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

1 **(a)** Two point masses are isolated in space and are separated by a distance x.

State an expression relating the gravitational force F between the two masses to the magnitudes M and m of the masses. State the name of any other symbol used.

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..... [1]

(b) A spacecraft is to be put into a circular orbit about a spherical planet.

The planet may be considered to be isolated in space. The mass of the planet, assumed to be concentrated at its centre, is 7.5×10^{23} kg. The radius of the planet is 3.4×10^{6} m.

(i) The spacecraft is to orbit the planet at a height of 2.4×10^{5} m above the surface of the planet. At this altitude, there is no atmosphere.

Show that the speed of the spacecraft in its orbit is $3.7 \times 10^{3}\,\text{m s}^{-1}$.

[2]

(ii) One possible path of the spacecraft as it approaches the planet is shown in Fig. 1.1.

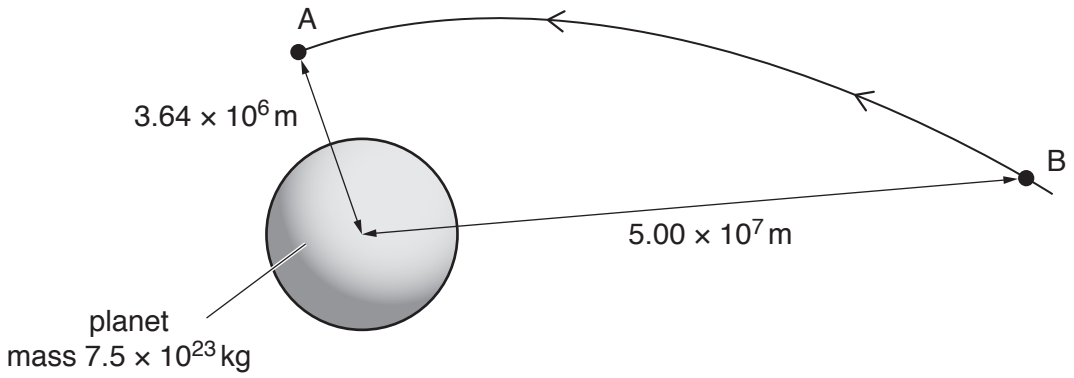

Fig. 1.1 (not to scale)

The spacecraft enters the orbit at point A with speed $3.7 \times 10^3\,m\,s^{-1}$.

At point B, a distance of $5.00 \times 10^7\,m$ from the centre of the planet, the spacecraft has a speed of $4.1 \times 10^3\,m\,s^{-1}$. The mass of the spacecraft is 650 kg.

For the spacecraft moving from point B to point A, show that the change in gravitational potential energy of the spacecraft is $8.3 \times 10^9\,J$.

[3]

(c) By considering changes in gravitational potential energy and in kinetic energy of the spacecraft, determine whether the total energy of the spacecraft increases or decreases in moving from point B to point A. A numerical answer is not required.

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..... [2]

[Total: 8]