MENGO SENIOR SCHOOL

MID TERM 3 EXAMS 2003

S.5 PHYSICS PAPER 2

TIME: 2 ½ HOURS

INSTRUCTIONS:
-Attempt all questions
-All questions carry equal marks
assume where necessary.

-Permittivity of free space = 8.85 x 10^{-12} FM^{-1}

-The constant $\frac{1}{4\pi_o}$ ***= 9.0 x 10^{9} $F^{-1}M$***

-Electron mass m = 9.11 x 10^{-31}kg

Electron charge e = 1.6 x 10^{-19}C

1(a)(i) What is meant by dielectric constant. (1)

(ii) A parallel plate capacitor was charged to a p.d of 60v and then isolated. When a glass slab was inserted between the plates, the p.d decreased to 30v. Calculate the dielectric constant of the slab. (3)

(b) A parallel plate air capacitor of plate separation d and plate area A has a capacitance c and is charged to a p.d v.

Two dielectric materials of constants k_1 and k_2 respectively and having thickness $\frac{d}{2}$ each are inserted between it's plates so that they just fill that space.

Show that the new capacitance c^1 is now given by $\frac{2k_1k_2}{(k_1+k_2)}$ c (5)

(c)

A charged ball is suspended using a thread and is gently lowered in a conducting container placed on an insulating stand as shown.

Explain the distribution of charge on the conductor when:

(i) The ball is well inside the container but still suspended. (2)

(ii) The ball touches the inner surface of the container. (2)

(d) A 20 F capacitor is charged to a p.d of 50v, it is then connected across terminals of a 10 F uncharged capacitor but having mica between it's plates. Given that the dielectric constant of mica is 2, calaculate.

(i) The final p.d across the combination. (2)

(ii) The difference in the initial and final energy stored in the capacitors. Comment on the difference. (5)

2(a)(i) What do you understand by the term capacitance of a capacitor? (1)

(ii) Using the atomic model, explain the effect of a dielectric on the capacitance of a capacitor. (5)

(b)(i) Derive an expression for the effective capacitance of three capacitors parallel.

(3)

(c) The figure above shows a net work of capacitors. Calculate the:

(i) Charge on the 2 F capacitor. (5)

(ii) Energy stored in the 3 F capacitor if the space between it's plates is filled with a material of dielectric constant 6. (4)

(d) Sketch the electric field pattern between two parallel plates that are oppositely charged. (2)

3(a) Differentiate between the terms electric potential and electric field intensity at a point in space. (4)

(b)(i) Derive an expression for the electric potential at a point r metres away from a charged particle Q. (5)

(ii)

Charges of -3×10^{-9}C, $^{+}4 \times 10^{-9}$ C and $^{+}3 \times 10^{-9}$C are placed in a vacuum at the vertices P, Q and R respectively of a rectangle as shown. Calculate the resultant electric field intensity at S. (6)

(c) With aid of a diagram describe how a large electric potential can be built up using a van der Graaf generator. (5)

4(a)(i) State coulomb's law of electrostatics. (1)

(ii) Two point charges A and B of magnitude -2×10^{-9}C and 1.6×10^{-9} C are placed 2cm apart as shown below.

Find the distance X at which another charge C of magnitude -1×10^{-9}C should be placed such that the net on it is zero. (4)

(b) Derive an expression showing the relation between electric field intensity and electric potential. (4)

(c) Two large horizontal parallel metal plates are 2cm apart in a vacuo and the upper is maintained at a positive potential so that the field strength between them is 2.5×10^{5} Vm^{-1}. If an electron is liberated from rest at the lower plate, what will be:

(i) It's speed on reaching the upper plate. (3)

(ii) The final momentum of the electron on hitting the upper plate. (1)

(d)(i) Explain why bodies get charged by rubbing. (3)

(ii) Using a diagram explain the term electrostatic shielding. (4)

5(a)(i) What is the centre of curvature of a convex mirror. (1)

(ii) With reference to a convex lens, explain the term spherical aberration. (3)

(b)(i) The deviation d by a prism of small angle A and refractive index n is $d = (n-1)A$. Use this to show that the focal length of a thin converging lens of refractive index n is given by $\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$ where r_1 and r_2 are the radii of curvature of the lens surfaces. (5)

(ii) Calculate the focal length of a converging meniscus with radii 25cm and 20cm whose index of refraction is 1.5. (2)

(c) An object is placed 30cm from a convex lens of focal length 10cm so that an image is formed on the screen. A concave lens is then placed half way between the first lens and the screen, it is then found necessary to shift the screen 4.5cm further away to obtain a clear image. Calculate the focal length of the concave lens. (5)

(d) A projector is needed to project slides which are 5cm square on to a screen that is 5m square.
If the focal length of the projection lens is 0.1m, what should be the distance between the screen and the slides. (4)

END