SECTION I.
One hour
Answer all questions

1. (a) Explain the fact that homogeneity of physical equation is not sufficient for the correctness of the equation.

(b) The electric field intensity E acting on a point charge, q, placed at a distance, r, from a test charge in a vacuum can be expressed as $E = \frac{q}{4\pi\varepsilon_0 r^2}$ where ε_0 is the permittivity. Show that this equation is homogenous.

(7marks)

2.

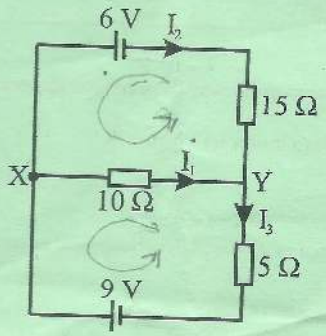

Figure 1

Figure 1 shows how resistors and cells may be connected in an electrical circuit.
Calculate values for

a) I_1, I_2 and I_3.
b) Pd across XY

(8marks)

3. (i) Distinguish between elastic and inelastic collision.
(ii) A ball of mass, m, falls vertically from a height, h_1, to the ground and rebounces to a height, h_2. Calculate the change in momentum of the ball in terms of m, h_1 and h_2.

(6 marks)

4. A cathode ray oscilloscope has its Y-sensitivity set at 20 V cm^{-1}. A sinusoidal input is suitably applied to give a steady trace with time –base so that the electron beam takes 10^{-2} s to traverse the screen. If the trace has a peak to peak of 4.0 cm and has 4 complete cycles.
Estimate the values for

(i) r.m.s. voltage
(ii) Frequency of the input signal.

(4 marks)

5.

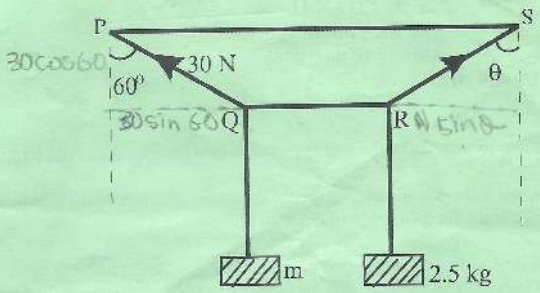

Figure 2

Figure 2 shows a string PQRS. P and S are attached to a fixed support and mass, m, and 2.5 kg are attached at the points Q and R respectively and the system is in equilibrium. Calculate

(i) the mass, m,

(ii) the tension, T,.

(iii) the angle, θ.

(6 marks)

6.

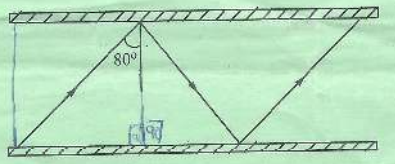

Figure 3

Figure 3 shows a cross section of an optical fibre used for telecommunication.

(a) State and explain two reasons why the optical fibre is preferred to the copper cable for this purpose.

(b) The speed of light in the core is 1.95×10^8 m s^{-1} while the smallest angle of incidence in the core is 80°.
Calculate the refractive indices for

(i) the core

(ii) the cladding

(5 marks)

7. (a) Explain why the specific heat capacity of a gas at constant pressure ,c_p, is greater than the specific heat capacity at constant volume c_v.

(b) Explain why a distinction between specific heat capacity at constant pressure and at constant volume is important for gases but not for solids and liquids.

(4 marks)

SECTION II

One hour

Answer all questions

Answer 8 (a), (b), and (c) or 8 (d), (e) and (f)
Either 8 (a), (b) and (c).

8. (a) (i) Define surface tension. **(2marks)**

(ii) Describe an experiment to show how the surface tension of a liquid varies with temperature. **(8 marks)**

(b) (i) A soap bubble of radius 8.0 cm is blown on the end of a tube which is connected to a U-tube containing water. Calculate the difference in the water levels.

(ii) If another soap bubble of radius of curvature 2.0 cm is now allowed to make contact with the first so that the radius of curvature of the common surface is r and the surface tension for soap solution is 3.5×10^{-2} N m^{-1}, calculate r. **(5 marks)**

(c) (i) The net force ,F, between two particles in a solid varies with their separation, r, according to the equation.

$$F = \frac{8.0 \times 10^{-20}}{r^2} - \frac{2.0 \times 10^{-96}}{r^{10}}$$

Calculate, r_o, the equilibrium separation **(3marks)**

(ii) Sketch a graph showing how the force, F, between two adjacent particles varies with their separation, r. **(2 marks)**
(20 marks)

OR **8, (d), (e), and (f).**

(d) (i) Define capacitance. **(2 marks)**

(ii) Describe an experiment to show how the capacitance of a parallel plate capacitor varies with the area between the plates. **(8 marks)**

(e) A tiny pith gall of mass 5.0×10^{-4} kg is suspended by a light thread of negligible mass. The ball is electrically charged and plated in a uniform horizontal electric field strength 4.0×10^{2} N C^{-1}.
Calculate the charge q when it is deflected through an angle of 10°. **(5 marks)**

(f) (i) Sketch a graph showing how the electric field strength E varies with distance, r, from the centre of a uniform solid metal sphere of radius, r, from the centre of a uniform solid metal sphere of radius, r_0,which is positively charged.

(ii) Explain the shape of your graph when $r < r_o$ and when $r > r_o$. **(5 marks)**
(20 marks)

Answer either 9(a), (b), and (c) or 9(d), (e), and (f)
Either 9(a), (b), and (c)

9. (a) (i) Explain what is meant by the half life of a radioactive nuclide. **(2 marks)**

(ii) Living wood has an activity of 16 counts $min^{-1}g^{-1}$ which is due to the disintegration of carbon -14 atoms in the wood. The half life of carbon -14 is 5.6×10^{3} years.
Calculate the age of ship with a sample of wood of mass 0.5 g from the ship whose activity is 6.5 counts min^{-1}. **(4 marks)**

(b) Natural Uranium contains 0.7 % U-235. When U-235 undergoes fission, 200 MeV of energy is released.
Calculate

(i) the number of U-235 nuclei contained in 1kg of natural uranium.

(ii) the cost to be paid to AES- SONEL at the rate of 60 francs per unit when the U-235 content in 1kg completely undergoes fission. **(5 marks)**

(c) Sketch a block diagram of a nuclear reactor and explain the functions of

(i) the coolant.

(ii) the moderator.

(iii) the control rods. **(9 marks)**
(20 marks)

Or 9(d), (e), and (f)

(d) (i) Explain what is meat by simple harmonic motion. **(2 marks)**

(ii) Sketch graphs showing how the following quantities vary with the period of oscillation for one complete cycle.
. Kinetic Energy
. Potential Energy
. Total Energy **(5 marks)**

(e) A pendulum of length 1.2 cm has a bob of mass 0.2 g. The bob is pulled aside a horizontal distance of 20.0cm and then released.
Calculate
(i) the velocity of the bob at is lowest point.
(ii) the maximum kinetic energy of the bob. **(4 marks)**

(f) (i) mechanical systems may undergo free, damped, and forced oscillations.
Explain the meaning of the underlined words. **(3 marks)**

(ii) A string has a length of 2.0 m and a density of 8.0×10^3 kg m^{-3}
When the string is vibrating in the fundamental mode with a frequency of 200 Hz the tension in the string produces a strain of 2 %. Calculate the young's modulus for the string. **(6 marks)**

(20 marks)

SECTION III
(30 minutes)

10 A student investigated the variation of potential difference, V, and the current, I, through a semiconductor diode. The corresponding values of the potential difference and the current are displayed in table 1.

V/mV	$I/10^{-4}$A
255	0.004
315	0.016
345	0.036
385	0.089
410	0.182
455	0.552
475	0.903
495	1.400
505	1.820
515	2.230
530	3.100

Table 1

The equation relating I and V is $I=I_o e^{BV}$ where I_o and P are constants.

(a) What is the physical significance of I_o **(2marks)**

(b) (i) Plot a suitable graph to determine the value for I_o and V **(9 marks)**

(ii) Determine the value of I_o and B. **(8 marks)**

(c) Another equation linking I and V is $I = I_o (e^{BV}-1)$
What physical approximation could be considered for $I = I_o e^{BV}$ **(1mark)**

(20 marks)
