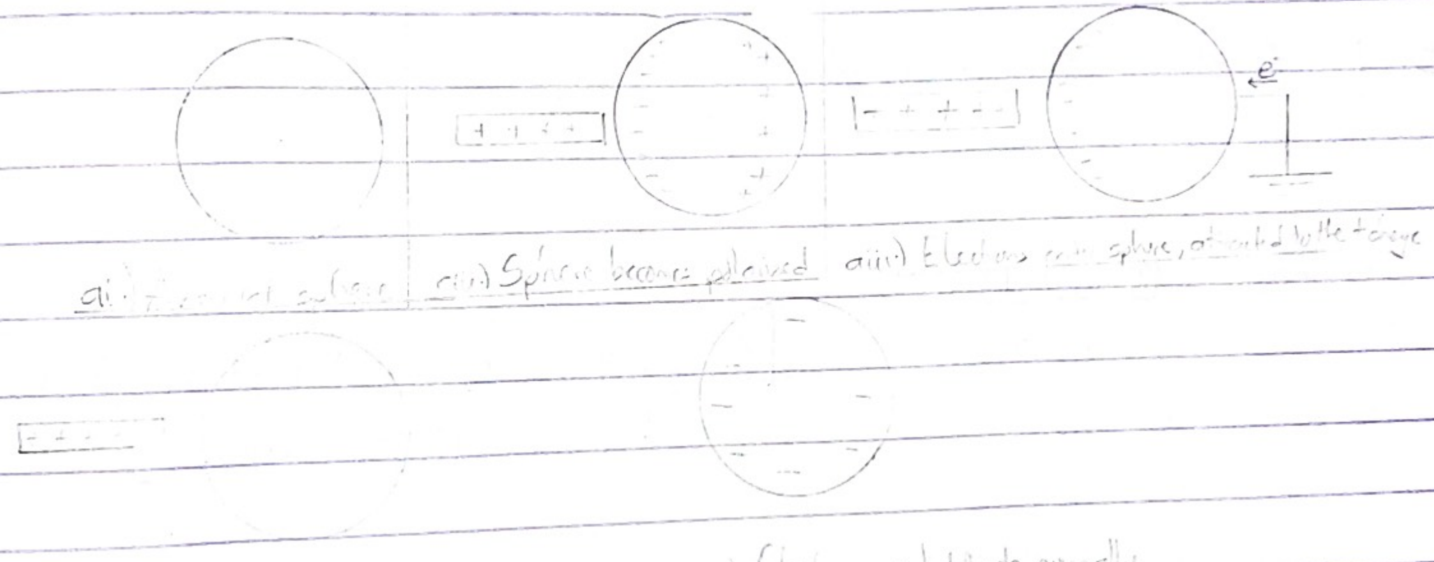
1.

a. A positively charged rod is brought near a neutral sphere which is insulated so there is no connection to ground. The electrons in the sphere migrate towards the side closest to the positively charged rod, so the region farthest from the rod has an excess of positive charge, the sphere is polarized.

When a grounded conducting wire is connected to the sphere, electrons enter the sphere, attracted to the +vely charged rod, and the +ve charges in the sphere. The wire is removed, leaving the sphere with an excess of negative charge. Finally, the rod is removed, the induced negative charge becoming uniformly distributed over the sphere.



ai) [illegible] aii) Sphere becomes polarized aiii) Electrons enter sphere, attracted to the + charge

aiv) Excess of -ve charge av) Electrons redistribute normally

b. Let the spheres be q_1 & q_2

$F_{12} = 1.0N$, $q_1 + q_2 = 5.0 \times 10^{-5} C$

$r = 2.0m$, $r^2 = 4m^2$

From Coulomb's Law; $F = \frac{kq_1q_2}{r^2}$

$$\frac{Fr^2}{k} = q_1q_2 = \frac{1 \times 4}{9 \times 10^9} = 4.44 \times 10^{-10} C^2$$

Taking ~~square root~~

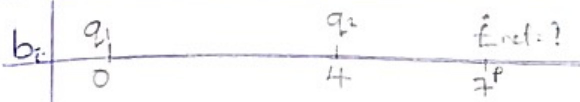
$kq = -1.03 \times 10^{5}$

$q = \dfrac{-1.03 \times 10^{5}}{9 \times 10^{9}} = -11 \times 10^{-6} C = -11 \mu C$

2.

a. An Electric Field is a region in space where an electric charge will experience an electric force, while Electric Field Intensity is the force per unit charge acting on a charged particle in an electric field.

b.i.



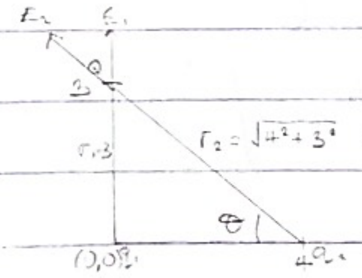
$q_1 = 8 \times 10^{-9} C$, $q_2 = 12 \times 10^{-9} C$, $r_1 = 7m$, $r_2 = 3m$

$E_1 = \dfrac{kq_1}{r_1^2} = \dfrac{9 \times 10^{9} \times 8 \times 10^{-9}}{7^2} = 1.47 N/C$

$E_2 = \dfrac{kq_2}{r_2^2} = \dfrac{(9 \times 10^{9})(12 \times 10^{-9})}{3^2} = 12 N/C$

$E_{net} = E_1 + E_2 = 13.47 N/C \approx 13.5 N/C$

ii. $E_1 = \dfrac{kq_1}{r_1^2} = \dfrac{(9 \times 10^{9})(8 \times 10^{-9})}{3^2} = 8 N/C$



$r_2 = \sqrt{4^2 + 3^2} = 5m$

$E_2 = \dfrac{kq_2}{r_2^2} = \dfrac{(9 \times 10^{9})(12 \times 10^{-9})}{5^2} = 4.32 N/C$

$\tan\theta = \dfrac{3}{4}$ $\theta = \tan^{-1}(0.75)$

$\theta = 37^\circ$

E	θ	x	y
E_1	90°	$+8\cos 90 = 0$	$+8\sin 90 = 8$
E_2	37°	$-4.32\cos 37 = -3.45$	$+4.32\sin 37 = 2.59$

$\Sigma E_x = -3.45$ $\Sigma E_y = 10.59$

$E_{net} = \sqrt{(-3.45)^2 + (10.59)^2} = \sqrt{124} = 11.14 N/C$

4.

a. Magnetic flux, Φ, is defined as the strength of magnetic field, represented by lines of force.

$$\Phi_B = \int \vec{B} \cdot d\vec{A} = BA\cos\theta$$

b. $m_e = 9.11 \times 10^{-31}$ kg

$B = 0.35$ weber/m²

$q = 1.60 \times 10^{-19}$ C

$\omega = ?$

$\therefore \omega$ (angular speed / cyclotron frequency) $= \dfrac{1.6 \times 10^{-19} \times 0.35}{9.11 \times 10^{-31}}$

$\omega = 6.15 \times 10^{10}$ rad/s

c. The electron oscillates at an angular frequency of 6.15×10^{10} rad/s.

6.

a. In an electric guitar, the coil [the pickup coil] is placed near the vibrating guitar string which is made up of a metal that can be magnetised. A permanent magnet inside the coil magnetises the portion of the string nearest the coil. When the string vibrates at some frequency, its magnetised segment produces a changing magnetic flux through the coil. The changing flux induces an emf in the coil that is fed to an amplifier. The output of the amplifier is sent to the loudspeaker, which produces the sound waves we hear.

b. $N = 300$ $A = (0.1)^2 = 0.01 m^2$ $|e| = ?$

$R = 2.0\Omega$ $\Delta\phi_B = 10T$ $\Delta t = 0.5s$

i. Induced emf $|e| = \frac{N\Delta\phi}{\Delta t} = \frac{300 \times 0.01 \times 10}{0.5} = 60V$

ii. Induced current $= \frac{|e|}{R} = \frac{60}{2} = 30A$

c. $A = 0.05 \times 0.08 = 4 \times 10^{-3} m^2$ $I = 0.1A$

$N = 75$ $R = 8\Omega$ $\Delta\phi_B = ?$ $\Delta t = ?$

$I = \frac{|e|}{R}$ $|e| = 8 \times 0.1A = 0.8V$

$|e| = \frac{N\Delta B}{\Delta t}$ $\therefore \frac{\Delta B}{\Delta t} = \frac{0.8}{75 \times 4 \times 10^{-3}} = 2.7 T/s$