5 Fig. 5.1 shows a simple electric motor. An armature is placed between 2 permanent magnets. Between the 2 magnets is a region of uniform magnetic field of flux density 40 mT. The armature consists of a single square coil of length 20 cm. The square coil is made of copper wire with a total resistance 0.50 Ω.

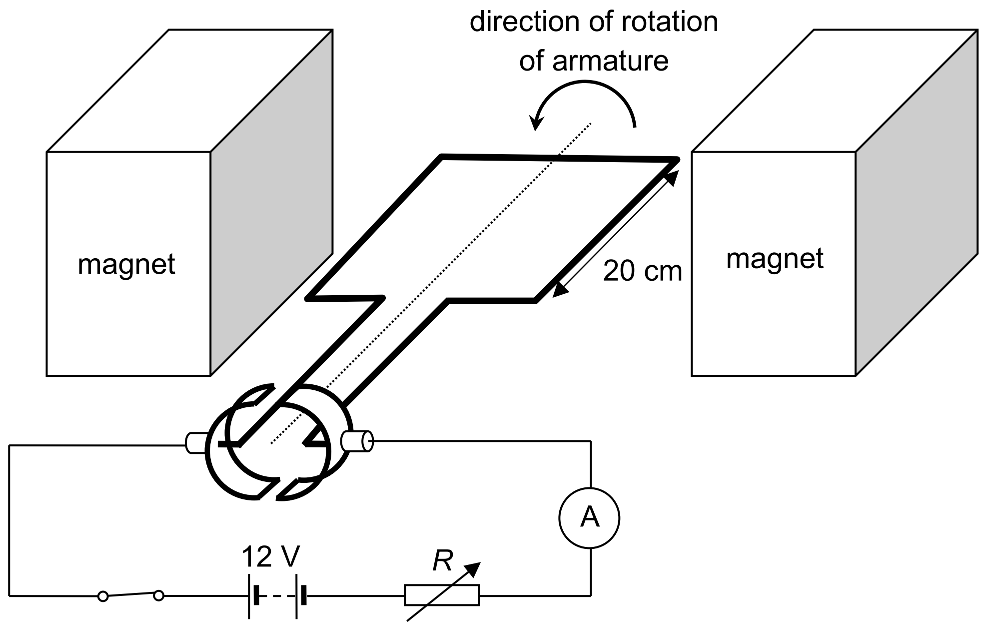

Fig. 5.1

(a) (i) On Fig. 5.1, sketch the magnetic flux in the region between the 2 magnets. [1]

(ii) The current in the armature is 0.55 A just as the armature starts to rotate from the instant shown in Fig. 5.1.

Calculate the magnitude of the torque acting on the armature just as it starts to move.

torque = ... N m [2]

(b) (i) Using Faraday's law and Lenz's law, explain why the current flowing through the armature falls below the value in **(a)(ii)** once it starts to rotate.

....

....

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....

....

.... [3]

(ii) The armature rotates at a constant angular velocity. At this steady state, current in the armature fluctuates periodically and reaches a minimum value of 0.14 A.

Determine the maximum rate of change of magnetic flux linkage that the armature experiences within the region of uniform magnetic flux density.

maximum rate = ... Wb s^{-1} [3]

(c) In reality, magnets used in motors typically have curved pole pieces, as shown in Fig. 5.2.

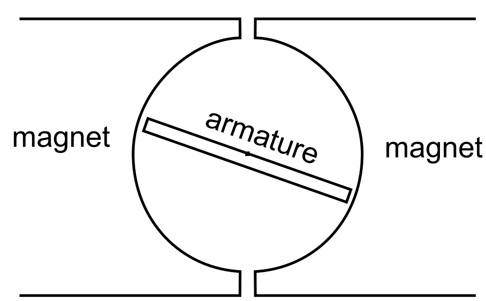

Fig. 5.2

Suggest how curved pole pieces can achieve a smoother running motor.

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.... [1]

[Total: 10]