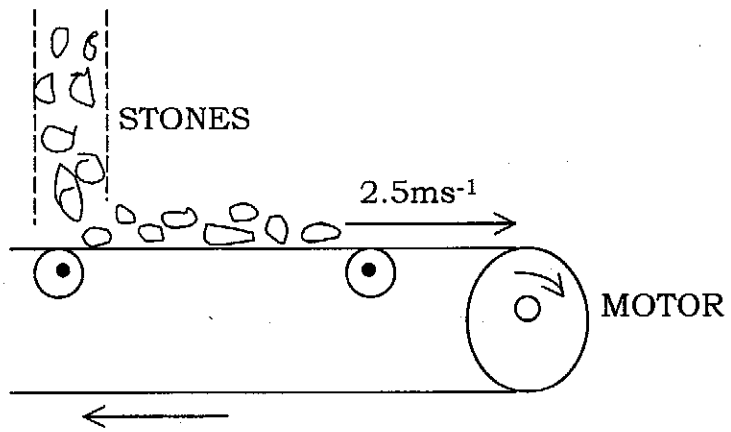
(a) 3 kW immersion heater in 3 hours. **(1½marks)**

(b) A car which uses 5 liters of petrol while traveling 80km if 1 liter of petrol produces 10kWh of energy when burnt. **(1mark)**

SECTION B: Answer only THREE questions from this section/30 marks.

16. Figure 6 shows a conveyor belt which carries freshly mined stones away from a quarry. The belt is horizontal and moves at 2.5ms^{-1}. Stones are damped vertically on to it with negligible kinetic energy at the rate of 20kg each second.

Figure 6.



(a) Determine the additional force needed to keep the belt moving at constant speed when the stones start fall on to it. **(2marks)**

(b) Determine the output power of the motor needed to drive the belt. (neglect power loses in the conveyor drive system) **(3marks)**

(c) At what rate do the stones gain kinetic energy? **(3marks)**

(d) State why the answers to (b) and (c) are different? **(2marks)**

17. (a) State the equation of state for an ideal gas. **(2marks)**

(b) Use the above equation to verify that "Equal volumes of all gases at the same temperature and pressure contain the same number of molecules. **(3marks)**

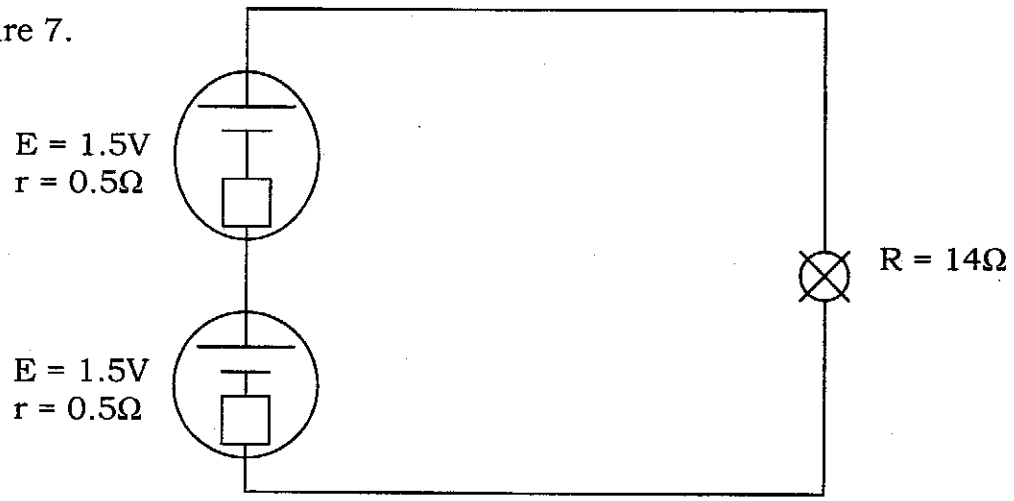
(c) If one mole of oxygen molecules occupies 22.41 at s.t.p (ie 273K and 1,00 x 10^{5}pa) calculate the value of the molar gas constant R in Jmol^{-1}K^{-1}. **(3marks)**

(d) What is meant by Absolute zero of temperature. **(1mark)**

(e) Convert a temperature change of 40°C to the Kelvin scale of temperature. **(1mark)**

18. Figure 7 shows a filament lamp connected to two cells in series. Each of the cells has an emf of 1.5V and internal resistance of 0.5Ω. Under these conditions, the resistance of the lamp is 14Ω.

Figure 7.



(a) Calculate the power dissipated in the internal resistance of one of the cells. **(4marks)**

(b) Explain why 8 such cells cannot be used to start a car engine instead of a single 12V accumulator. **(2marks)**

(c) The filament has a cross-sectional area of $2.1 \times 10^{-9}m^2$, is made of a material of resisitivity $4.9 \times 10^{-7}\Omega m$, and has a resistance of 14Ω. Calculate the length of the wire. **(4marks)**

19. (a) What is meant by:
(i) Alternating current, (A,C) **(1mark)**
(ii) Direct current, (D,C) **(1mark)**

(b) What is the main difference between static and current electricity with regard to currents and potential differences. **(2marks)**

(c) The expression for the impedance, Z of an L-C,-R circuit in series is given by $Z^2 = R^2 + (wL - \frac{1}{wc})^2$ with the usual notation.

(i) What is meant by impedance? **(2marks)**

(ii) Deduce an expression for the resonance frequency. **(2marks)**

(iii) Sketch a graph of I(current) against frequency and indicate the resonance frequency on it. **(2marks)**

20.(a) (i) Draw and label not to scale, the main regions of the Electro-magnetic (E-M) spectrum. **(4marks)**

(ii) State TWO features that all the E-M waves have in common. **(2marks)**

(b) A stream of electrons, accelerated through a p.d of 12kV, is directed against the target of an x-ray tube.

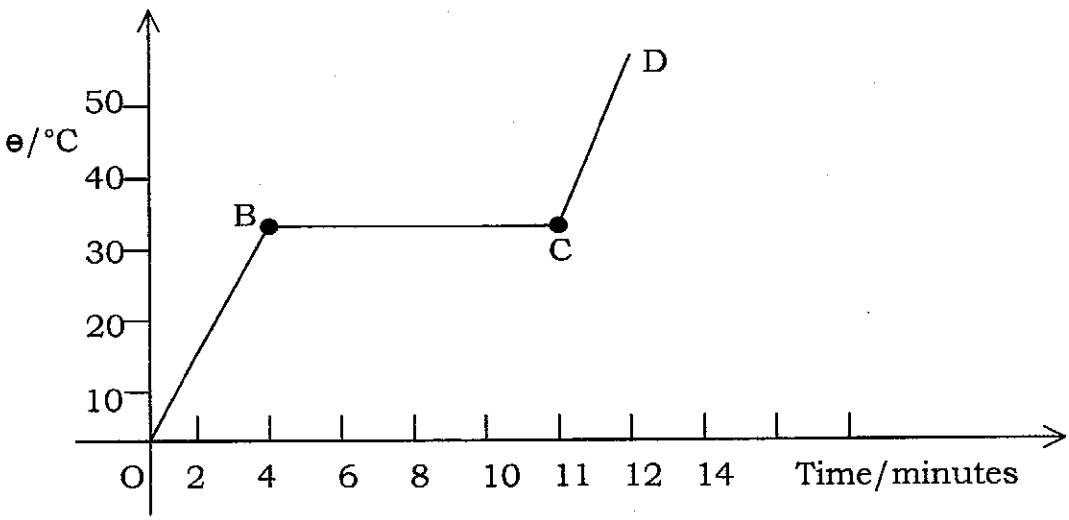
Estimate:
(i) the kinetic energy of each electron. **(2marks)**

(ii) the maximum frequency of the x-rays which could be emitted by the target. **(2marks)**

SECTION C: Answer only ONE question from this section /15 marks.

21. Figure 9 shows a graph of temperature θ°C against time/minutes which shows the behaviour of 4.0kg of a substance, initially solid and temperature rising when it is heated uniformly at 4000J min^{-1}. From the figure

Figure 9.



Answer the following:

(a) What is the melting point of the substance? **(1mark)**

(b) What is the specific heat capacity of the substance when solid? **(4marks)**

(c) Calculate the specific latent heat of fusion of the substance. **(4marks)**

(d) Briefly explain why the temperature remains constant whereas the heat is constantly supplied. **(4marks)**

(e) Label the region beyond C. **(2marks)**

22. (a) An object is placed between the focal point and the optical center of a converging lens. Draw a ray diagram not to scale to indicate the position and nature of the image of the object which is formed so that it can be seen clearly by a normal eye. **(7marks)**

(b) (i) Show that the numerical angular magnification of a simple microscope (magnifying glass) is given by the expression with the usual notation.

$$M = \frac{D}{f} + 1.$$ **(5marks)**

(ii) State the expression for the magnification when the image is formed at infinity. **(2marks)**

(c) How can the magnifying power in the above cases (i) and (ii) be improved practically. **(1mark)**