ARANMORE CATHOLIC COLLEGE

YEAR 12 PHYSICS 3A3B - 2010

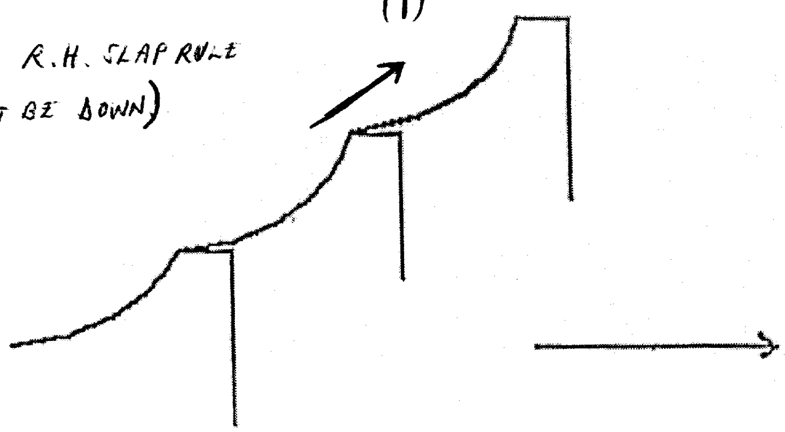
ASSIGNMENT 3 - ELECTROMAGNETISM

NAME: ____________________ **MARK:** /50

1. When the direct current is switched on and flows through this power line the wire sags more. Indicate on the diagram which direction the current is flowing in the wire. (2 marks)

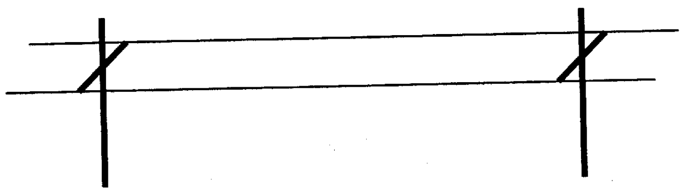
(1) USING R.H. SLAP RULE (F MUST BE DOWN)

(1)



2. A 150m span of electrical transmission cable that is suspended between two power poles, casts a shadow that lies to the south throughout the day. The cable is located in an area where the horizontal component of the Earth's magnetic field is 2.5×10^{-5} T. If a DC current of 5.00A flows through the cable towards the east, what is the magnitude and direction of the force experienced by the cable due to this current? (4 marks)

(1) N



$B = 2.5 \times 10^{-5}$ T

$I = 5.00$ A EAST

$\ell = 150$ m

$F = BI\ell$ (1)

$= 2.5 \times 10^{-5} \times 5 \times 150$

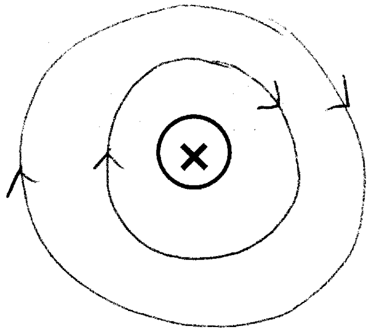
$= 1.9 \times 10^{-2}$ N UP. (1.88×10^{-2} N is OK)

(1) (1)

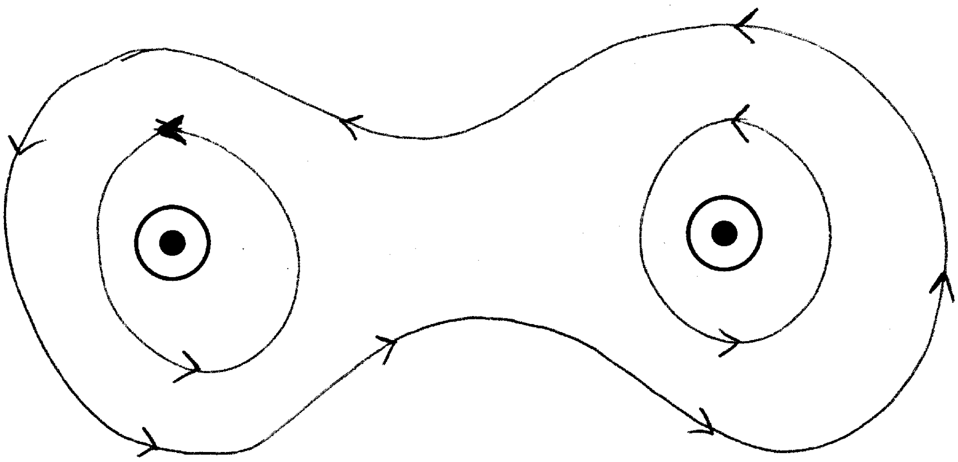
3. For each situation shown below, draw the associated magnetic field. (6 marks)

(1 each for shape
1 each for direction)

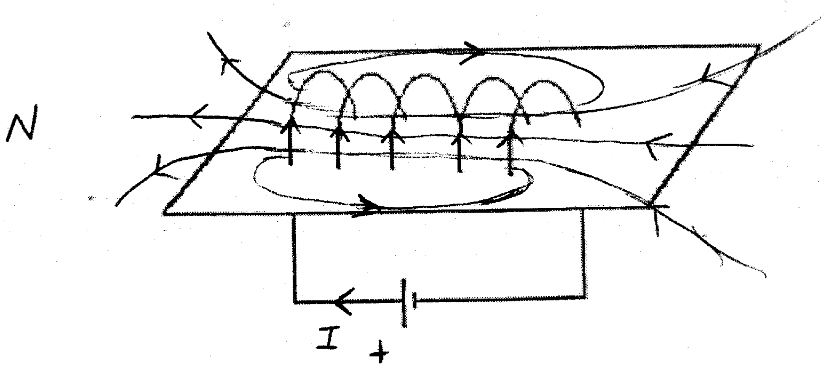
(a)



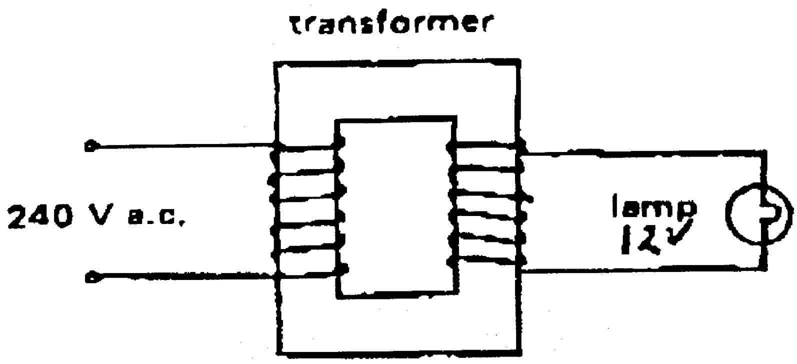
(b)



(c)



4. Consider the transformer below.



(a) If the primary winding was connected to 240V AC and draws a current of 100 mA, what is the power delivered to the lamp? The transformer is 95% efficient. (3 marks)

$P_{TOTAL} = VI$ (1)

$= 240 \times 0.100$

$= 24 W$ (1)

$P_{LAMP} = 0.95\, P_{TOTAL}$

$= 22.8 W.$ (1)

(c) What type of transformer is it? (1 mark)

STEP-DOWN. (240V → 12V)

(d) If the secondary winding had 20 turns and delivered 12V, how many turns has the primary winding? (2 marks)

$\frac{N_P}{N_S} = \frac{V_P}{V_S}$ (1)

$N_P = \frac{240}{12} \times 20$

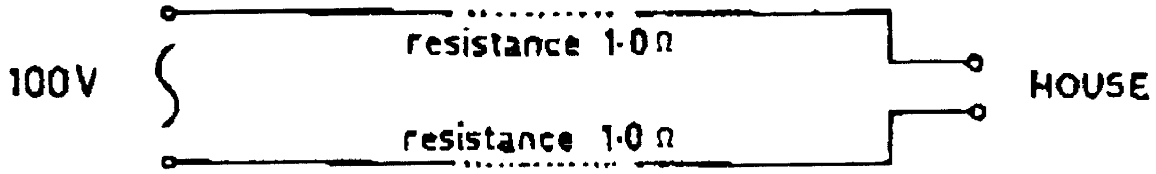
$= 400$ TURNS. (1)

(e) What would happen if the primary winding was connected to 240V D.C.? (1 mark)

NOTHING – SINCE $\Delta\phi = 0$.

NO INDUCED EMF – MUST BE A CHANGE IN FLUX.

5. A windmill drives a 100 V generator that produces 1000 W of electrical power. This energy is supplied to a distant house through cables that have a total resistance of 2.00 Ω.



(a) What is the voltage drop over the length of the cables and how much power is dissipated in the cables? (4 marks)

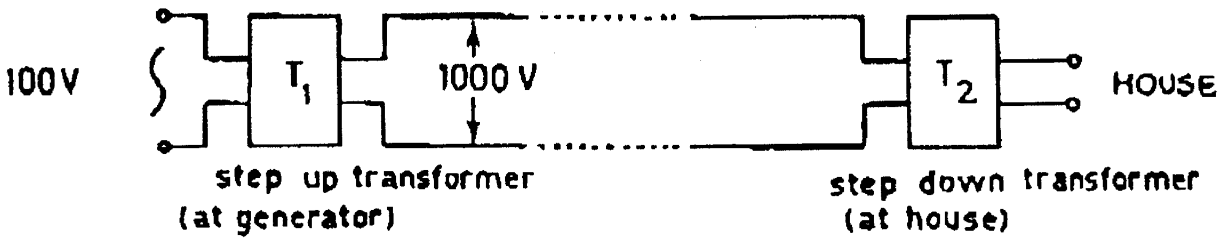
$R_T = 2\,\Omega$; $I = \frac{P}{V} = \frac{1000}{100} = 10\ A.$ (1)

$V = 100V$; $V_{CABLES} = IR = 10 \times 2 = 20V$ DROP. (1)

$P = 1000W$; $P_{LOSS} = I^2R = 10^2 \times 2 = 200W$ LOSS.

(1) (1)

(b) Two transformers (T1 and T2) of 100% efficiency are used to step-up the voltage at the windmill and step-down the voltage at the house to reduce this power loss as shown below.



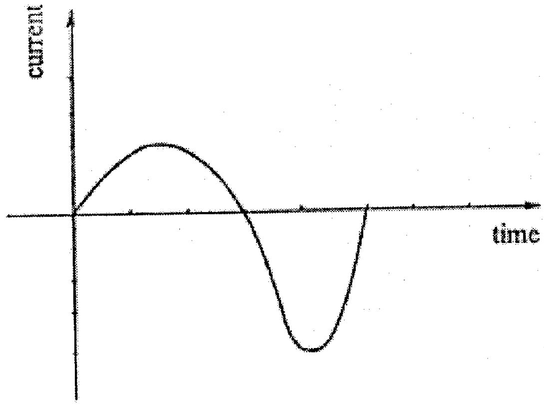
Calculate the voltage drop over the length of the cables between the two transformers and the power dissipated in the cables now? (4 marks)

$V_{NEW} = 1000V$; $I = P/V = \frac{1000W}{1000V} = 1\ A.$ (1)

(1) $\therefore V_{CABLES} = IR = 1 \times 2 = 2V.$ (1)

$P_{LOSS} = I^2R = 1^2 \times 2 = 2W.$ (1)

6. A computer data logger is used by a group of students to analyse the current produced when a magnet is dropped through a coil of copper wire wound on a hollow cardboard cylinder. The graph of current versus time, produced on the screen of the computer is similar in shape to the one shown below. Explain why the shape of the graph is not symmetrical above and below the time axis. (3 marks.)



(1) WHEN MAGNET IS DROPPED THROUGH A COIL, IT IS ACCELERATING AT g.
AS MAGNET APPROACHES COIL, $\emptyset$ INCREASES WHICH INDUCES A CURRENT.
(1) SINCE IT IS ACCELERATING, THEN THE RATE OF $\Delta\emptyset$ IS INCREASING SO I INCREASES. AS MAGNET PASSES THROUGH COIL $\emptyset$ DECREASES AND SO INDUCED CURRENT IS IN OPPOSITE DIRECTION. SINCE IT IS STILL
(1) ACCELERATING THE INDUCED CURRENT WILL BE STRONGER, BUT LAST LESS TIME THAN WHEN MAGNET APPROACHES COIL.

7. Hamish was attempting to measure the **emf** induced in a car antennae as the car was being driven in an easterly direction. The value of the horizontal component of the Earth's magnetic field, in this region, was 58.0 μT and the antennae measured 1.45 m in length. Hamish had used a protractor to determine that the antennae was bending at an angle of 15° to the vertical and the car was travelling at a speed of 78 km h^{-1}. Determine the **emf** that Hamish would have measured under these conditions. (4 marks)

(1) $v = 78\ kh^{-1}$
$= 21.7\ ms^{-1}$.

(1) $\theta = 90 - 15^\circ$
$= 75^\circ$.

$B = 58 \times 10^{-6}\ T$

$l = 1.45\ m$

$\mathcal{E} = Blv\sin\theta$ (1)
$= 58 \times 10^{-6} \times 1.45 \times 21.7 \times \sin 75^\circ$
$= 1.76 \times 10^{-3}\ V$ (1)
$= 1.76\ mV$.

[$\mathcal{E} = 1.82\ mV$ IF θ IGNORED $= 90°$ (3 MARKS)]

8. A coil in a simple motor has 250 turns and measures 15 cm x 8.0 cm. A current of 0.12 A is flowing through the coil which is situated between permanent magnets that produce a steady field of 0.50 T.

(a) Find the maximum torque acting on the coil.

(4 marks)

$F = NBI\ell$ (1)

(1) $\tau_{TOTAL} = 2Fr$

$= NBIA$

$= 250 \times 0.50 \times 0.12 \times (0.15 \times 0.08)$

$= 0.18$ Nm.

(1) (1)

9. Give a brief description (or draw a diagram) of a 'dynamic' microphone and explain how it works.

(4 marks)

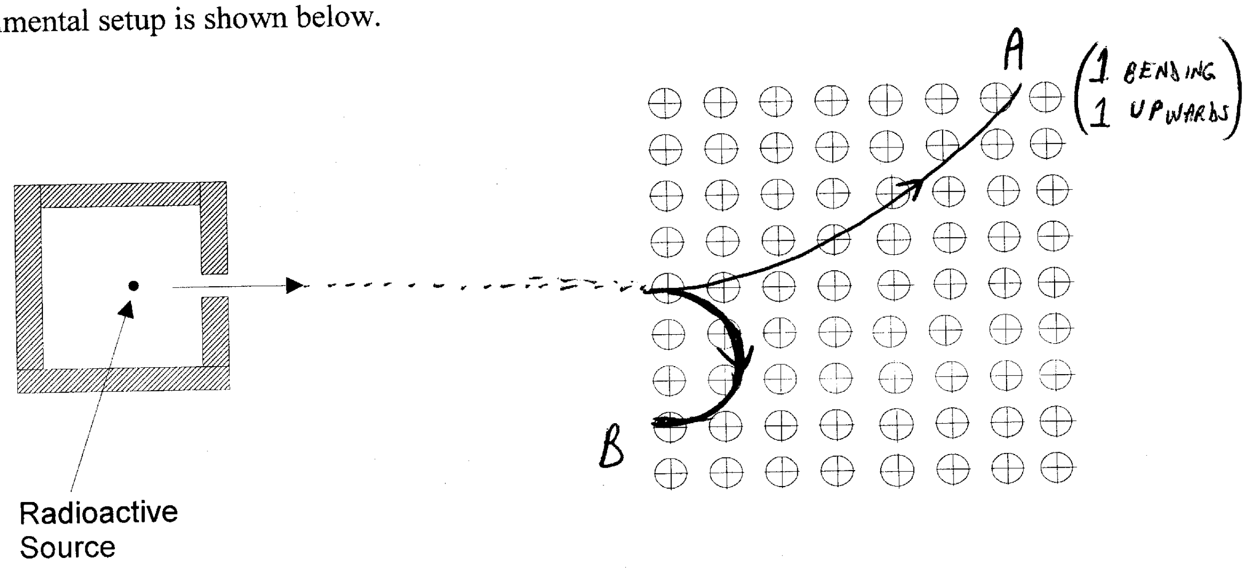
(1) A COIL IS ATTACHED TO A DIAPHRAGM WHICH VIBRATES WITH SOUND.

(1) THE COIL IS IN A MAGNETIC FIELD.

(1) THE MOVEMENT OF THE COIL IN THE B, INDUCES AN EMF WHICH VARIES WITH THE SOUND PRODUCING THE MOVEMENT.

(1) THE EMF IS USED TO PRODUCE A SMALL CURRENT WHICH CAN THEN BE AMPLIFIED AND FED BACK INTO SPEAKERS AND HENCE SOUND.

10. A radioactive source is used to fire alpha particles (He^{2+} ions) into a magnetic field. The experimental setup is shown below.



a) On the diagram carefully indicate a possible path for the alpha particles when they enter the magnetic field. Label the path (A).

(2 marks)

b) If the alpha particles are moving at a speed of 4.20x 10^4 ms^{-1} when they enter a uniform 1.50 T magnetic field, calculate their predicted radius in the magnetic field.

(4 marks)

$V = 4.2 \times 10^4 ms^{-1}$

$B = 1.50 T$

$m_\alpha = 6.65 \times 10^{-27} kg$

(1) $q = 2 \times e$

$= 3.20 \times 10^{-19} C$

$r = \frac{mV}{Bq}$ (1) $\left(F = Bqv = \frac{mv^2}{r} \right)$

$= \frac{6.65 \times 10^{-27} \times 4.2 \times 10^4}{1.5 \times 3.2 \times 10^{-19}}$ (1)

$= 5.82 \times 10^{-4} m$ (1)

$= 0.582 mm.$

c) If an electron was fired into the magnetic field, carefully indicate a possible path for that particle when it enters the magnetic field. Label the path (B). Describe the two main differences in the path of the electron as compared to that of the alpha particle.

(2 marks)

- OPPOSITE DIRECTION (OF BEND) (1)
- SMALLER r (DUE TO SMALLER MASS) (1)