7 **(a)** State Faraday's law of electromagnetic induction.

.....

.....

..... [2]

(b) An aircraft is flying horizontally at constant speed v through the Earth's magnetic field, as shown in Fig. 7.1.

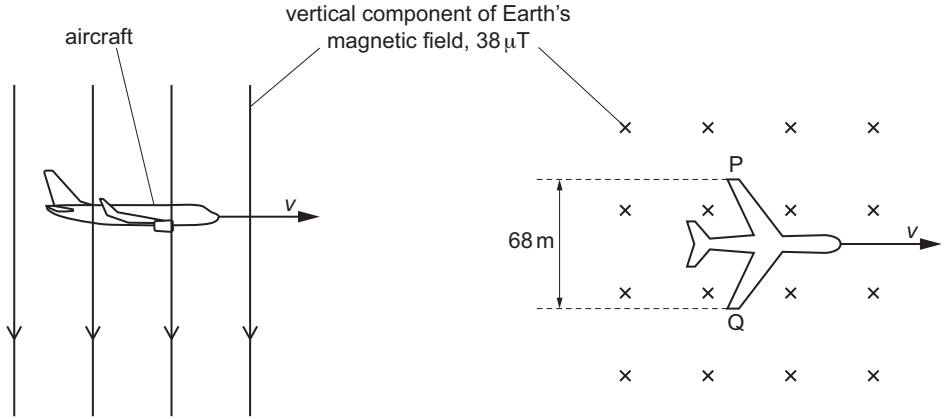

Fig. 7.1

At the location of the aircraft, the vertical component of the Earth's magnetic field is 38 μT towards the ground.

The distance between the wingtips P and Q of the aircraft is 68 m.

As the aircraft moves through the magnetic field, an electromotive force (e.m.f.) of 0.54 V is induced between the wingtips P and Q.

(i) Calculate the magnetic flux cut by the wings of the aircraft in a time of 15 s. Give a unit with your answer.

magnetic flux = ... unit ..... [2]

(ii) Determine the area of flux cut by the wings in a time of 15 s.

area = ...m^2 [2]

(iii) Use your answer in **(b)(ii)** to determine the speed v of the aircraft.

v = ...$m\,s^{-1}$ [2]

(iv) Use Lenz's law of electromagnetic induction to explain which of the wingtips P and Q is at the higher induced potential.

.....

.....

.....

.....

..... [3]

[Total: 11]

7 A bar magnet is suspended from a spring. One pole of the magnet oscillates freely in a coil of wire, as shown in Fig. 7.1.

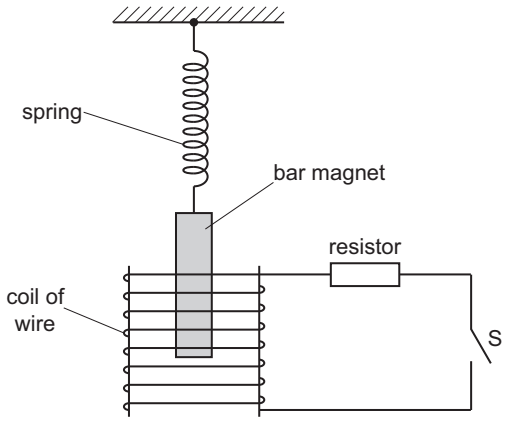

Fig. 7.1

The switch S is initially open.

(a) The switch S is now closed. As a result, the oscillations of the magnet are lightly damped.

(i) State what is meant by damping.

.....

.....

..... [2]

(ii) Describe what is observed to indicate that the damping is light.

.....

..... [1]

(iii) By reference to electromagnetic induction and to conservation of energy, explain why the oscillations are damped.

.....

.....

.....

..... [3]

(b) The procedure in **(a)** is repeated after replacing the resistor with one of greater resistance.

Suggest, with a reason, the effect of this change on the oscillations.

.....

.....

..... [2]

[Total: 8]

7 **(a)** State Faraday's law of electromagnetic induction.

.....

.....

..... [2]

(b) A metal rod is accelerated uniformly from rest in a uniform magnetic field as shown in Fig. 7.1.

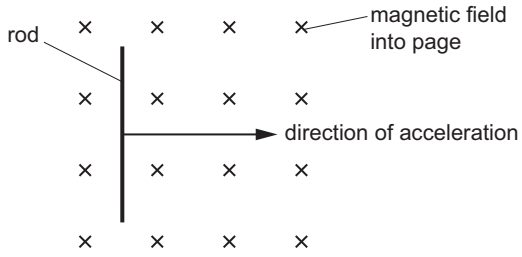

Fig. 7.1

The rod has length l and the flux density of the magnetic field is B.

An electromotive force (e.m.f.) is induced in the rod. The variation with time t of the induced e.m.f. E is shown in Fig. 7.2.

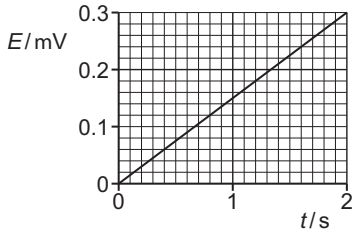

Fig. 7.2

(i) Explain how Fig. 7.2 shows that E is proportional to the velocity v of the rod.

.....

.....

..... [2]

(ii) Use Faraday's law to show that the variation of E with time t is given by

$$E = Blat$$

where a is the acceleration of the rod.

[3]

(iii) The length of the rod is 0.45 m. The acceleration a of the rod is 7.8 m s^{-2}.

Determine the value of B.

B = ... T [2]

[Total: 9]