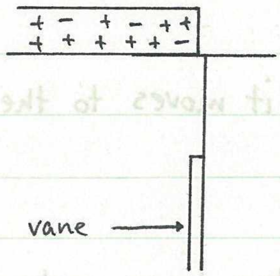
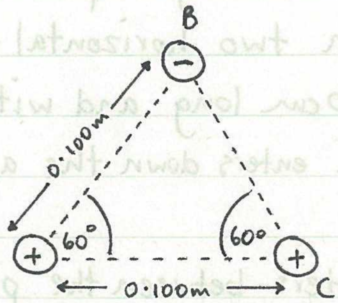
# YEAR 12 PHYSICS
## SEMESTER 2 TEST 1

CONSTANTS: Charge on an electron $\doteqdot -1.60 \times 10^{-19}$ C.
Mass of electron $\doteqdot 9.11 \times 10^{-31}$ kg
Permittivity of free space $(\varepsilon_0) = 8.85 \times 10^{-12}\ C^2 N^{-1} m^{-2}$
Mass of proton $\doteqdot 1.67 \times 10^{-27}$ kg.

1. A charged rod is placed in contact with a neutral electroscope as shown.




Draw a diagram of the electroscope to show what happens to the charge distribution on it. Explain why the vane rises and what the overall charge on the electroscope will be. (3)

2. 


Each of the charges at left have the same magnitude, namely $4.60\,\mu C$. Calculate the force experienced by charge C due to the presence of the other two charges. (4)

3. Two small spheres, each of mass 5·00g, are each supported from the same point by a light insulating thread $5.00 \times 10^2$ mm long. When they are given equal charges, they repel each other so that the distance between them is $8.00 \times 10^1$ mm. Find the charge on each. (5)

4. Draw the electric field that exists between and around the following:
   (a) two oppositely charged point charges.
   (b) a negative point charge and a positive plate. (2)

5. Two small spheres, carrying charges of +Q and +4Q, are 12·0cm apart in a vacuum. At what distance from the charge of +4Q will the nett electric field be zero? (3)

P.T.O.

6. A small plastic sphere of mass $2.90 \times 10^{-8}$ g, when introduced midway between two parallel plates 4.91 mm apart with a potential difference of 285 V across them, is found to "float". Calculate the magnitude of the charge on the sphere (4)

7. An electron is stationary between two parallel plates 6.00 cm apart. If the potential difference between the plates is $4.50 \times 10^{2}$ V and the electron is 1.00 cm away from the negative plate, calculate:

(a) the force on the electron.

(b) the kinetic energy gained by the electron as it moves to the positive plate. (4)

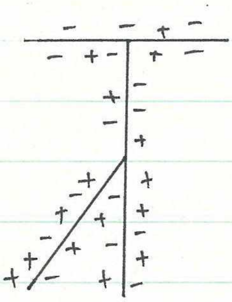
8. A proton is accelerated from rest in a particle accelerator by a potential of $2.50 \times 10^{3}$ V. It then enters the region between two horizontal and parallel plates which are 4.00 cm apart, 5.00 cm long and with a potential of $5.00 \times 10^{2}$ V across them. If the proton enters down the axis between the plates, calculate:

(a) the horizontal velocity of the proton as it enters between the plates.

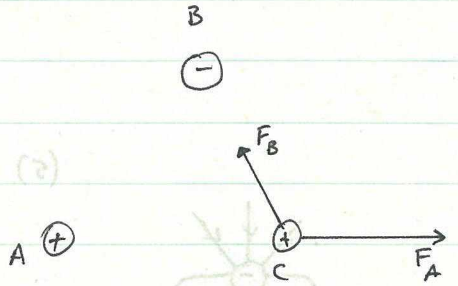
(b) the vertical displacement of the proton caused by the electric field as a result of travelling between the plates. (6)

TOTAL: 31

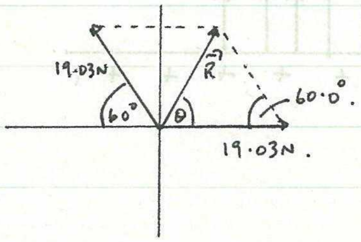
# YEAR 12 PHYSICS
## SEMESTER 2 TEST 1

1. 

Electrons are removed from the top of the electroscope to the positive rod. The overall charge is positive on the electroscope with the electrons at the top while the rod is in contact. The vane rises due to the repulsion of the positive charges. When the rod is removed, the vane drops slightly as the electrons at the top redistribute themselves over the electroscope and negate the repulsive force between the vane and centre post slightly. (3)

2. 

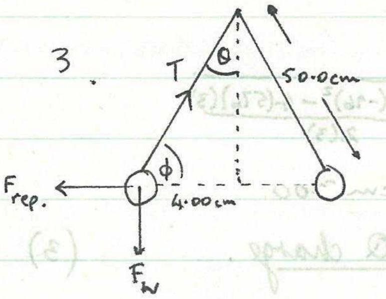

$$F_A = F_B = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{d^2}$$
$$= \frac{1}{4\pi(8.85\times10^{-12})} \cdot \frac{(4.60\times10^{-6})^2}{(0.100)^2}$$
$$= 19.03\,N.$$




$$\vec{R} = \sqrt{(19.03)^2 + (19.03)^2 - 2(19.03)^2\cos 60.0^\circ}$$
$$= \sqrt{362.14}$$
$$= 19.03\,N.$$

$$\frac{19.03}{\sin\theta} = \frac{19.03}{\sin 60^\circ}$$
$$\Rightarrow \theta = 60.0^\circ.$$

$\therefore$ force on C is 19.0N at 60.0° to BC. (4)

3. 


$$\sin\theta = \frac{4.00}{50.0}$$
$$\Rightarrow \theta = 4.589^\circ.$$

$$\Sigma F_V = 0$$
$$\Rightarrow T\cos\theta = F_W = mg.$$
$$\Rightarrow T\cos 4.589^\circ = (5.00\times10^{-3})(9.80)$$
$$\Rightarrow T = 4.916\times10^{-2}\,N.$$

$\Sigma F_h = 0.$

$\Rightarrow T\cos\phi = F_{rep.}$

$\Rightarrow F_{rep} = (4.916\times10^{-2})(\cos 85.411^\circ)$

$= 3.933\times10^{-3}\ N.$

$F_{rep} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{d^2}$

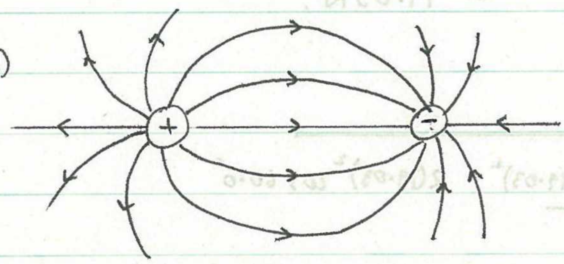
$\Rightarrow 3.933\times10^{-3} = \frac{1}{4\pi(8.85\times10^{-12})}\cdot\frac{q^2}{(8.00\times10^{-2})^2}$

$\Rightarrow q = \sqrt{2.799\times10^{-15}}$

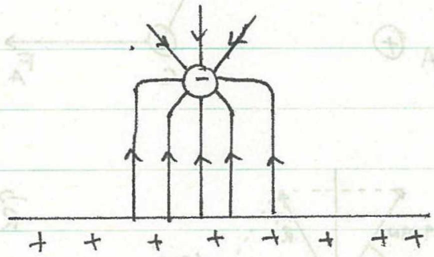
$= 5.291\times10^{-8}\ C.$

$\therefore$ charge on each sphere is $5.29\times10^{-8}$ C. (5)

4. (a)

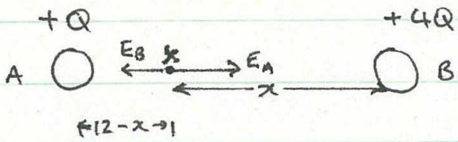


(b)



(2)

5.



At point X: $E_A = E_B$

i.e. $\frac{1}{4\cancel{\pi}\varepsilon_0}\cdot\frac{4Q}{x^2} = \frac{1}{4\cancel{\pi}\varepsilon_0}\cdot\frac{Q}{(12-x)^2}$

$\Rightarrow 4(12-x)^2 = x^2$

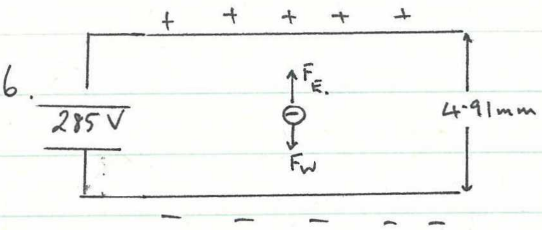
$576 - 96x + 3x^2 = 0$

$\Rightarrow x = \frac{96 \pm \sqrt{(-96)^2 - 4(576)(3)}}{2(3)}$

$\Rightarrow x = 24.0$ or $8.00$

$\therefore$ point x is 0.0800m from +4Q charge. (3)

6.




$$\Sigma F = 0$$

$$\Rightarrow F_E = F_W$$

$$\text{ie. } Eq = mg$$

$$\Rightarrow \frac{Vq}{d} = mg$$

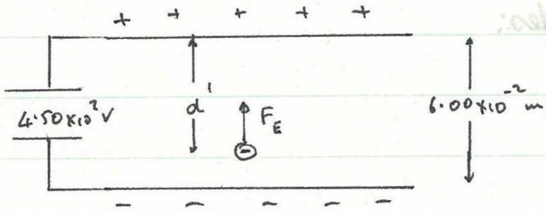
$$\Rightarrow q = \frac{mgd}{V}$$

$$= \frac{(2.90\times10^{-11})(9.80)(4.91\times10^{-3})}{285}$$

$$= 4.896\times10^{-15}\ \text{C}.$$

∴ <u>charge on the sphere is $4.90\times10^{-15}$ C</u>. (4)

7.




(a)

$$F = Eq.$$

$$= \frac{Vq}{d}$$

$$= \frac{(4.50\times10^{2})(1.60\times10^{-19})}{6.00\times10^{-2}}$$

$$= 1.20\times10^{-15}\ \text{N}.$$ (2)

∴ <u>force on the electron is $1.20\times10^{-15}$ N towards +ve plate</u>.

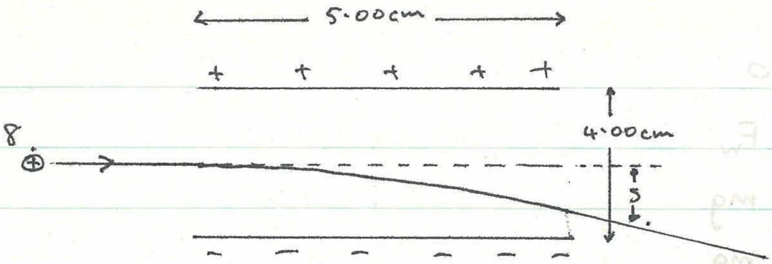
(b)

$$W = \Delta E_K = Fd'$$

$$= (1.20\times10^{-15})(5.00\times10^{-2})$$

$$= 6.00\times10^{-17}\ \text{J}.$$

∴ $E_K$ gained is $6.00\times10^{-17}$ J. (2).




(a) . $W = Vq = \frac{1}{2}mv^2$

$\Rightarrow \quad v = \sqrt{\frac{2Vq}{m}}$

$= \sqrt{\frac{2(2\cdot50\times10^{3})(1\cdot60\times10^{-19})}{1\cdot67\times10^{-27}}}$

$= 6\cdot921\times10^{5}\ ms^{-1}$

∴ horizontal velocity is $6\cdot92\times10^{5}\ ms^{-1}$. (2)

(b). To calculate the time spent between the plates:

$v_h = \frac{s}{t}$

$\Rightarrow t = \frac{s}{v_h}$

$= \frac{5\cdot00\times10^{-2}}{6\cdot921\times10^{5}}$

$= 7\cdot224\times10^{-8}\ s$.

To calculate the acceleration due to the electric field:

$F = Eq = ma$

$\Rightarrow \frac{Vq}{d} = ma$

$\Rightarrow a = \frac{Vq}{md}$

$= \frac{(5\cdot00\times10^{2})(1\cdot60\times10^{-19})}{(1\cdot67\times10^{-27})(4\cdot00\times10^{-2})}$

$= 1\cdot198\times10^{12}\ ms^{-2}$.

$v = ?$

$u = 0\cdot0\ ms^{-1}$

$a = 1\cdot198\times10^{12}\ ms^{-2}$

$t = 7\cdot224\times10^{-8}\ s$

$s = ?$

$s = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}(1\cdot198\times10^{12})(7\cdot224\times10^{-8})^2$

$= 3\cdot126\times10^{-3}\ m$.

(4)

∴ vertical displacement is $3\cdot13\times10^{-3}$ m towards the -ve plate.

TOTAL: $\overline{31}$.

# YEAR 12 PHYSICS

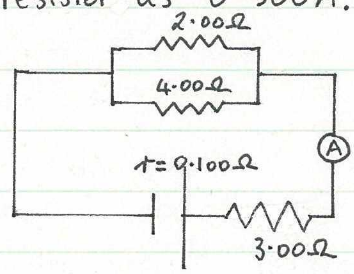
## SEMESTER 2 TEST 2

CONSTANTS: Specific heat of water = $4.18 \times 10^{3}$ J kg$^{-1}$ °C$^{-1}$.

1. Distinguish between the electromotive force of a source of electrical energy and the potential difference of a source (consider this in terms of energy). (1)

2. There are several major sources of EMF for use in electrical circuits. List THREE of them and briefly explain how electrical energy is produced by each method. (3)

3. The following circuit was set up and the current measured in the 3.00Ω resistor as 0.300 A.




(a) Calculate the potential difference that appears across the terminals of the cell.

(b) What is the cell EMF? (3)

4. An electric heater is marked "240 V, 2.4 kW".
   (a) When in normal use, what is the current in its heating element?
   (b) How much electrical energy does it transform to heat energy in a 2.00 hr period if it is 75.0% efficient? (4)

5. A well-insulated calorimeter contains 0.200 kg of water at 15.0°C. A heating coil is placed in the water and connected to a power source. The water temperature rises to 25.0°C in 7.00 min while a current of 2.50 A flows. Assuming the heat lost to the calorimeter and surroundings is negligible, calculate:
   (a) the amount of electrical energy converted into heat energy.
   (b) the power developed in the heating coil
   (c) the potential difference across the heating coil. (4)

6. Explain carefully (a diagram may be helpful) why a particular electron may "drift" relatively slowly along a conductor yet when a light switch is turned on the effect of the electrons is virtually instantaneous. (2).

TOTAL: 17

W-95

Year 12 Physics

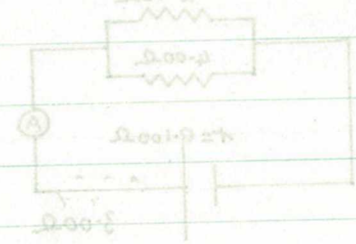
Semester 2 Test 2

Constants: Specific heat of water = $4.18 \times 10^3\ J\ kg^{-1}\ °C^{-1}$

1. Distinguish between the electromotive force of a source of electrical energy and the potential energy use of a source (consider this in energy of energy). (1)

2. There are several major sources of EMF for use in electrical circuits. List THREE of them and briefly explain how electrical energy is produced by each method. (3)

3. The following circuit was set up and the current measured in the 3.00 Ω resistor as 0.300 A.




(a) Calculate the potential difference that appears across the terminals of the cell.
(b) What is the cell EMF? (4)

4. An electric heater is marked "240V, 2.4KW".
(a) When in normal use, what is the current heating/heating element?
(b) How much electrical energy is it transform to heat energy in a 2.00 hr period if it is 75.0% efficient? (4)

5. A well-insulated calorimeter contains 0.200 kg of water at 15.0°C. A heating coil is placed in the water and connected to a power source. The water temperature rises to 25.0°C in 7.00 min while a current of 2.50 A flows. Assuming the heat lost to the calorimeter and surroundings is negligible, calculate:
(a) the amount of electrical energy converted into heat energy.
(b) the power developed in the heating coil
(c) the potential difference across the heating coil. (4)

6. Explain carefully (a diagram may be helpful) why a particular electron may "drift" relatively slowly along a conductor yet when a light switch is turned on the effect of the electrons is virtually instantaneous. (2)

TOTAL: 17

YEAR 12 PHYSICS

SEMESTER 2 TEST 2.

1. EMF: energy supplied per unit charge in a circuit

POTENTIAL DIFFERENCE: energy released per unit charge in a circuit. (1)

2. ELECTROMAGNETIC: coil of wire rotated in a magnetic field, electrons in the wire experience a force.

CHEMICAL: oxidation-reduction reactions transfer electrons from one chemical to another in cells.

PHOTOELECTRIC EFFECT: electrons are emitted from certain metals when light of sufficiently high frequency is shone on them.

PIEZOELECTRIC EFFECT: when certain crystals are stressed, one side of the crystal becomes charged, and sets up a potential difference.

THERMOELECTRIC EFFECT: wire of different metals can be placed as junctions in different extreme temperatures (heat and cold) to move electrons (3)

3. For the parallel component:

$$\frac{1}{R_x} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{2.00} + \frac{1}{4.00}$$
$$= \frac{2+1}{4.00}$$
$$\Rightarrow R_x = 1.333\ \Omega.$$

$$\therefore R_T = R_x + R_{3\Omega}$$
$$= 1.333 + 3.00$$
$$= 4.333\ \Omega.$$

Since the current is 0.300 A:

$$V = IR_T$$
$$= (0.300)(4.333)$$
$$= 1.300\ V$$

$\therefore$ potential across the terminals is 1.30 V.

(b) $$\text{EMF} = V + Ir$$
$$= 1{\cdot}30 + (0{\cdot}300)(0{\cdot}100)$$
$$= 1{\cdot}33\text{ V}$$

$\therefore$ EMF = 1·33 V (3)

4. (a) $$P = VI$$
$$\Rightarrow I = \frac{P}{V}$$
$$= \frac{2{\cdot}4\times10^3}{240}$$
$$= 10{\cdot}0\text{ A.}$$

$\therefore$ current flowing is $1{\cdot}0\times10^1$ A.

(b) $$W = VIt$$
$$= (240)(1{\cdot}0\times10^1)(2{\cdot}00\times3{\cdot}60\times10^3)$$
$$= 1{\cdot}728\times10^7\text{ J}$$

Since it is only 75·0% efficient:
$$W = 0{\cdot}75\times1{\cdot}728\times10^7$$
$$= 1{\cdot}296\times10^7\text{ J.}$$

$\therefore$ amount of heat energy produced is $1{\cdot}3\times10^7$ J. (4)

5. (a) $$Q = m_w c_w \Delta T$$
$$= (0{\cdot}200)(4{\cdot}18\times10^3)(10{\cdot}0)$$
$$= 8{\cdot}360\times10^3\text{ J}$$

$\therefore$ amount of electrical energy used is $8{\cdot}36\times10^3$ J.

(b) $$P = \frac{W}{t} = \frac{Q}{t}$$
$$= \frac{8{\cdot}36\times10^3}{(7{\cdot}00\times60{\cdot}0)}$$
$$= 19{\cdot}90\text{ W.}$$

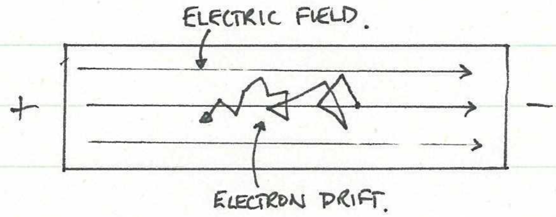
$\therefore$ power developed = 19·9 W.

(c)

$$P = VI$$
$$\Rightarrow V = \frac{P}{I}$$
$$= \frac{19.90}{2.50}$$
$$= 7.96\,V.$$

$\therefore$ potential difference across coil is 7.96V. (4)

6.




Electrons in the "sea" that exist between metal ions move from one ion to the next. Hence their movement is determined by the +ve ions nearby and is slow. (relatively)

When a potential difference is placed across the ends of a conductor, one electron will enter the conductor at the −ve end. As this happens, one electron will leave at the +ve end to maintain the electrical neutrality of the conductor. This process appears almost instantaneous. The actual electron that has entered at the −ve end will move from metal ion to metal ion and drift slowly down the conductor. (2)

TOTAL: 17

# YEAR 12 PHYSICS

## SEMESTER 2 TEST 3.

CONSTANTS: Permeability of free space ($\mu_o$) = $4\pi \times 10^{-7}$ $NA^{-2}$. mass ($e^-$) = $9.11 \times 10^{-31}$ kg

Permittivity of free space ($\varepsilon_o$) = $8.85 \times 10^{-12}$ $Fm^{-1}$. mass (proton) = $1.67 \times 10^{-27}$ kg.

Charge ($e^-$) = $1.60 \times 10^{-19}$ C.

1. Three vertical wires A, B, C are arranged so that when viewed from above they form an equilateral triangle of side 20.0 cm. A current of 2.00A flows down wires A and C, while B carries a 3.00A current upwards. Calculate the resultant force on wire A. (4)

2. A rectangular coil of dimension 20.0 cm x 10.0 cm is in a magnetic field of $4.00 \times 10^{-1}$ T. If the field is parallel to the shorter side, calculate the torque that is tending to turn the coil, given the current flowing is 2.00A. (4)

3. A charged particle enters a uniform magnetic field of $4.50 \times 10^{-4}$ T directed vertically upward, and moves in a horizontal circle of radius 0.633 m in a clockwise direction. Calculate:
   (a) the speed of the particle
   (b) the period of its revolution. (5)

4. A stream of protons move undeflected through a region where an electric field of $4.50 \times 10^{-1}$ $Vm^{-1}$ and a magnetic field of $1.17 \times 10^{-6}$ T exist together. Given the electric field is produced by parallel plates:
   (a) draw a diagram to show the orientation of the two fields and the stream of protons.
   (b). calculate the velocity of the protons. (3)

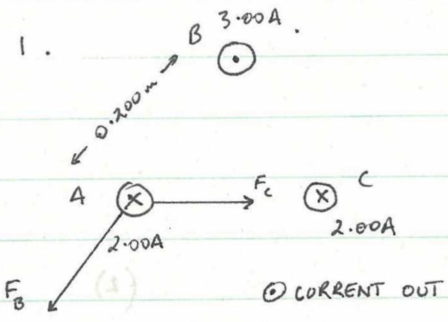
5. A small rectangular coil 3.00 cm x 1.00 cm consists of $5.00 \times 10^{2}$ turns and is suspended in a uniform magnetic field of 0.400T. If the plane of the coil makes an angle of 30.0° to the field, and the long side is at right angles to the field, find the force exerted to turn the coil when 12.0 μA flows in it. (3)

TOTAL: 19

YEAR 12 PHYSICS

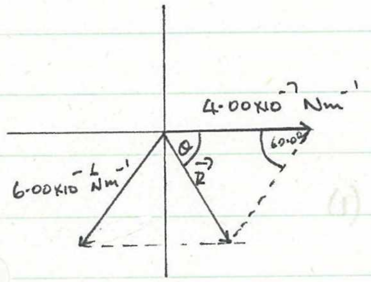
SEMESTER 2 TEST 3

1.




$$\frac{F}{\ell}_B = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d} = \frac{4\pi\times10^{-7}}{2\pi}\cdot\frac{(2.00)(3.00)}{0.200} = 6.00\times10^{-6}\ \mathrm{Nm^{-1}}.$$

$$\frac{F}{\ell}_C = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d} = \frac{4\pi\times10^{-7}}{2\pi}\cdot\frac{(2.00)^2}{(0.200)} = 4.00\times10^{-6}\ \mathrm{Nm^{-1}}.$$




$$\vec{R} = \sqrt{(4.00\times10^{-6})^2 + (6.00\times10^{-6})^2 - 2(4.00\times10^{-6})(6.00\times10^{-6})\cos 60.0^\circ}$$

$$= \sqrt{2.80\times10^{-11}}$$

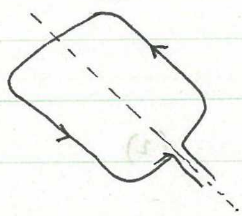
$$= 5.292\times10^{-6}\ \mathrm{Nm^{-1}}.$$

To find $\theta$: $\frac{6.00\times10^{-6}}{\sin\theta} = \frac{5.292\times10^{-6}}{\sin 60^\circ}$

$\Rightarrow \theta = 79.08^\circ$

$\therefore$ resultant force is $5.29\times10^{-6}$ Nm$^{-1}$ of length at $79.1^\circ$ to $\overline{AC}$. (4)

2.



Force on each side: $F = I\ell B$

$= (2.00)(0.200)(4.00\times10^{-1})$

$= 0.160\mathrm{N}.$

Since there is a couple formed (two forces acting in the same direction):

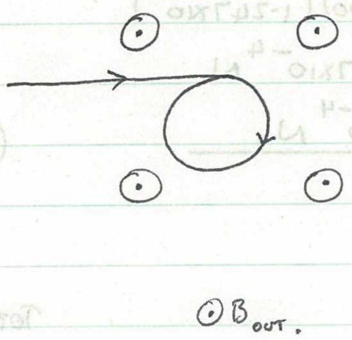
$M = 2(F\times d)$

$= 2(0.160)(0.0500)$

$= 1.60\times10^{-2}$ Nm.

$\therefore$ torque acting is $1.60\times10^{-2}$ Nm. (4)

3.




Particle is a proton. (1)

(a) $r = \frac{mv}{qB}$

$\Rightarrow v = \frac{rqB}{m}$

$= \frac{(0.633)(1.60\times10^{-19})(4.50\times10^{-4})}{1.67\times10^{-27}}$

$= 2.729\times10^{4}$ ms$^{-1}$

$\therefore$ speed of the particle is $2.73\times10^{4}$ ms$^{-1}$. (2)

(b) $v = \frac{2\pi r}{T}$

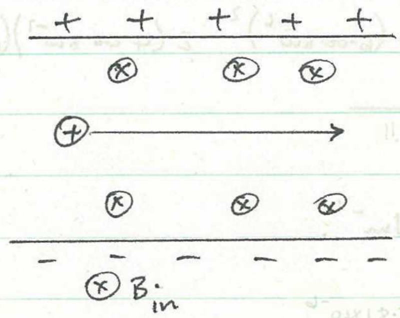
$\Rightarrow T = \frac{2\pi r}{v}$

$= \frac{2\pi(0.633)}{2.729\times10^{4}}$

$= 1.457\times10^{-4}$ s

$\therefore$ period of revolution is $1.46\times10^{-4}$ s. (2)

4. (a).




(1)

(b). $F_E = F_B$

$\Rightarrow Eq = qvB$

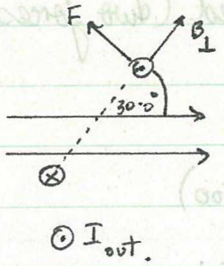
$\Rightarrow v = \frac{E}{B}$

$= \frac{4.50\times10^{-1}}{1.17\times10^{-6}}$

$= 3.8246\times10^{5}$ ms$^{-1}$

$\therefore$ velocity of the protons is $3.85\times10^{5}$ ms$^{-1}$. (2)

5.




Force on one side: (1 wire only).

$F = I\ell B\cos 30.0°$

$= (12.0\times10^{-6})(3.00\times10^{-2})(0.400\cos 30.0°)$

$= 1.247\times10^{-7}$ N. (1)

Since there are $5.00\times10^{2}$ coils, and there are two forces acting in the same direction:

$F_{ACTING} = 2(500)(1.247\times10^{-7})$

$= 1.247\times10^{-4}$ N

$\therefore$ total force acting is $1.25\times10^{-4}$ N. (2)

TOTAL: 19

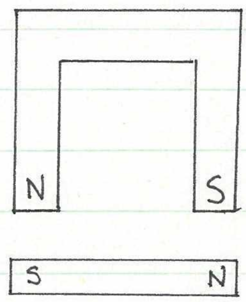
# YEAR 12 PHYSICS

## SEMESTER 2 TEST 4.

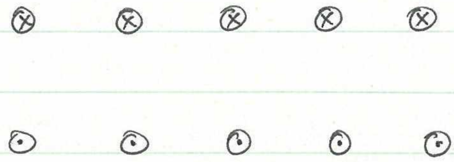
1. Substances can be categorized according to their magnetic properties. List the characteristics of these groups and give an example of each. (3)

2. Copy the following diagrams and draw in the magnetic field lines

(a).




(b)



⊗ I in. (4)

3. (a) Draw the magnetic field associated with the earth.

(b). Define: (i) angle of declination

(ii) angle of dip. (3)

4. Explain, using a diagram if necessary, how a simple D.C. generator works. (3)

5. An F111C fighter-bomber has wings of span 21.0 m when swept back. It is flying horizontally in an area where the earth's magnetic field is $4.90 \times 10^{-6}$ T at $55.0^{\circ}$ angle of dip. If it performs a perfect loop (no loss of speed occurs), and its initial direction of movement horizontally is due north at $1.20 \times 10^{2}\ ms^{-1}$, calculate the induced EMF in the wings when the plane is:

(a) $\frac{1}{4}$ of the way through the loop.

(b) $\frac{1}{2}$ way through the loop. (3)

6. Graph the change in EMF with time for the plane in question 5 (No scale needs to be used on the time axis). (3)

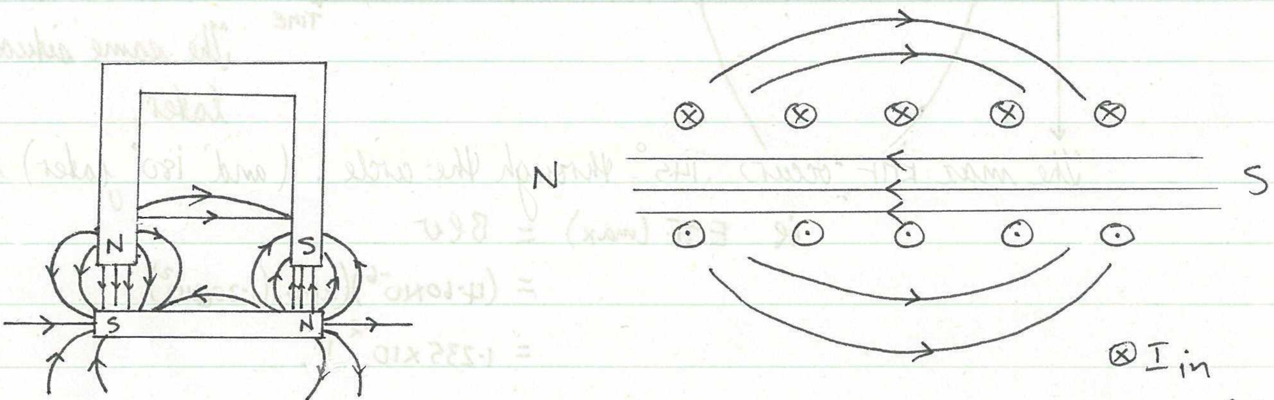
7. Define Lenz's Law. (1)

8. A coil of wire of $1.00 \times 10^{2}$ turns and dimensions 10.0 cm x 4.00 cm lies with its plane parallel to a 2.00 T magnetic field. Calculate the induced EMF if the coil rotates $\frac{3}{4}$ of a turn in 0.0900 s. (3)

# YEAR 12 PHYSICS
## SEMESTER 2 TEST 4

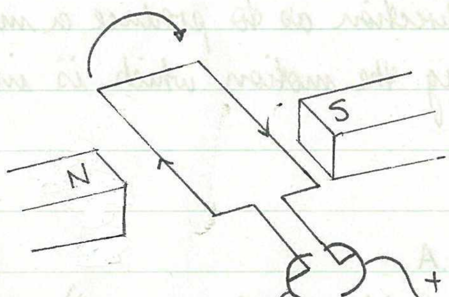
1. FERROMAGNETIC - strongly attracted e.g. Fe, Ni, Co.
   PARAMAGNETIC - weakly attracted e.g. Mn, Al, Pt, $O_{2}(l)$
   DIAMAGNETIC - weakly repelled e.g. Cu, Au, Bi. (3)

2. (a)



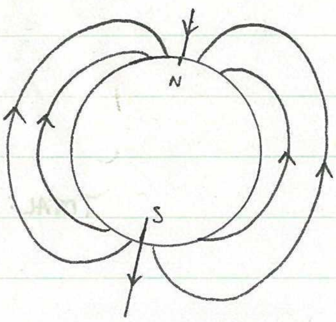

(4)

4.



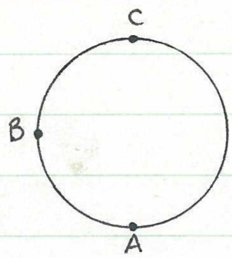

when the coil is turned clockwise, the induced EMF is set up as shown. In order to keep the current "in the same direction" a split-ring commutator is used. The EMF established is in a direction that causes a force that opposes the force turning the coil. (3)

3. (a)




(b) (i) ANGLE OF DECLINATION - angle between true north and magnetic north.
(ii) ANGLE OF DIP - angle to the horizontal of the earth's magnetic field at a point. (3)

5. (a)




At B: $\text{EMF} = B l v$

$= (4.90\times10^{-6} \cos 55.0^\circ)(21.0)(1.20\times10^{2})$

$= 7.083\times10^{-3}$ V.

$\therefore$ induced EMF $= 7.08\times10^{-3}$ V.

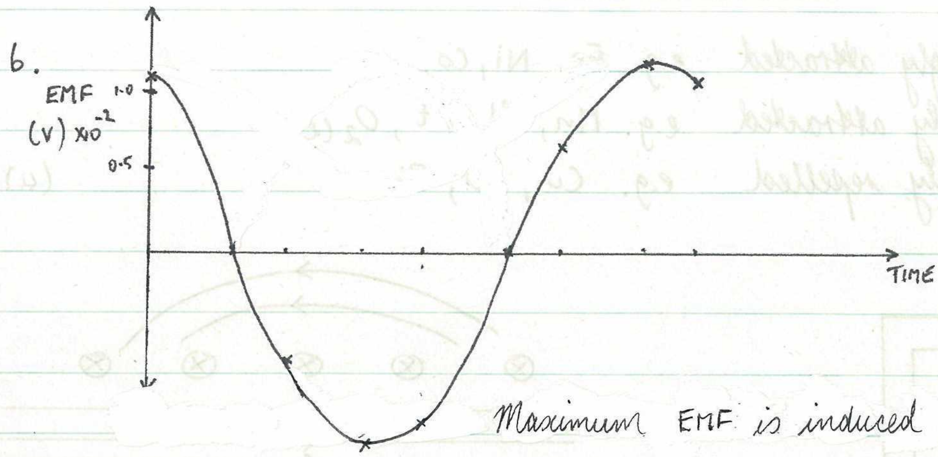
(b) At C: $\text{EMF} = B l v$

$= (4.90\times10^{-6} \cos 35.0^\circ)(21.0)(1.20\times10^{2})$

$= 1.011\times10^{-2}$ V.

$\therefore$ induced EMF $= 1.01\times10^{-2}$ V. (3)

6.




When the plane has moved through $55.0^\circ$ of the circle, its wings move parallel with $B$ (earth) $\therefore$ EMF = 0. The same situation occurs $180^\circ$ later.

Maximum EMF is induced $145^\circ$ through the loop (and $180^\circ$ later)

ie EMF (max) $= B\ell v$

$= (4.60\times10^{-6})(21.0)(1.20\times10^{2})$

$= 1.235\times10^{-2}$ V. (3)

7. LENZ'S LAW: an induced current is in such a direction as to produce a magnetic force that opposes the force causing the motion which is inducing the current. (1)

8. $\text{EMF} = -N\dfrac{\Delta\phi}{\Delta t}$

$\phi = B.A.$

$= (2.00)(4.00\times10^{-2}\times 1.00\times10^{-1})$

$= 8.00\times10^{-3}$ Wb.

$= \dfrac{-1.00\times10^{2}(8.00\times10^{-3})}{0.0300}$

$= -26.67$ V.

$\therefore$ induced EMF is 26.7 V. (3)

TOTAL: $\overline{23}$