Answer **all** the questions in the spaces provided.

1 A satellite is in a circular orbit of radius r about the Earth of mass M, as illustrated in Fig. 1.1.

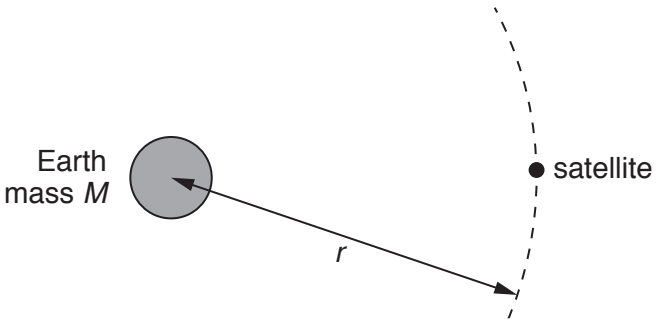

Fig. 1.1

The mass of the Earth may be assumed to be concentrated at its centre.

(a) Show that the period T of the orbit of the satellite is given by the expression

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

where G is the gravitational constant. Explain your working.

[3]

(b) (i) A satellite in geostationary orbit appears to remain above the same point on the Earth and has a period of 24 hours.
State two other features of a *geostationary* orbit.

1. .....

.....

2. .....

.....

[2]

(ii) The mass M of the Earth is 6.0×10^{24} kg.
Use the expression in **(a)** to determine the radius of a geostationary orbit.

radius = ... m [2]

(c) A global positioning system (GPS) satellite orbits the Earth at a height of 2.0×10^{4} km above the Earth's surface.
The radius of the Earth is 6.4×10^{3} km.

Use your answer in **(b)(ii)** and the expression

$$T^2 \propto r^3$$

to calculate, in hours, the period of the orbit of this satellite.

period = ... hours [2]

[Total: 9]

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[Turn over