ALL SAINTS' COLLEGE

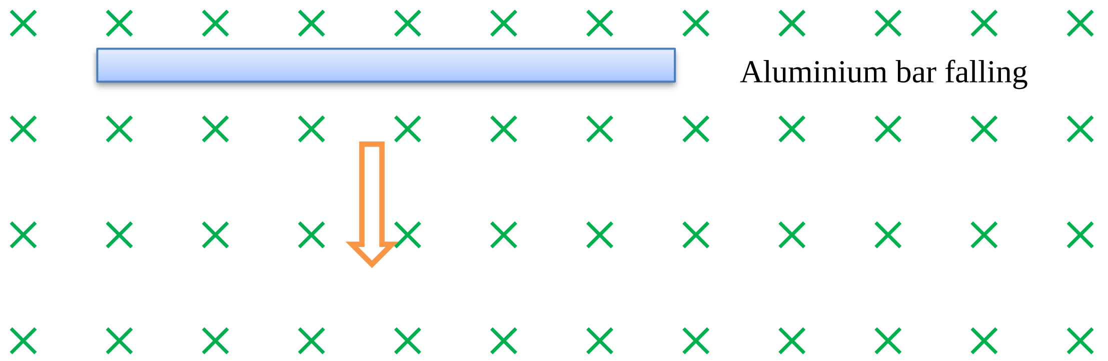
Ewing Avenue, Bull Creek, Western Australia

Year 12 Physics ATAR | Electromagnetism Test 2 | 2017

Time allowed: 50 minutes
Total marks available: 50
Show calculation answers to 3 significant figures

Student Name:________________________

1. An aluminium bar of length 2.20 m is dropping in a magnetic field of flux density of 5.50 mT
   A potential difference of 7.60×10^{-2} V is established across the ends of the bar.



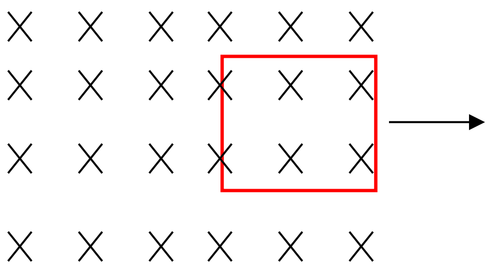
a) Determine the speed of the aluminium bar at the instant shown.

(2)

b) Indicate on the diagram where there is a build-up of electrons on the aluminium bar and briefly explain your response.

(2)

2. A square coil made of five (5) loops of copper wire is moving at a speed of 4.00 m s^{-1} right and has just reached the edge of a uniform magnetic field of flux density 84.0 mT. The square coil has a size of 25 cm by 25 cm.

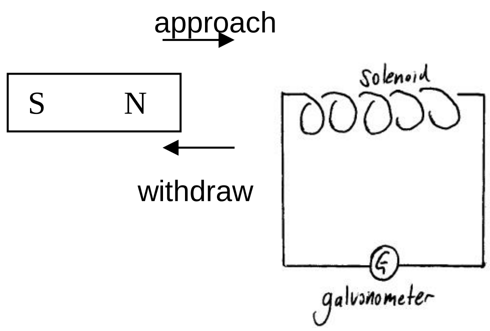


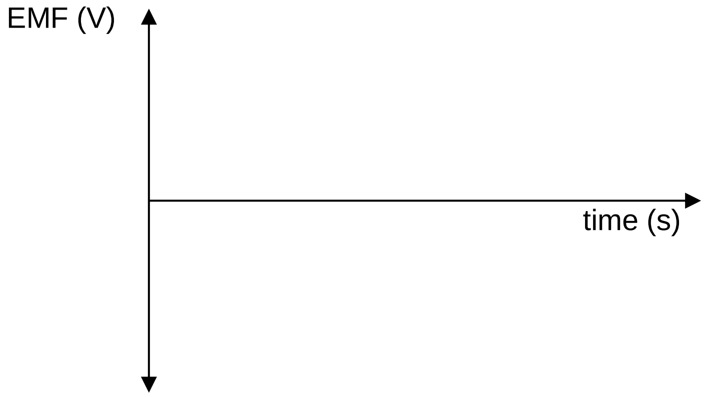
a) Show by calculation that the coil will be fully removed from the field in a time of 6.25 x 10^{-2} s
(2)

b) Indicate on the diagram the direction of induced current in the coil as it is removed and explain how you arrived at your response.
(2)

c) Calculate the magnitude of induced emf as the coil is removed from the field.
(3)

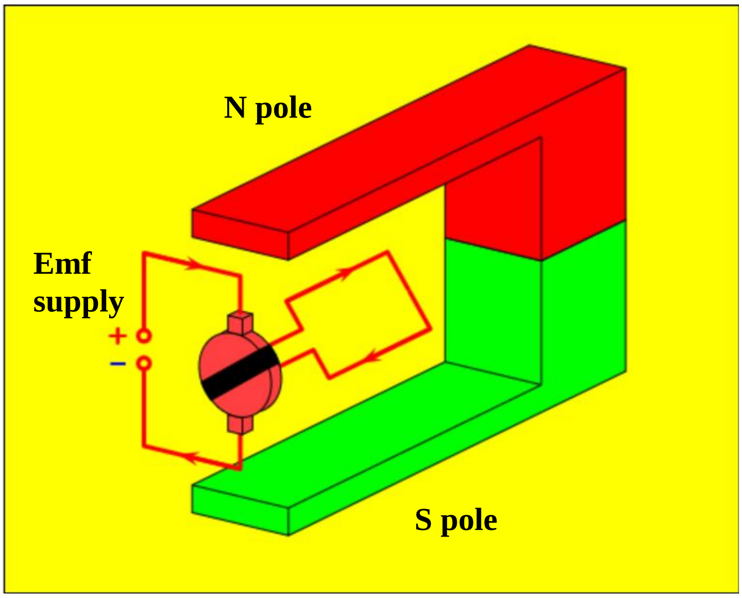
3. A permanent magnet approaches a solenoid, stops briefly, and is withdrawn again. Sketch the general shape of a graph of EMF versus time on the axes provided.
(3)





Indicate current direction in the solenoid circuit as the magnet approaches. Put an arrow on the diagram and label it current.

4. The diagram shows a DC electric motor. An external source of emf delivers a supply voltage to a coil that is free to rotate. The supply voltage introduces a current into the coil and its direction is shown on the diagram.



a) When the motor is turned on it starts to rotate anticlockwise (as viewed from the commutator). Explain why it rotates in this direction.

(1)

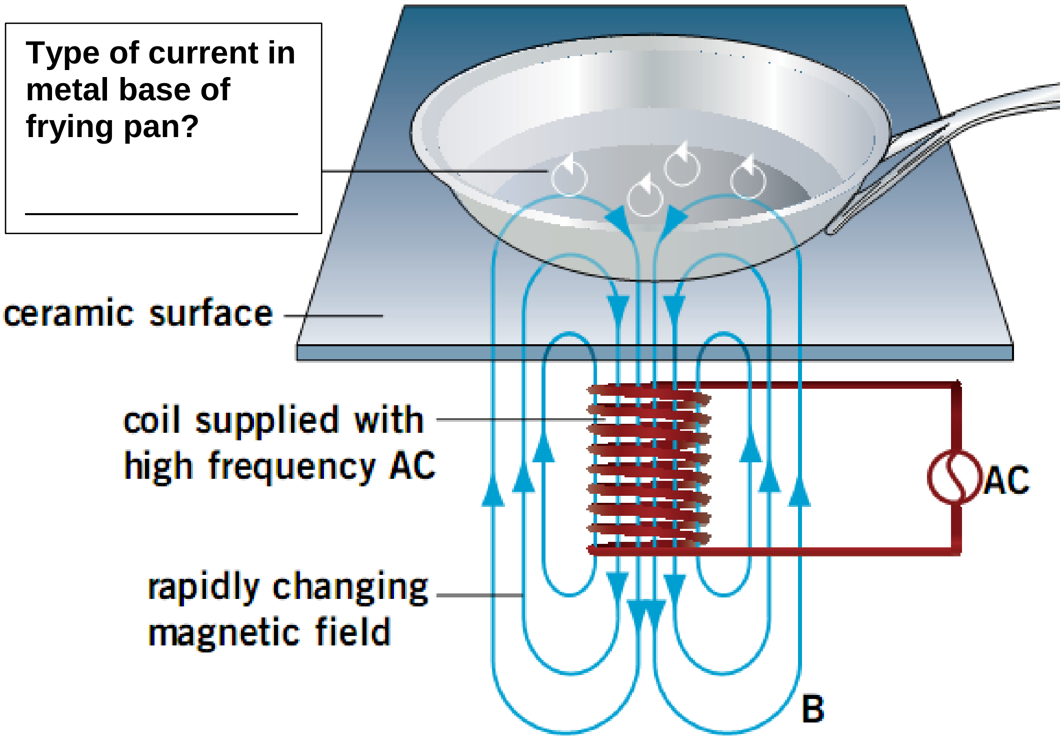
b) Clearly explain how a back emf is established, the direction of back emf and what effect this has on the net current in the motor.

(3)

c) When the motor is doing work (e.g. used to turn a fan blade) the rate of rotation slows. Explain what effect this will have on the electrical power of the motor. You must refer to physics principles.

(2)

5. The diagram shows the operating principles of an induction cooktop. A frying pan is placed on the ceramic cooking surface. A copper coil is mounted beneath the cooking surface. The coil is connected to a high frequency AC voltage. Heat is generated in the frying pan (i.e. its internal energy increases).



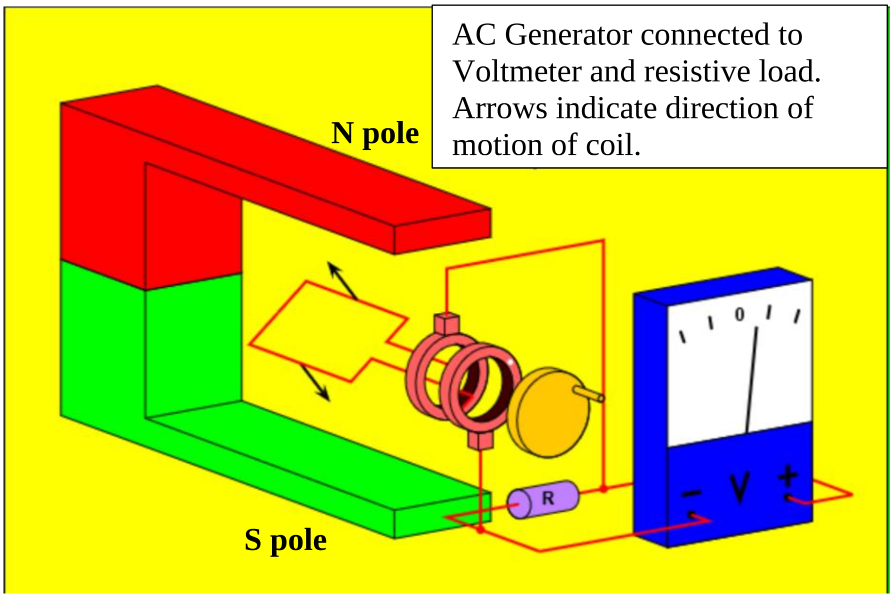
a) Name the type of current flowing in the metal base of the frying pan. Label this in the box on the diagram above.

(1)

b) Explain how this design enables the temperature of the frying pan to increase. You must refer to physics principles in your response and demonstrate how the concepts are linked.

(3)

6. An AC generator is shown in the diagram. A rectangular conducting coil of 85 turns is situated in a uniform magnetic field of flux density 253 mT. The coil is provided with an anticlockwise driving torque (the arrows on the coil indicate direction of motion at this instant). The rate of rotation about an axis is 1500 r.p.m. The coil width = 15 cm and the coil length = 20 cm.



a) Calculate the maximum value of **flux** contained within the coil whilst it is turning.

(2)

b) Calculate the magnitude of **maximum induced EMF** in the AC generator.

(3)

c) Indicate, on the coil length next to the South Pole in the diagram, the direction of current flow, as the coil rotates from this position.

(1)

d) Briefly describe how you arrived at your answer for part c)

(1)

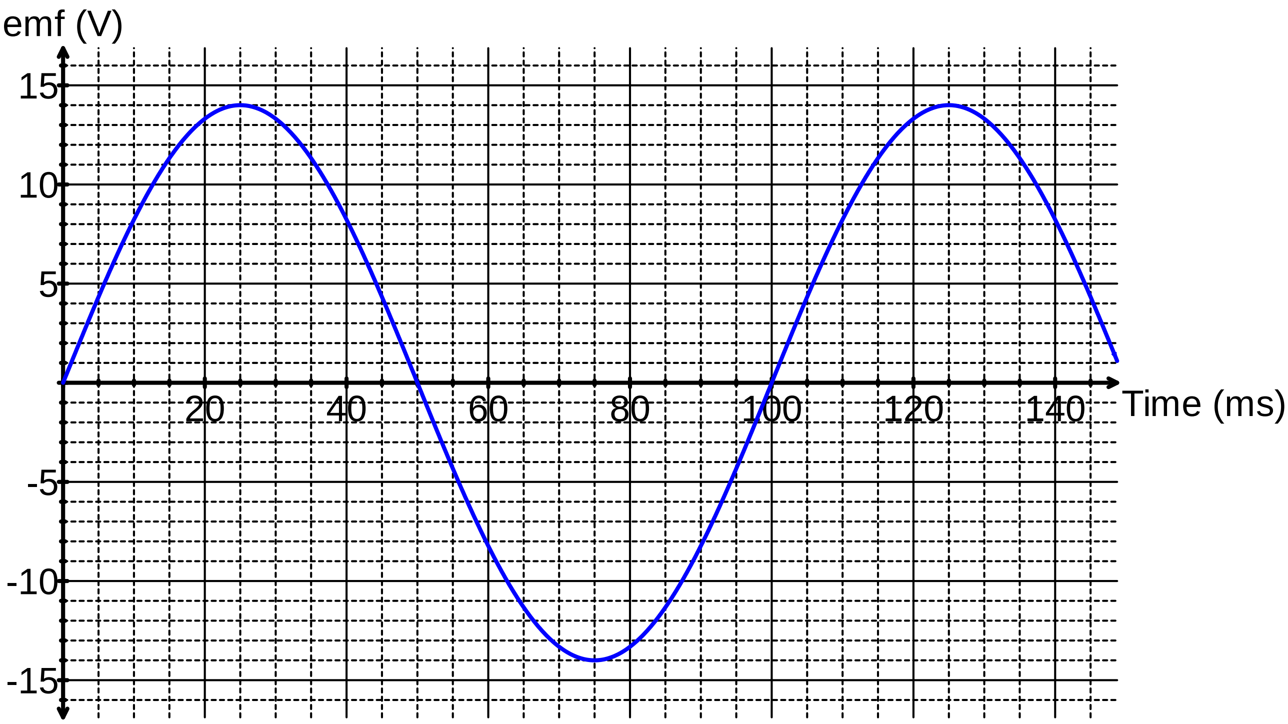
e) Considering the position of the coil shown in the diagram above.

i) The magnitude of induced emf at this instant is: (circle a response) (2)

Increasing Zero Decreasing Maximum

Explain how you arrived at your answer

The emf output of a **different** AC generator is shown on the graph below.



f) Determine the RMS voltage of this AC generator

(2)

g) Determine the rate of rotation of the coil in r.p.m (revolutions per minute) from this graph.

(3)

7. A farmer needs to supply an AC electric pump with high voltage but only has a 240 V_{RMS} domestic supply available. He uses a transformer with 400 turns of wire on the primary stage to step up the voltage to 3.30 kV_{RMS}. Assume that the transformer is 100 % efficient in terms of flux linkage but only 89.0 % efficient in terms of power transfer.

a) Calculate the number of turns required on the secondary winding? (2)

The maximum allowable voltage drop (potential difference) across the cables that connect the secondary coil of the transformer to the AC pump is 5% of the output voltage. The transformer has an electrical power output of 4.85 kW.

b) Calculate the maximum allowable resistance of the cables. (4)

c) Calculate how much current is drawn on the primary stage of the transformer. (3)

In a *non-ideal* transformer the electrical energy output is less than the electrical energy input.

d) Explain how a soft iron core made of laminations can increase efficiency. (2)

e) Is copper a suitable material for the transformer core? Explain briefly. (1)

End of test