8 **(a)** **(i)** Force-fields may be represented using lines that have direction. Conventionally, arrows on the field lines define the direction of a force acting on a test object.

State the property of the object that experiences a force in this direction for

1. gravitational field,

....[1]

2. an electric field

....[1]

(ii) Suggest why, when defining electric field strength, the object must be stationary.

....

....[1]

(b) Two long wires *X* and *Y* carrying the same current 290 A but in opposite direction is placed parallel to each other as shown in Fig. 8.1. Distance between each wire is 5.0 cm.

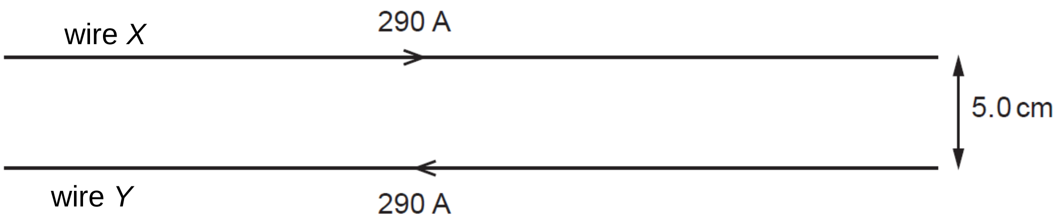

Fig. 8.1

(i) Show that the magnitude of magnetic flux density at wire *X* is 1.2×10^{-3} T.

[1]

(ii) Calculate the force per unit length on wire *X*.

force per unit length = ... N m^{-1} [2]

(c) An electron is halfway between the wires *X* and *Y* in **(b)**, travelling at a speed of 2.9×10^7 m s^{-1} parallel to the wires as shown in Fig. 8.2.

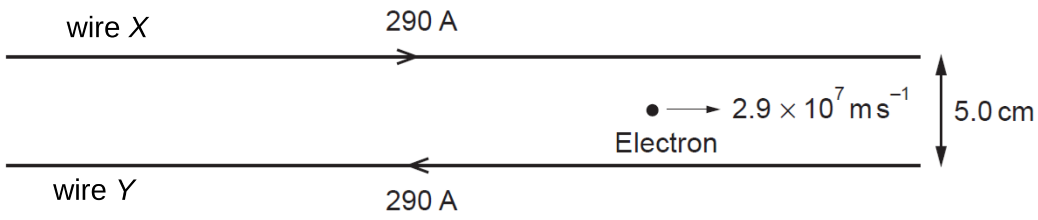

Fig. 8.2

(i) The magnetic flux density halfway between the wires is 4.64 mT. Show that the resultant force acting on the electron is 2.2×10^{-14} N.

Explain your working.

[2]

(ii) A student claims that this electron will perform a circular motion between the wires.

Explain why the student's claim is incorrect.

....

....

....

....[2]

(iii) Sketch the motion of the electron in Fig. 8.3.

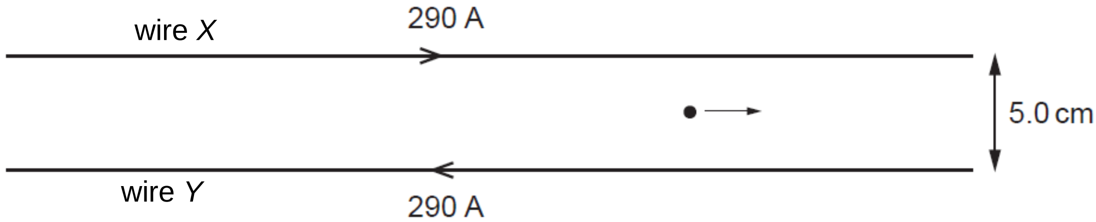

Fig. 8.3

[1]

(d) Suppose that an electron travels in a region with a magnetic field and an electric field due to two parallel metal plates as shown in Fig. 8.4.

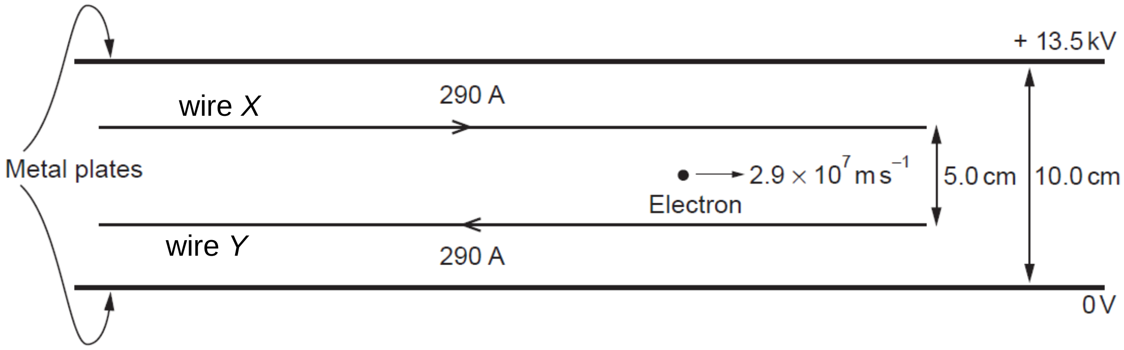

Fig. 8.4

Deduce whether the electron continues with constant velocity.

....[2]

(e) Assume that the Earth is an isolated perfect sphere as shown in Fig. 8.5, draw its gravitational field lines with solid line and equipotential surfaces with dashed line.

Fig. 8.5

[3]

(f) The Earth E and the Moon M can be considered as isolated point masses at their centres. The mass of the Earth is 5.98×10^{24} kg and the mass of the Moon is 7.35×10^{22} kg. The Earth and Moon are separated by a distance of 3.84×10^{5} km as shown in Fig. 8.6.

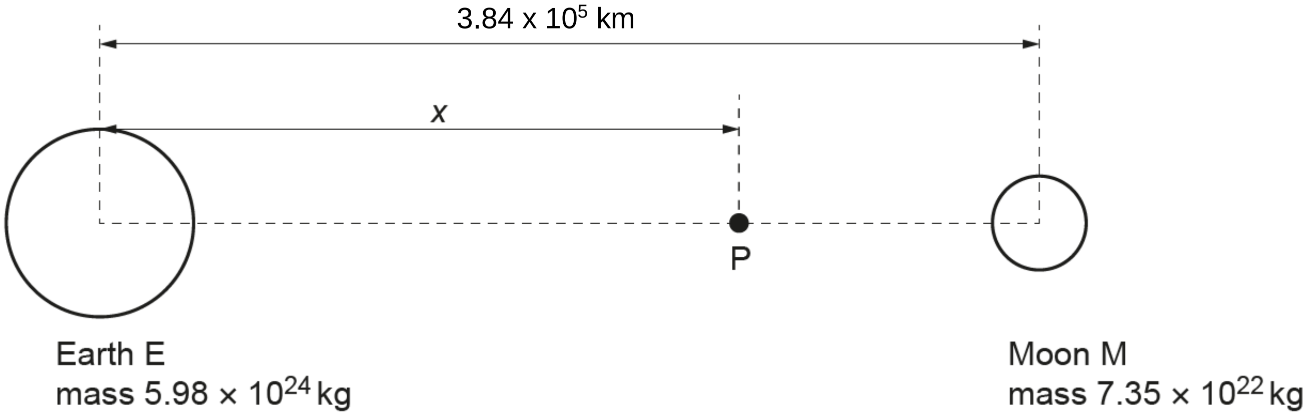

Fig. 8.6 (not to scale)

Point P is a point along the line joining the centres of E and M, where the resultant gravitational field strength is zero. Point P is at a distance x from centre of the Earth.

(i) Show that x is approximately 3.5×10^{8} m.

[2]

(ii) The resultant force on a 2.5×10^{4} kg spaceship is zero at point P. The force would increase by approximately 0.50 N for every 10 km moved away from point P towards the Earth.

A student claims that the spaceship will perform simple harmonic motion about point **P.** Deduce whether or not the student's claim is correct. (No further calculations are required.)

………

………

………

………[2]

[Total: 20 m]

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