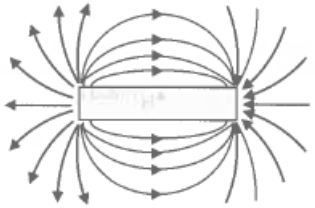
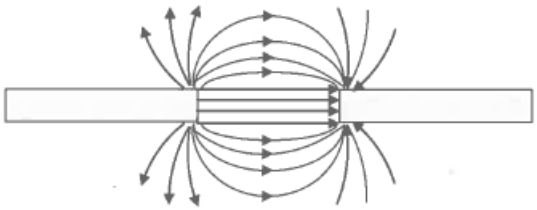
Kingsway Christian College Physics 3AB Test 4 Name _____
Magnetism, Motors, Generators, Transformers and Transmission
15 May 2015 Mark: _____/ 90 = _____% Time 85 minutes

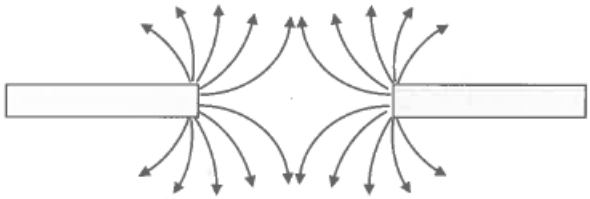
Give sufficient working out to obtain full marks in any questions involving calculations. Give ALL numerical answers correct to 3 significant figures unless otherwise stated or required by the given data.

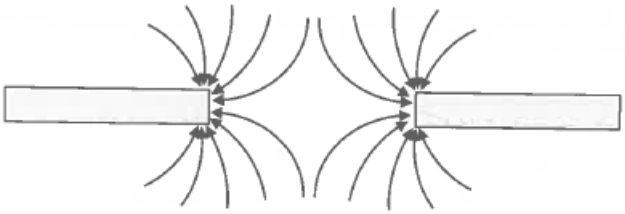
Section A: Short answers

1. Identify the poles of the magnets whose 2-D field lines are shown. [4]

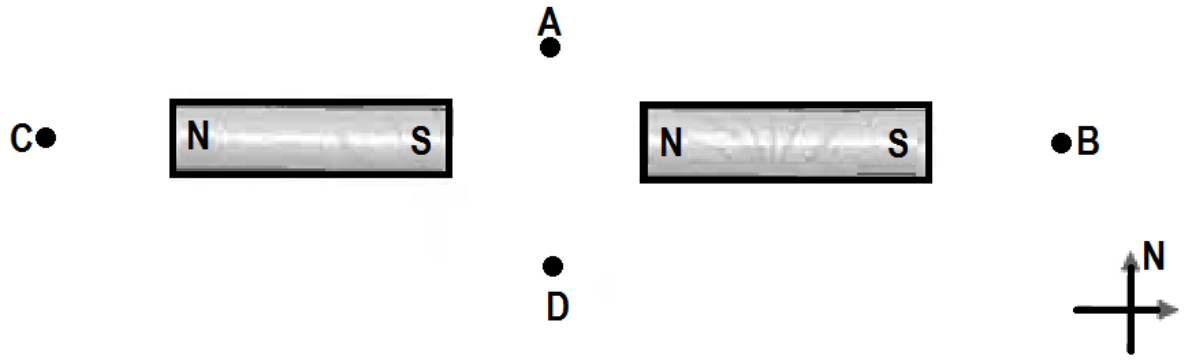
a) 

b) 

c) 

d) 

2. The horizontal magnetic field strength due to the Earth B_{HE}, at a certain location, has the same magnitude as the magnetic field strength due to any pole of the two magnets shown of equal strength at the locations marked $A, B, C \wedge D$. Sketch the resultant magnetic field at each of those locations due to a combination of the magnets and the Earth's horizontal magnetic field. Consider only the effect of the pole(s) closest to the points and the Earth's field. [4]

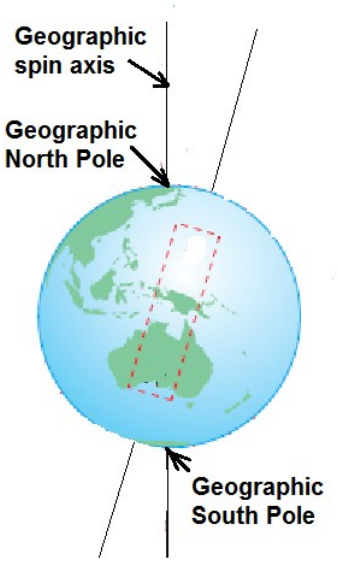


3. On the map of the world provided, mark the following:

(i) The Magnetic North Pole [1]

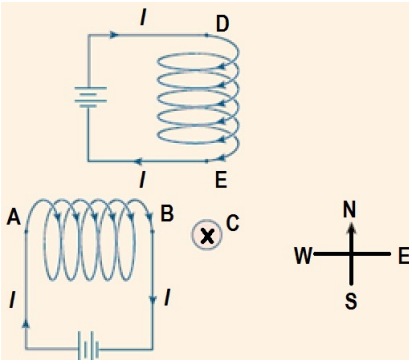
(ii) The Magnetic South Pole [1]

(iii) 8 magnetic field lines symmetrical about the magnetic axis. [4]



4. The diagram shows two current-carrying solenoids located equidistant from and at right angles to a long, straight, current-carrying conductor C (perpendicular to page) that carries a current into the page.

The magnitude of the magnetic force due to the solenoids on C is 5.00 μN.



(a) In what direction is the magnetic force on C? [1]

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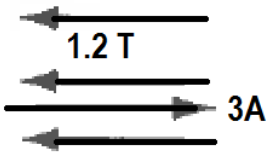
(b) The direction of the current in the solenoid DE is reversed and its magnitude halved. The current in conductor C is also reversed and its magnitude doubled. Calculate the force on conductor C now? [3]

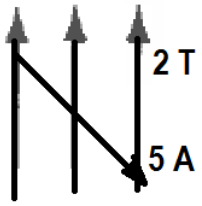
5. Each diagram below shows 50.0 cm of current-carrying conductor within a magnetic field. Calculate the force acting on each conductor due to the magnetic field.

a) 

[2]

b) 

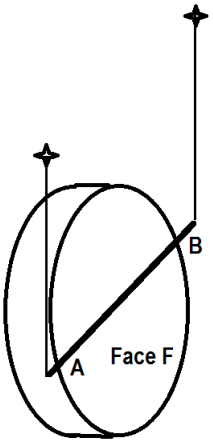
[2]

c) 

[2]

6. In an experiment students suspended a copper wire ABbeside a face F of a disc magnet as shown. They noticed that when the wire was connected to a DC supply, it moved up (was levitated).

a) Which choice correctly shows the direction of the current in the wire and the polarity of the face$F$? Circle the correct one. [1]



(A) Current from A¿B and face F polarity is north.

(B) Current from B to A and face F polarity is south.

(C) Current from B to A and face F polarity is north.

b) Explain in detail your choice. You must draw appropriate magnet field interaction diagrams and a simple mention of the right hand slap rule is not sufficient. [3]

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7. Transformers are devices that step up and step down voltages for many applications.

a) Why are transformers laminated? [2]

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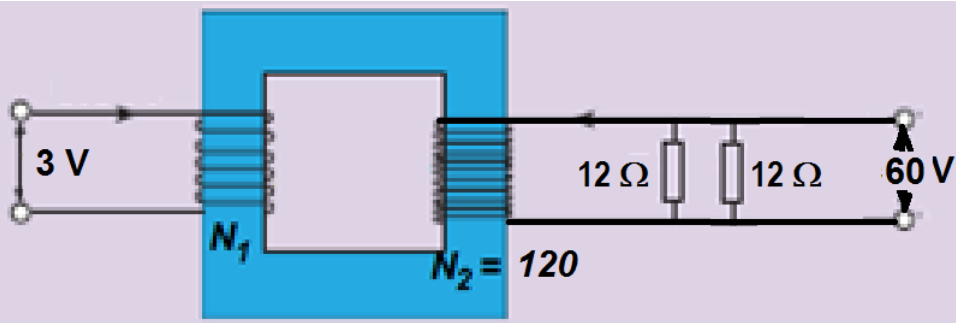
A 75% efficient transformer is needed to supply two 12-Ω globes an RMS output voltage of 60.0 V. The input voltage is 3.0 V RMS.



There are 120 turns in the secondary winding.

a) What is the RMS output current? [1]

b) How many turns are there in the primary winding? [1]

c) How much power is generated by the input source? [1]

d) What is the peak input current? [1]

Section B. Calculations

8. The following is a simplified diagram of a DC motor

(a) Briefly write down the functions of the following parts.

(i) Battery [1]

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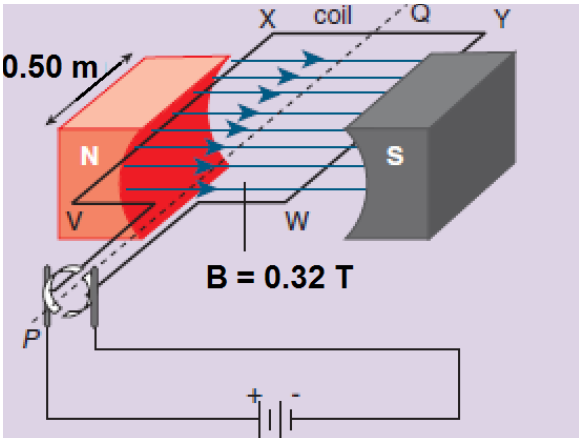

(ii) Soft iron core or armature (not shown) [1]

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(iii) Split ring commutator [1]

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(iv) Carbon brushes [1]

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(b) The coil shown has 100 turns. The side XY is 1.00 m. and caries a current of 0.50 A. Calculate the magnetic force on the following sides at the instant shown:

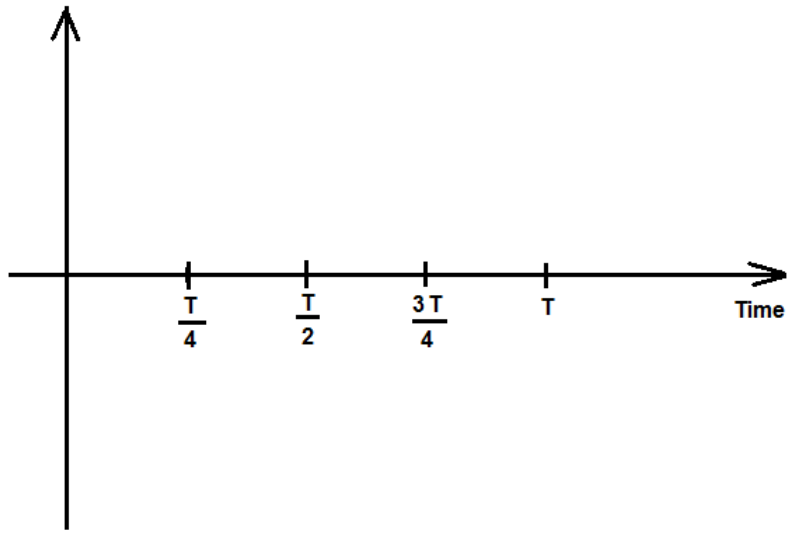
(i) VX [1]

(ii) XY [1]

(iii) YW [1]

(c) Calculate for the instant shown, the torque on the coil and state which direction the coil will rotate (clockwise or anticlockwise) as viewed from the split ring side. [2]

(d) Sketch a torque versus time graph for one complete rotation, using the shown position as zero time. [2]



(e) List four ways in which the DC motor could be modified so the maximum torque could increase. [2]

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(g) Motors can be used as generators if they are modified in a certain way. How could this motor be converted into a generator? [2]

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(h) If the motor was modified and converted into a generator, would the generator produce AC or DC current? Explain briefly. [1]

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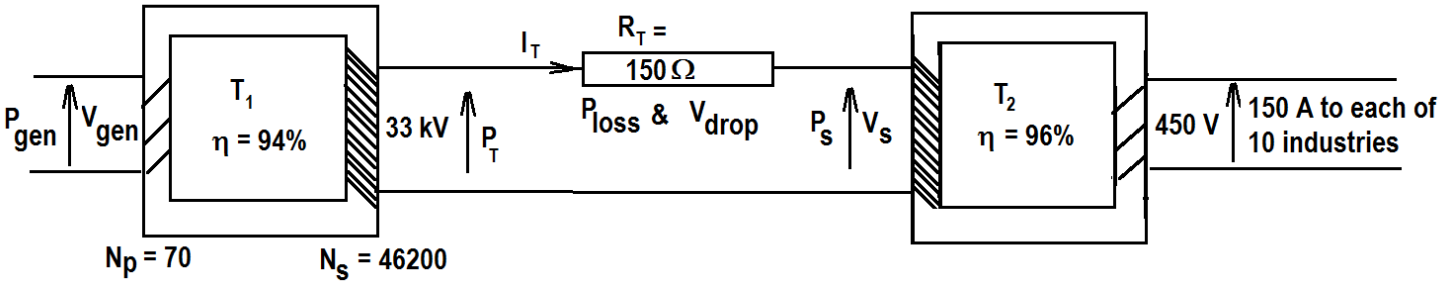
9. An industrial estate with 10 industries each needing $150\,A$ at $450\,V$ is supplied by a generating station. The generated voltage, V_{gen} is stepped up to $33\,kV$ across a $94\,\%$ efficient transformer T_1. The input coils to T_1 have 70 turns and the output coils have 46200 turns. The transmission line total resistance R_T is 150. At the substation to the industrial estate, the input voltage V_s to a second $96\,\%$ efficient transformer T_2 is stepped down to the required $450\,V$.



a) What is the total current drawn by the ten industries? [1]

b) What is the power output to the industrial estate? [2]

c) What is the power input P_s to the substation transformer T_2? [2]

d) What is the generated voltage, V_{gen}**?** [1]

e) Write an expression for the transmission line current I_T in terms of $P_s \wedge V_s$. [1]

f) Calculate the power output of the generator P_{gen}. [2]

10. The diagram below is that of a simple AC generator. At the instant shown the emf generated produces current as indicated.

a) Which direction is the coil spinning? (Clockwise or anticlockwise? As viewed from the commutator's end.) [1]

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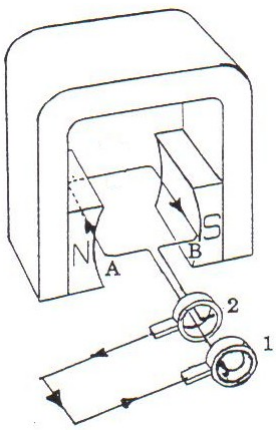


b) The magnetic field in the coil area is of intensity 0.45 T. The 20 cm $\times$ 20 cm coil has 150 turns and is spinning at 3000 rpm. Calculate:

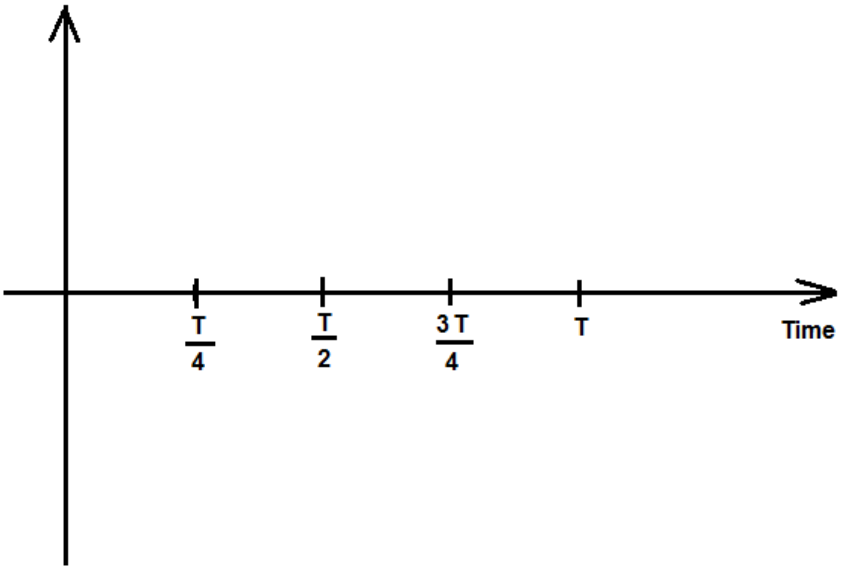
(i) The frequency of rotation of the coil in Hz. [1]

(ii) The flux linking the coil at this position. [1]

(iii) The flux linking the coil after ¼ turn from the horizontal position shown. [1]

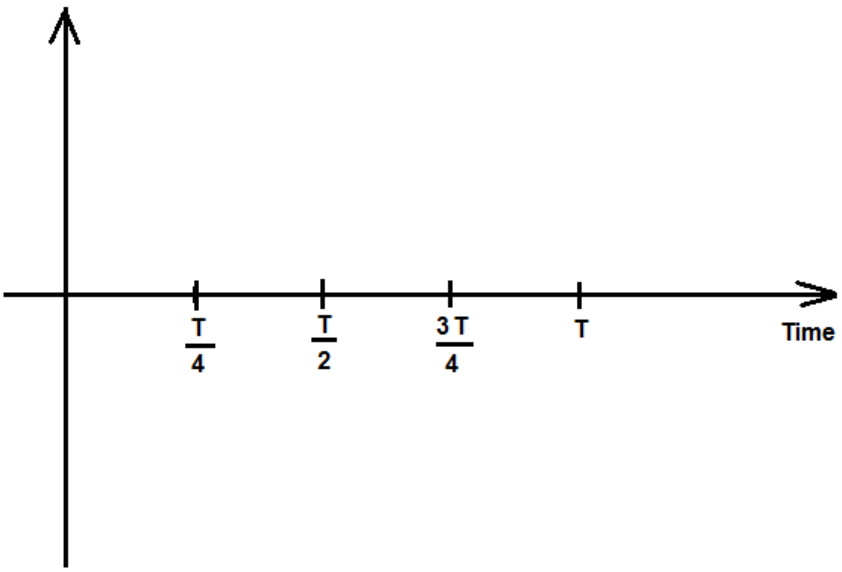
(b) Sketch the following graphs for one full cycle.

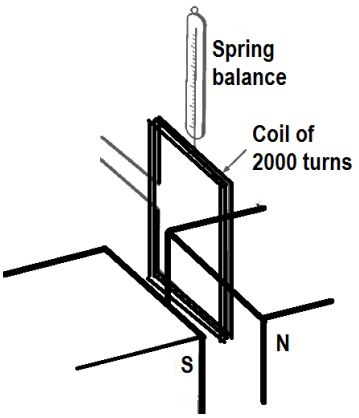
(i) Flux Φ versus time graph [2]



(ii) The induced ***EMF*** versus time graph.

[2]





c) What changes would be observed in the induced emf if the coil was spun at 9000 rpm? [2]

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iv) What changes would be observed in the induced emf if the coil was spun at 1500 rpm? [2]

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Section C: Experimental interpretation:

11. A group of students set up a 2000 turn rectangular coil of wire suspended from a spring balance so that its lower side (5 cm in length) was between the poles of a magnet as shown in the diagram.

They passed various currents through the coil and recorded the reading on the spring balance. Their results are shown.

Current in coil (A)	Reading on balance (N)	
0	3.7	
1	3.8	
2	3.9	
3	4.0	
4	4.1	
5	4.2	

a) Identify three factors that have been controlled. [3]

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b) Identify the dependent variable. [1]

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c) Identify the independent variable. [1]

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d) Determine which direction the current must floe in the coil as viewed from the left to produce the experimental results. (Clockwise or anticlockwise?) [1]

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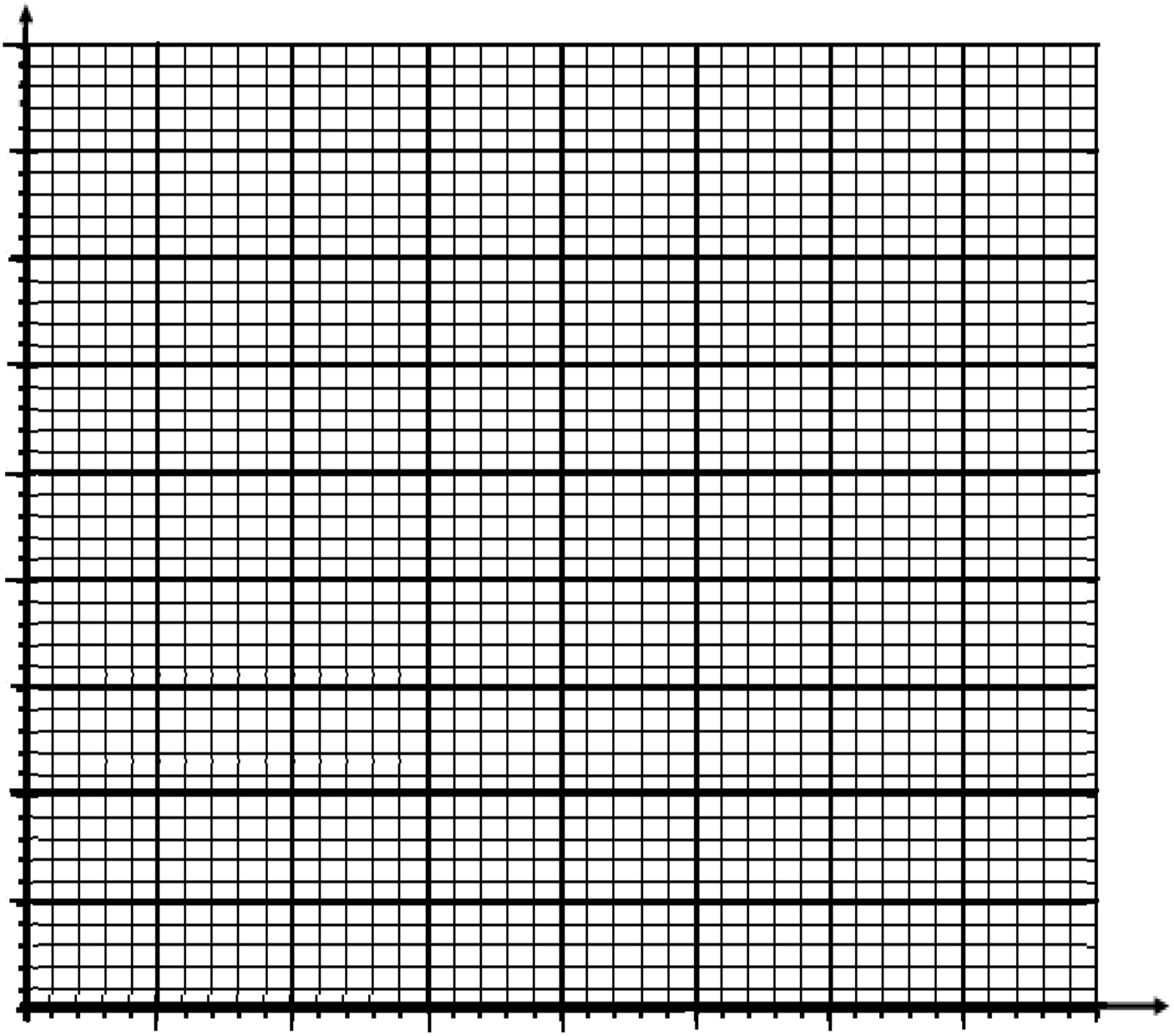
e) Graph the results of the experiment. [4]



f) Analyse the graph and the related equations from your formula sheets to calculate the following:

i) Mass of the coil. [1]

ii) Strength of the magnetic field. [2]

iii) Reading of the spring balance if a current of 12.0 A was flowing in the coil. [2]

iv) Reading of the spring balance if a current of 5.0 A was flowing in the opposite direction through the coil. [2]

v) The students repeated the experiment with the same coil but with a magnet twice as strong. On your axes above, draw and label a second graph to predict what their results would be. [1]

vi) The students then repeated the original experiment again, this time using a coil with 1000 turns. Graph and label the results you would expect on the same axes above. [1]

END OF TOPIC TEST