# GCE A-LEVEL June 2006 Physics paper 2

## JUNE 2006

1.(a) $F = BIl\sin\theta$

One condition for an equation to be physically correct is that it should be homogeneous.

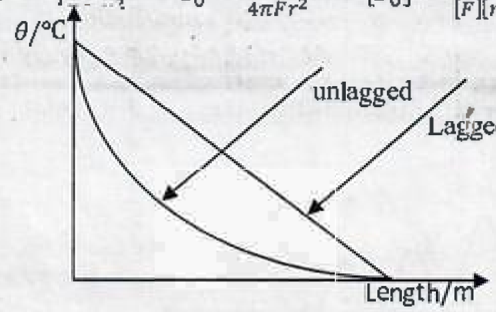
Units of LHS =units of force= $kgms^{-2}$

Units of right hand side= (units of B)x(units of I)x(units of l)=$kgA^{-1}s^{-2}$.A.m= $kgms^{-2}$

Since the base units on both sides of the equation are the same, it means the equation is homogeneous and may be physically correct.

(b) $F = \frac{Q^2}{4\pi\varepsilon_0 r^2} \Rightarrow \varepsilon_0 = \frac{Q^2}{4\pi F r^2} \Rightarrow [\varepsilon_0] = \frac{[Q]^2}{[F][r]^2} = \frac{A^2 s^2}{kgms^{-2}m^2} = kg^{-1}m^{-3}A^2s^4$

2.




3.(i) $E_{max} = hf - \phi \Rightarrow \phi = hf - E_{max} = \frac{hc}{\lambda} - E_{max} \Rightarrow \phi = \frac{6.63\times10^{-3}\times3.0\times10^{8}}{248\times10^{-9}} - 8.6 \times 10^{-20}J$

$\Rightarrow \phi = 7.2 \times 10^{-19} = \frac{7.2\times10^{-19}}{1.6\times10^{-19}} = 4.5$ eV

(ii) $\phi = hf_0 \Rightarrow f_0 = \frac{\phi}{h} = \frac{7.2\times10^{-19}}{6.63\times10^{-34}} = 1.09 \times 10^{15}$ Hz

4.See June 2002 Q10

5.(i) Let $s_s$ be the distance travelled by superman $s_b$ be the distance travelled by the baby.

Let superman take time t to catch the baby.

$\Rightarrow s_s = s_b \Rightarrow v_s t = \frac{1}{2}g(t+2)^2 \Rightarrow 39.2t = \frac{1}{2}(9.8)(t+2)^2 \Rightarrow 8t = t^2 + 4t + 4 \Rightarrow t^2 - 4t - 4 = 0$

$(t-2)^2 = 0 \Rightarrow t = 2s$ .Thus the time taken by superman to catch the child is t=2 s.

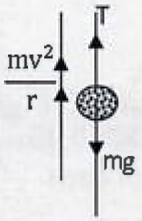
(ii) $s_s = v_s t = 39.2 \times 2 = 78.4$ m.

6.$C_P = 3\mu F + 1\mu F = 4\mu F$, $C_T = \frac{4\times4}{4+4} = 2\mu F$

(i) $Q = CV = 2 \times 10^{-6} \times 12 = 24\ \mu C$. Thus the charge on the 4 $\mu F$ is 24 $\mu C$

(ii) If $S_1$ is opened and $S_2$, the capacitors will discharge through the resistance, R, and the initial maximum current that will flow is $I_0 = \frac{V}{R} = \frac{12}{\ } = 2.4\ A$

7.




$$T - mg = \frac{mv^2}{r} \Rightarrow T = m\left(g + \frac{v^2}{r}\right)$$

$$\Rightarrow T = 45\left(9.8 + \frac{3^2}{7.5}\right) = 495\ N$$

8.(a) A uniform magnetic field can be produced in the laboratory by

**Using a solenoid.** This is achieved by passing a steady d.c through a long coil and a uniform magnetic field is created at the centre.

**Using Helmholtz coils.** To do this, the same d.c is passed through two Helmholtz coils connected in series and a uniform magnetic field is produced between them.

(b) As the electron enters the field, magnetic force= centripetal force

$\Rightarrow Be\vartheta = \frac{m\vartheta^2}{r} \Rightarrow \vartheta = Br\left(\frac{e}{m}\right)$ ................................(1)

Electrical energy lost = gained in kinetic energy

$\Rightarrow eV = \frac{1}{2}m\vartheta^2 \Rightarrow eV = \frac{1}{2}m\left(\frac{Ber}{m}\right)^2 \Rightarrow \frac{e}{m} = \frac{2V}{B^2r^2}$ as requred to demonstrate.

(c) Consult your textbooks

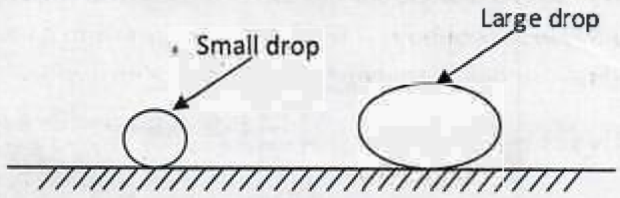
(d) (i) $eV = \frac{1}{2}m\vartheta^2 \Rightarrow \vartheta = \sqrt{\frac{2eV}{m}} = \sqrt{2 \times 1.76 \times 10^{11} \times 1400} = 1.2 \times 10^5 ms^{-1}$

(ii) For no deflection, magnetic force equal electric force

$\Rightarrow Be\vartheta = eE \Rightarrow E = B\vartheta = 0.4 \times 1.2 \times 10^5 = 4.8 \times 10^4 NC^{-1}$

(e) Surface tension is the force per unit length acting normally to one side of an imaginary line drawn in the surface of the liquid.

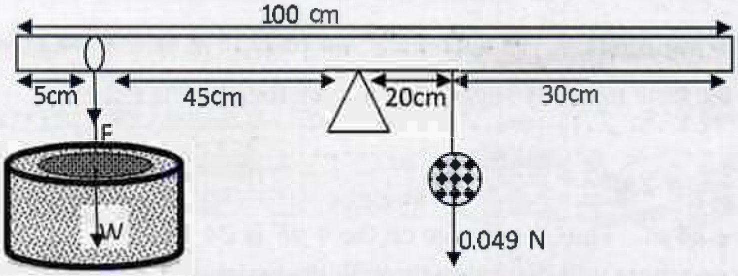
(f)




The small mercury drop is spherical because the surface tension force is greater than the weight of the drop but the large one tend to flatten because the weight of the drop is greater than the the surface tension force

**N.B $\gamma \propto A$ and weight $\propto$ volume**

(g)




When the ring is balanced by the 5 g mass, its weight w is given by

$W(0.45) = (0.049)(0.1) \Longrightarrow W = 0.0109$ N

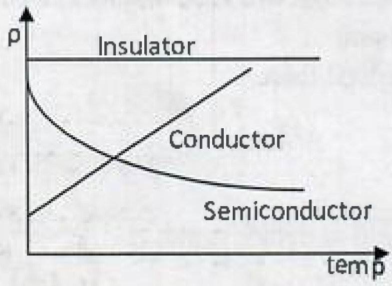
When the beaker is placed and the 5 g mass moves to the 70 cm mark,

By the principle of moment $(w + F)(0.45) = (0.049)(0.2) \Longrightarrow W + F = 0.0218\ N$

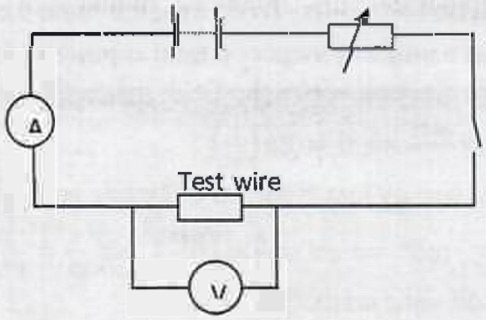
$\Longrightarrow F = 0.0218\ N - 0.0109\ N = 0.0109\ N$, but $\gamma = \frac{F}{2\pi r} = \frac{0.0109}{2\pi \times 0.01} = 0.18\ N$

9.(a) (i)The resistivity of a material is the resistance per unit length of a material of unit cross.

(ii)




b(i)



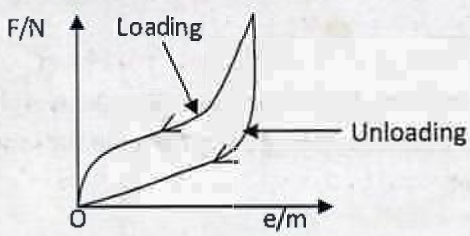

(ii)From $V = IR \Rightarrow slope = \frac{\Delta V}{\Delta I} = R \Rightarrow R = \frac{6.4-2.0}{1.00-0.32} = \frac{4.4}{0.68} = 6.47\ \Omega$

$\Longrightarrow \rho = \frac{RA}{l} = \frac{\pi d^2 R}{4l} = \frac{\pi \times (5\times10^{-3})^2 \times 6.47}{4\times80\times10^{-2}} = 1.6 \times 10^{-4}\ \Omega m$

c) $W = IVt = 60 \times 12 \times 60 \times 60 = 2.59 \times 10^6\ J$

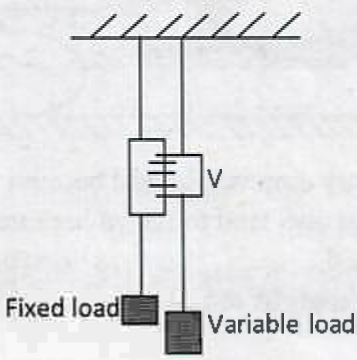
d) (i) A material is elastic if it has the ability to regain its original length after the removal of a deforming force.

(ii)




Energy dissipated equal area of the loop

(e) (i)



(ii) $E = \frac{F/A}{e/l} \Rightarrow F = \left(\frac{AE}{l}\right) e \Rightarrow slope = \frac{AE}{l} \Rightarrow E = \frac{l \times slope}{A}$. From the graph,

$$slope = \frac{(6-0)10^3}{2.8-0} = 2.143 \times 10^3 Nm^{-1} \Rightarrow E = \frac{0.8 \times 2.143 \times 10^3}{\pi(7.5 \times 10^{-3})^2} = 9.7 \times 10^7 Pa$$

(iii) W area under graph, $W = \frac{1}{2} \times 6.6 \times 1000 \times 3 = 9900\ N$

(f) $F = mg = (450 + 750) \times 9.8 = 11760\ N$

$stress = \frac{F}{A} \Rightarrow A = \frac{Force}{stress} = \frac{11760}{4.0 \times 10^8} = 2.94 \times 10^{-5} m^2$.

But $A = \pi r^2 \Rightarrow r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{2.94 \times 10^{-5}}{\pi}} = 3.06\ mm$

10. (a) (i), (ii) See June 2002 Q10

(b)(i)

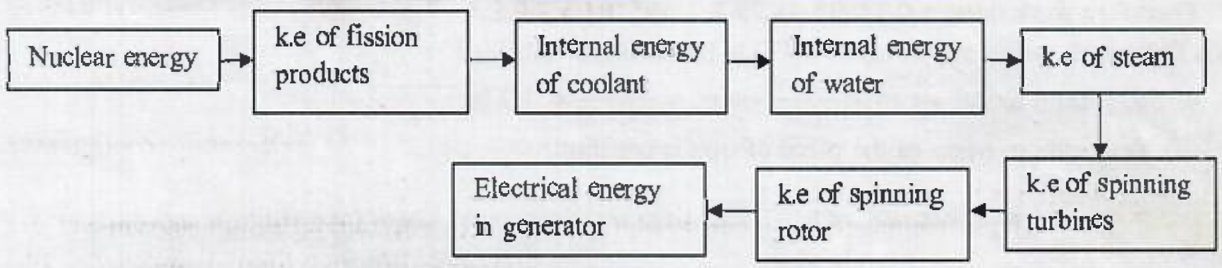
(ii) The presence of different types of elements could be identified by comparing their spectra with those of known element until they correspond

(iii) Energy difference, $\Delta E = E_1 - E_2 = \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right) hc$

$\Rightarrow \Delta E = \left(\frac{1}{589.0 \times 10^{-9}} - \frac{1}{589.6 \times 10^{-9}}\right)(6.67 \times 10^{-34})(3.0 \times 10^8) = 3.46 \times 10^{22} J$

(c) (i) Nuclear fission is the splitting of a larger nuclei into smaller ones accompanied with the release of energy.

A controlled chain reaction is a reaction in which the product one reaction initiates a further reaction, giving rise to more products which in turn cause further reactions.




(d) See June 2003 Q10

(e) (i) Temperature increases, the more electrons leave the valence band and enter the conduction band and conductivity of the intrinsic semiconductor increases.

(ii) The depletion layer in a pn junction is fairly free from majority charge carriers. The width of the depletion layer is smaller than that of the p – and n – type regions.

(f)(i) When temperature rises, the resistance of the thermistor decreases, leading to a drop in the input p.d, which is unable to turn on a large collector current. As a result, the alarm does not ring. When temperature falls, the resistance of the thermistor increases, leading to an increase in the input voltage, resulting in a large collector current, which enables the alarm to ring.

N.B: if the alarm is to ring when temperature rises, then the thermistor should be placed in position R.

(ii) In the dark, the resistance of the LDR increases. The input or base voltage increases, leading to an increase in the collector current, which causes the alarm to ring. As daylight comes, the resistance of the LDR falls, and the input voltage also drops, resulting in a fall in the collector current and the alarm goes off.