2   (a) A satellite is used to broadcast television signals to north-western Europe.

   (i)   State the type of orbit that is required for a satellite used for this purpose.

   .... [1]

   (ii) The satellite moves at a constant speed.

         Explain why it is accelerating.

         ....

         ....

         ....

         ....

         ....

         ....

         .... [3]

   (b) Table 2.1 shows data for some of the planets in the solar system.

Table 2.1

name	orbital period T/years	radius r of orbit around Sun/AU
Mercury	0.24	0.39
Venus	0.62	0.72
Earth	1.0	1.0
Mars	1.9	1.5
Saturn	30	9.5

(i) 1 AU means 1 astronomical unit which is the radius of the orbit of the Earth around the Sun.

It is suggested that the orbital period T and the radius of the orbit around the sun r are related by the equation:

$$T = p \times r^q$$

where p and q are constants.

Describe how a graph can be plotted to determine the constants p and q.

....

....

....

....

....

....

.... [3]

(ii) It is found that, when T is in years and r is in AU, the numerical value of p is 1.0 and the value of q is 1.5.

The planet Uranus has an orbital period of 84 years.

Calculate the radius of its orbit in AU.

radius = ... AU [2]

(c) A scientist plots some values of the gravitational force F acting on a satellite orbiting the Earth.

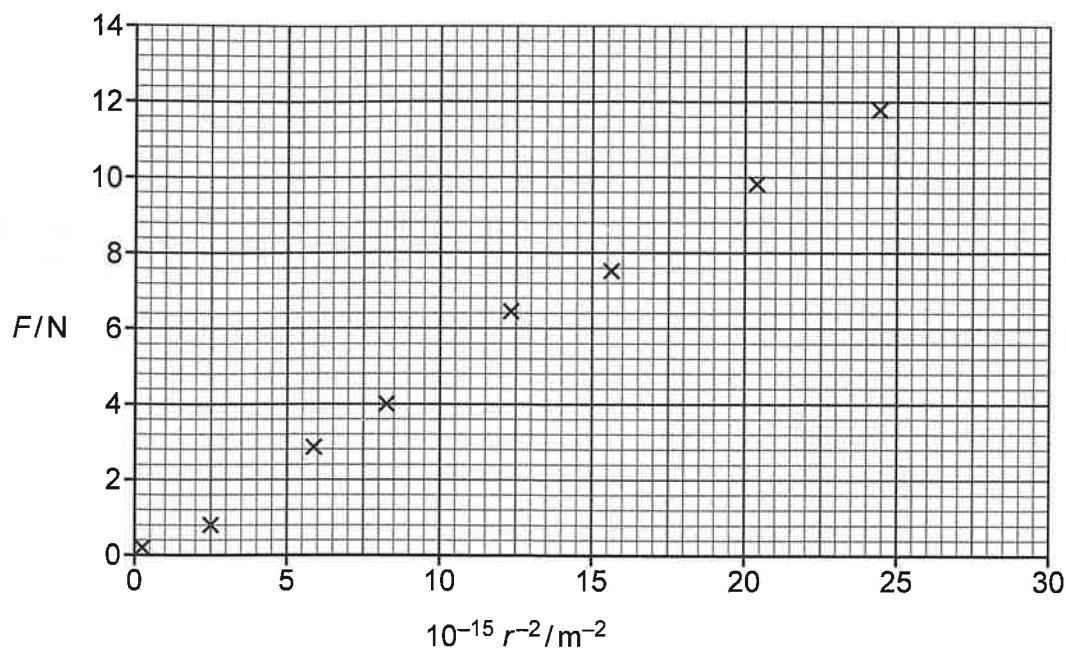Fig. 2.1 shows how F varies with $1/r^2$, where r is the radius of the orbit.

Fig. 2.1

(i) On Fig. 2.1, draw the line of best fit. [1]

(ii) Calculate the gradient of the graph.

State the unit.

gradient = ... unit .... [3]

(iii) Prior to launch, the mass of the satellite was measured to be 1200 g ± 10 g. The satellite is a cube with side length 10.0 cm ± 0.1 cm.

Calculate the density of the satellite with an estimate of its percentage uncertainty.

density = ... g cm^{-3}

uncertainty = ... %
[3]

[Total: 16]