FUKIEN SECONDARY SCHOOL

S5 Final Examination (2020-2021)

Physics Paper 1

Section B

(2 hours 30 minutes)

Date: 15th June 2021 Name: _____

Time: 8:30a.m. – 11:00a.m. Class: _____ No:_____

INSTRUCTIONS FOR SECTION B

1. Refer to the general instructions on the cover of the Question Paper for Section A.
2. This section carries 84 marks. **Answer ALL questions**.
3. Write your answers in the spaces provided in this Question-Answer Book.
4. The diagrams in this section are **NOT** necessarily drawn to scale.

Section B. Answer ALL questions. Write your answers in the spaces provided.

1, On a linear air track shown in Figure 1, a rider of mass 1 kg is connected to a block of mass 0.5 kg by a light inextensible string passing over a smooth pulley.

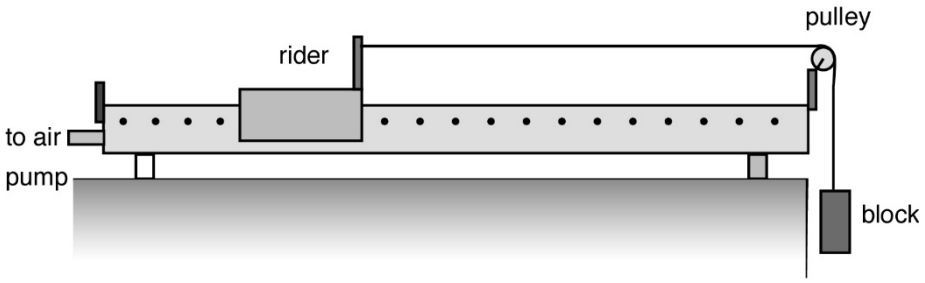

Figure 1

The block is released at $t = 0$ and it hits the ground at $t = 0.3$ s. The rider hits the pulley 0.4 s later.

(a) Calculate the acceleration of the rider at $t = 0$. Assume that there is no friction acting on the rider and the block. (3 marks)

(b) Find the displacement of the block. (2 marks)

(c) "If the mass of the block is doubled, the acceleration of the rider is doubled." Comment on this statement. (2 marks)

2. Read the following passage about **safety helmets** and answer the questions that follow.

Safety helmets can reduce the severity of head injury of construction workers in case of accident. A safety helmet consists of a hard plastic shell and elastic bands which held the helmet in place on a worker's head (Figure 2.1).

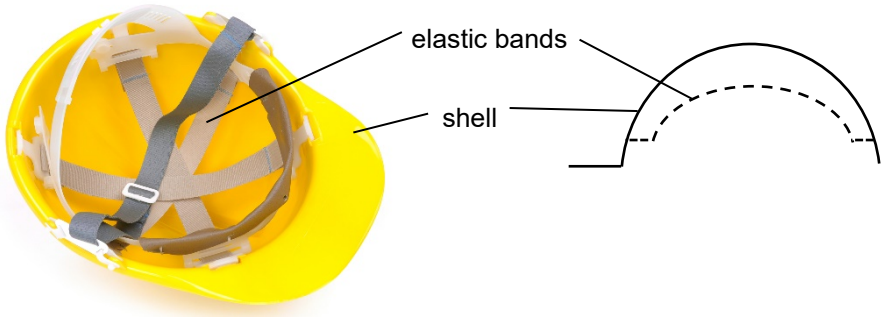

Figure 2.1 (Photo credit: Kozini | Dreamstime.com)

A deformation of the shell and stretching of the elastic bands can reduce the impact force acting on the workers by a falling object. Moreover, the impact force is spread over the surface of the head, so the chance of injury is reduced. A qualified helmet should pass an impact test to ensure the protective effect.

(a) In an impact test, helmet *X* is hit by a striker of mass 5 kg released from rest at 1 m above it. Figure 4.2 shows the moments when the striker is just released (A), just before hitting the helmet (B) and reaches the lowest point (C). The maximum displacement *d* of the striker after hitting the helmet is 45 mm.

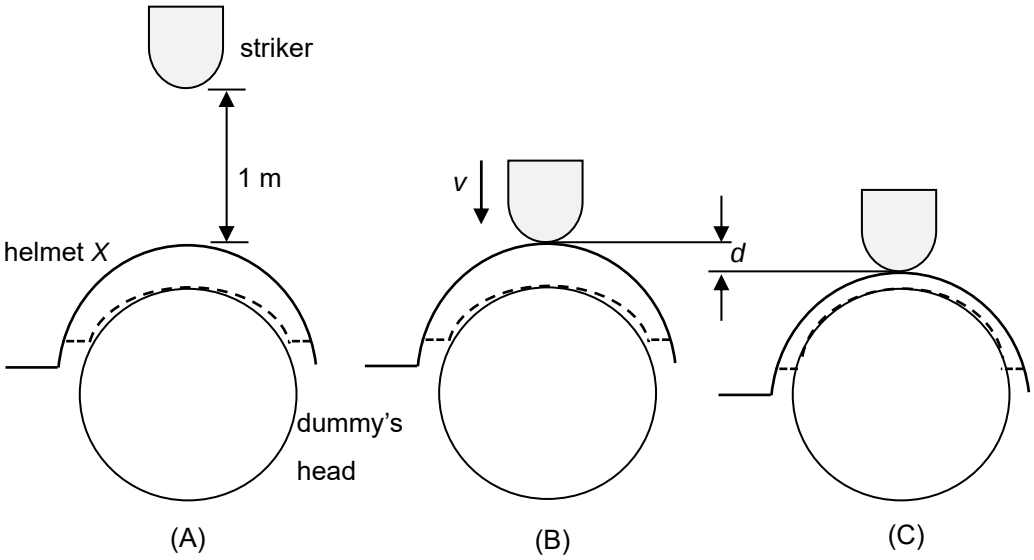

Figure 4.2

(i) Describe briefly the energy conversion from moments (A) to (C) in the test.

(2 marks)

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_____

(a) (ii) What is the speed v of the striker just before hitting the helmet? (2 marks)

(iii) Estimate the magnitude of the average impact force acting on the helmet by the striker. (2 marks)

(b) Helmet *Y* undergoes the same impact test. The value of d is measured to be 15 mm. Explain whether helmet *X* or *Y* is more effective in protecting the worker. (2 marks)

3. Andrew constructs a lever system as shown in Figure 3. Assume that the bar *PQ* has negligible mass. *O* is the mid-point of the bar while *X* is fixed by the movable joint. An elastic cord connects positions *P* and *Y*. When an object of weight 2000 N is hung at position *Q*, the rod becomes horizontal. *PX* = 0.8 m and *OQ* = 1.2 m.

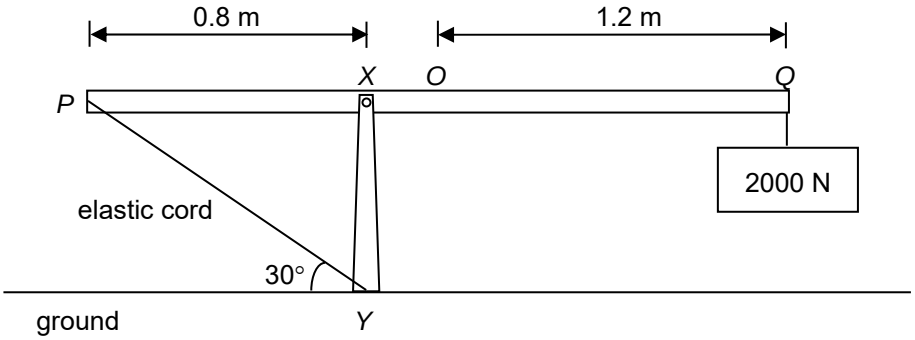
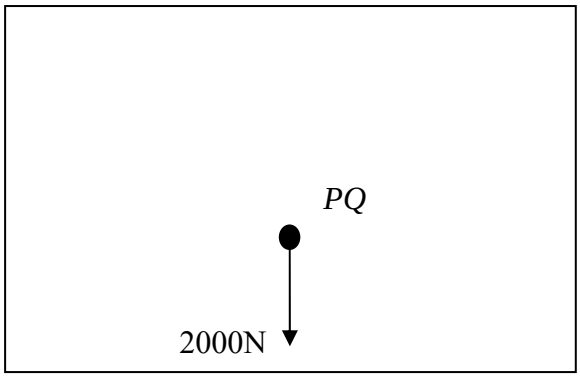


Figure 3

(a) Find the magnitudes of the tension of the elastic cord. (2 marks)

(b) Draw the free body diagram of rod *PQ*. Then, find magnitude of the reaction force acting on the bar at *X*. (3 marks)



4. A horizontal ground consists of a smooth region and a rough region. A cannon, of mass 1200 kg, with a metal ball of mass 5 kg, rests on the smooth region initially. Figure 4.1 shows that as the metal ball is launched horizontally from the cannon, the cannon recoils with a speed of 0.9 m s^{-1}.

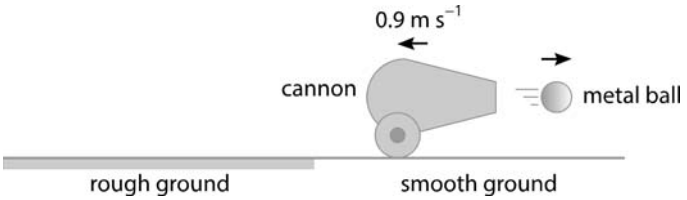


Figure 4.1

(a) Explain, in terms of Newton's laws of motion, why the cannon recoils. (2 marks)

(b) Find the speed of the metal ball just after it is launched. (2 marks)

(c) The cannon then enters the rough region and comes to rest after travelling a distance of 1.35 m under uniform deceleration. The velocity–time (v–t) graph of the cannon is shown in Figure 4.2. The instant the cannon enters the rough region is at $t = 0$.

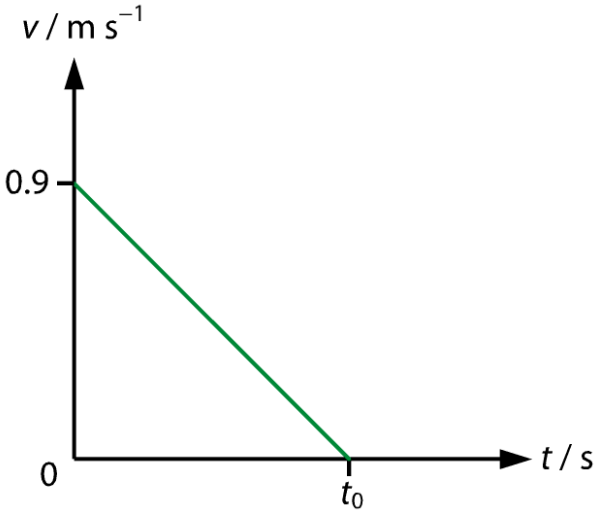


Figure 4.2

(i) Find t_0, the time elapsed in the rough region before the cannon comes to rest. (2 marks)

(ii) A metal ball of smaller mass is launched from the cannon with the same velocity. In Figure 4.2, sketch the expected velocity–time graph of the new cannon as it recoils. (1 mark)

(c) If the metal ball obtains a special speed v and there is no resistive force, it will orbit around the Earth as shown in Figure 4.3. Find v.
(Given: radius of the Earth = 6400 km.) (3 marks)

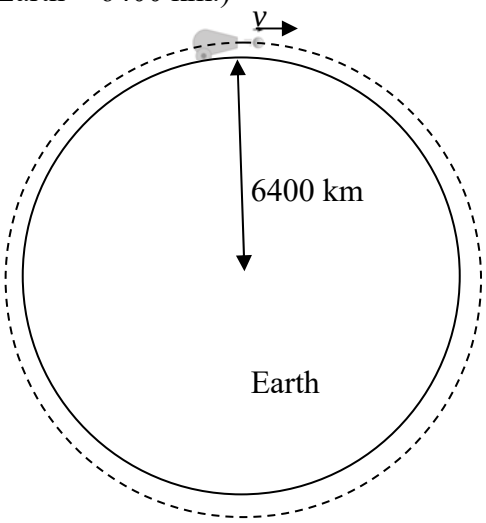


Figure 4.3

5. In an evacuated tube abeam of electrons is deflected by an electric field between two parallel plates as shown in Figure 5.

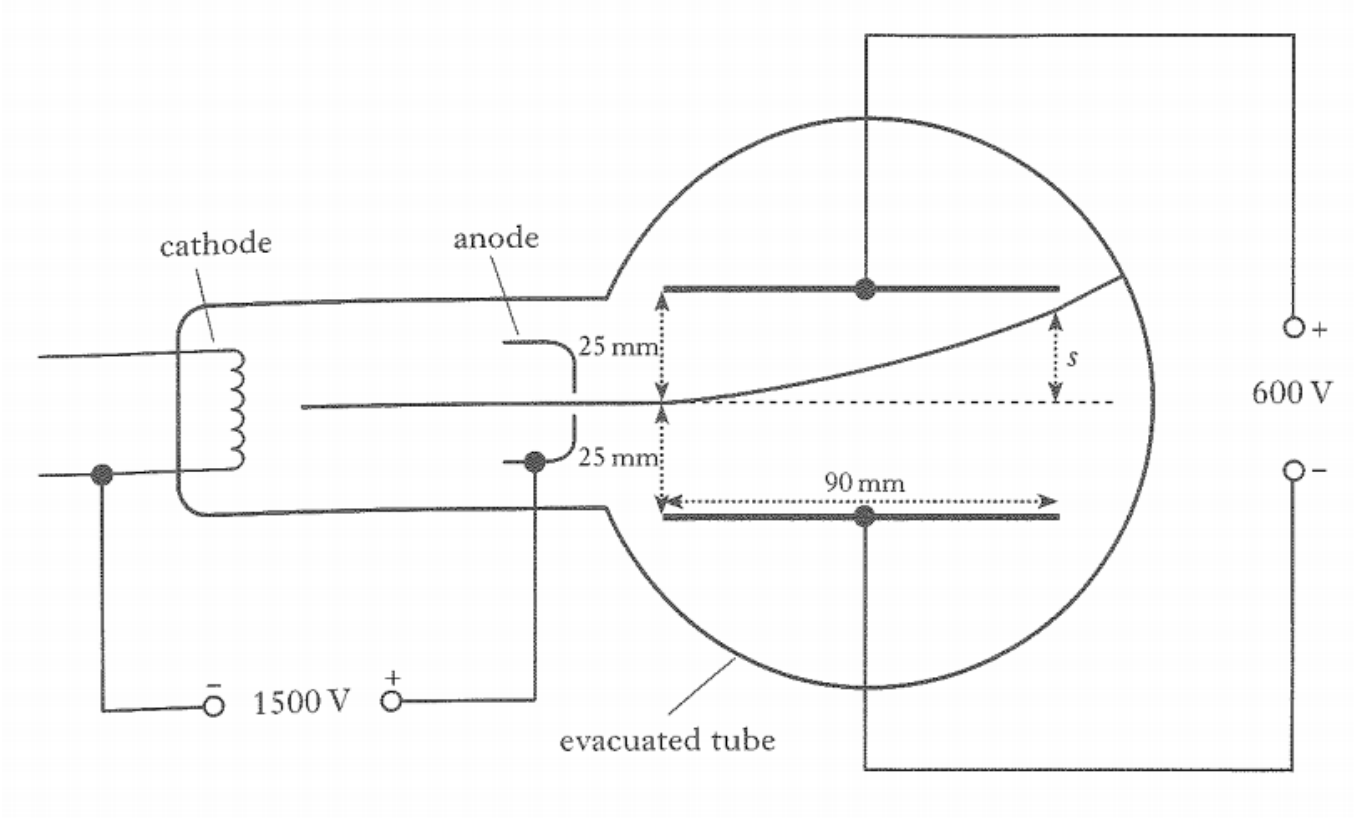


Figure 5

The electrons start from rest at the cathode and are accelerated towards the anode by a potential difference of 1500V. Electrons enter the electric field at a point midway between the two parallel deflecting plates. The deflecting plates are 90mm long and 50mm apart. There is a potential difference of 600V between the deflecting plates.

(a) Show that the speed of an electron at the anode is 2.3×10^7 ms^{-1}. (2 marks)

(b) Calculate the time an electron takes to pass between the deflecting plates. (2 marks)

(c) In Figure 5, sketch the electric field between the parallel plates. (2 marks)

(d) Find the acceleration of the electron inside the parallel plates. (2 marks)

(e) Find s. (2 marks)

(f) If the potential difference between the deflecting plates decreases, sketch the new path of the electrons in Figure 5. (1 mark)

6. Susan uses an ammeter and a voltmeter to measure the resistance of a tungsten filament of a light bulb. She draws the following circuit diagram for the experiment.

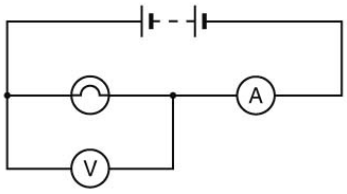


Figure 6.1

(a) Draw lines in Figure 6.2 to connect the apparatus given below into a circuit according to the above circuit diagram. (2 marks)

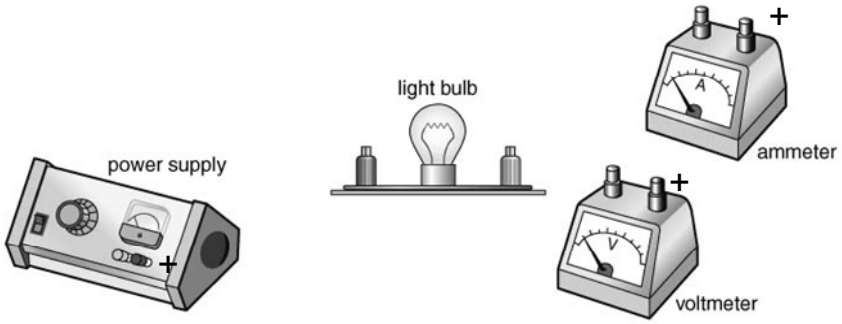


Figure 6.2

She found that the reading of the voltmeter and ammeter is 12V and 0.4A.

(b) Find the measured resistance of the light bulb, *R*. (1 mark)

(c) Susan found that the ammeter is nearly ideal but the voltmeter is not ideal. The resistance of the voltmeter is 1000 Ω. Using the experiment data, find the real resistance of the light bulb. (3 marks)

(d) Explain briefly why the ammeter reading decreases when the circuit is switched on after 15 minutes. (2 marks)

7. Figure 7 shows the circuit diagram of a certain hair dryer, which contains a fan motor rated "220V, 200W" and two heating elements of resistance *R* and *R'* respectively. The hair dryer is off when the switch connects terminal "0". The hair dryer has two operating modes, 'hot' and 'healthy'. The total power consumptions in 'hot' and 'healthy' mode are 1200W and 500W respectively.

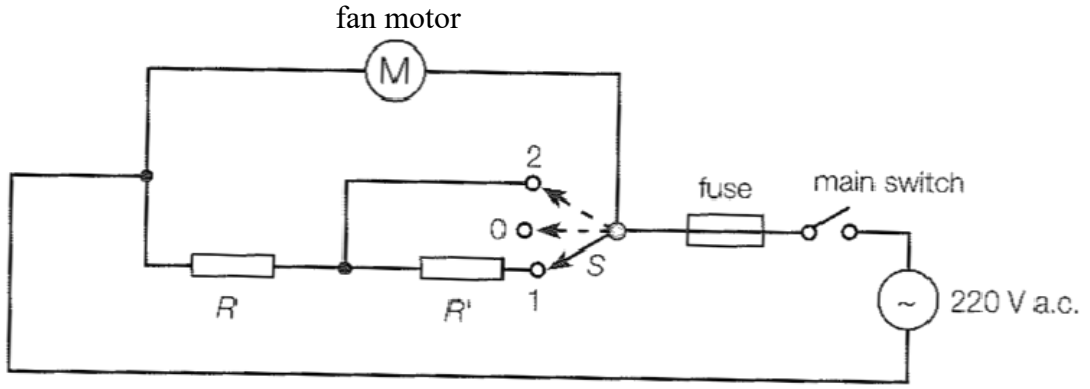


Figure 7

(a) Find the resistance of the fan motor. (1 mark)

(b) Which terminal is 'hot' mode? Explain briefly. (2 marks)

(c) Find the resistance *R* and *R'*. (3 marks)

(d) Suggest a suitable fuse rating for the hair dryer. Explain your answer. (2 marks)

(e) Normally, hair dryer does not have an earth wire. Explain why it is still safe to use it. (1 mark)

8. In Figure 8, *AB* and *CD* are two parallel infinitely long wires 20 cm apart, carrying currents I_1 and I_2 respectively. The magnetic flux density at point *P* 10 cm from wire *CD* is zero. I_2 is equal to 0.6 A.

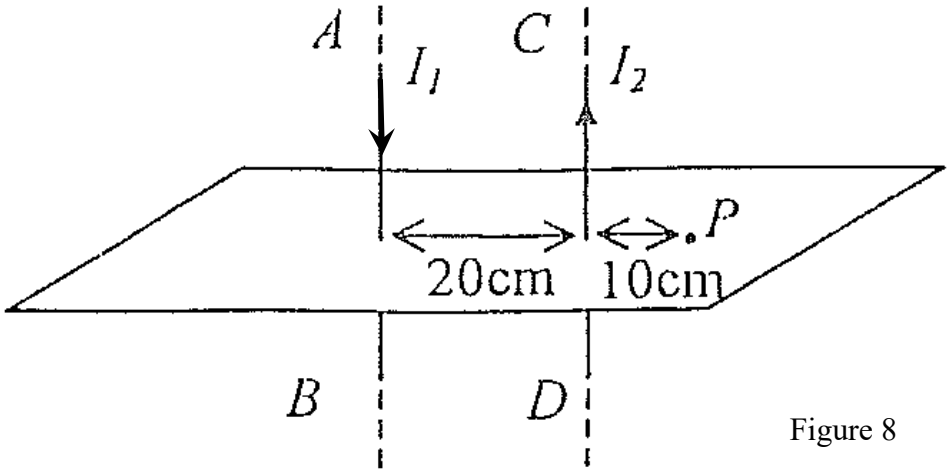


Figure 8

(a) In Figure 8, draw
  (i) the magnetic field due to **long wire *AB***, and
  (ii) the magnetic fore, F_B, exerted on *AB* by *CD*. (3 marks)

(b) Find I_1. (2 marks)

(c) A student claims that, "since I_1 and I_2 are different, the magnetic force exerted on *CD* by *AB* is not equal to F_B." Comment on his statement. (2 marks)

9. A copper rod is placed on two parallel rails inside a pair of magnets as shown in Figure 9. When the d.c. power supply is switched on, a current of 2 A passes through the copper rod. Then, it moves to the right at a uniform speed of 1 cm s^{-1}. The separation between two copper rails is 15 cm. The total friction between rails and rod is 5 x 10^{-3} N.

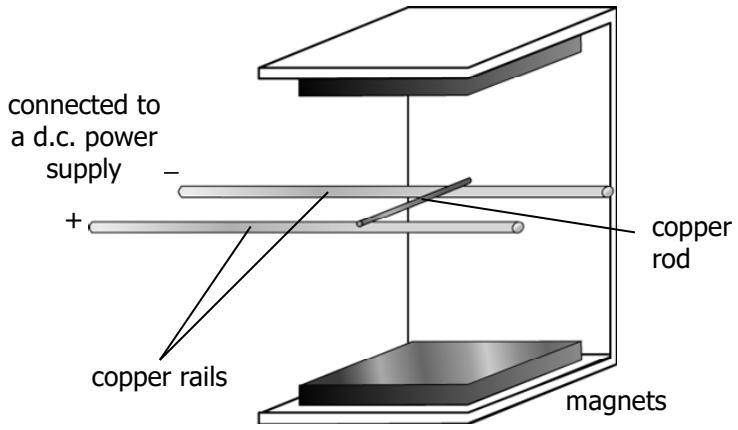


Figure 9

(a) In Figure 9, mark the polarities of the pair of magnets. (1 mark)

(b) (i) Find the magnetic field strength of the magnets. (2 marks)

(ii) Find the power of the d.c. supply. (2 marks).

(c) What happens to the rod when the following situations change separately?

(i) the polarity of the d.c. power supply is reversed. (1 mark)

(ii) the separation between two copper rails is decreased. (1 mark)

(iii) the power supply is change to 50 Hz a.c. power supply. (1 mark)

10. Figure 10 shows a closed square coil *ABCD* of 50 turns, length 1.2 m and total resistance 0.8 Ω. The coil is placed in a uniform magnetic field with flux density 2 μT pointing into the paper. Initially the coil is at rest and the magnetic field lines are normal to the coil. When the coil rotates about its diagonal *AC* through 180° in 0.18 s in the direction shown, an induced current is recorded in the coil.

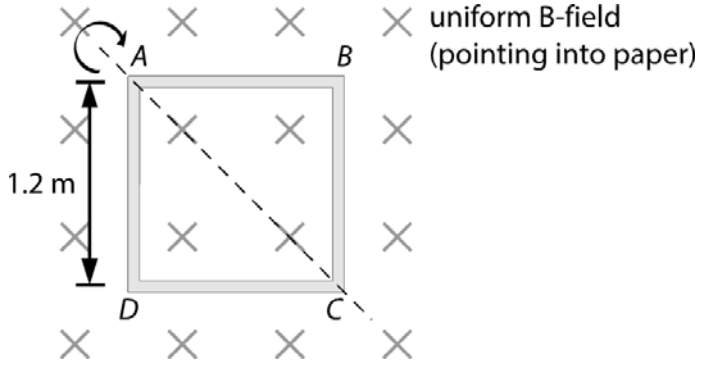


Figure 10

(a) Explain why current is induced as the coil rotates about its diagonal *AC*. (3 marks)

(b) In Figure 10, use an arrow to indicate the direction of the induced current flow in the coil at the instant the coil starts to rotate. (1 mark)

(c) (i) Find the initial magnetic flux linkage of the coil. (2 marks)

(ii) Estimate the average value of the induced current. (3 marks)

(d) Without changing the shape and the structure of the coil, suggest **ONE** way to increase the current induced as the coil rotates. (1 mark)

End of Section B

End of paper