2 (a) A star and a planet orbit their mutual centre of mass as shown in Fig. 2.1. The diagram is not to scale.

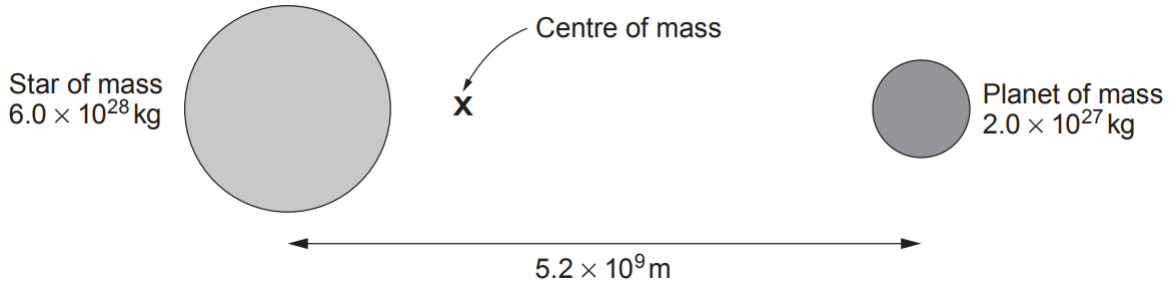

Fig. 2.1

(i) Calculate the distance of the centre of mass from the centre of the star. Explain your working clearly.

distance = ... m [2]

(ii) Calculate the period of orbit.

period = ... s [2]

(iii) Astronomers note a periodic dip in the brightness of the star as shown in Fig. 2.2.

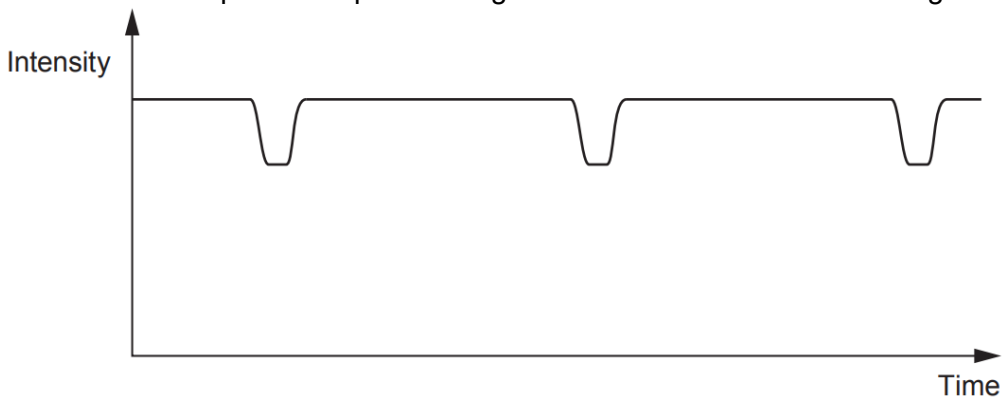

Fig. 2.2

Explain this observation.

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.....

.....[1]

(b) The satellite NOAA-20 was launched in November 2017. The satellite has an approximately circular orbit at an altitude of 825 km above the Earth's surface. The radius of the Earth = 6.4×10^6 m.

Fig. 2.3 shows how the gravitational field strength g of the Earth varies with distance r from the centre of the Earth.

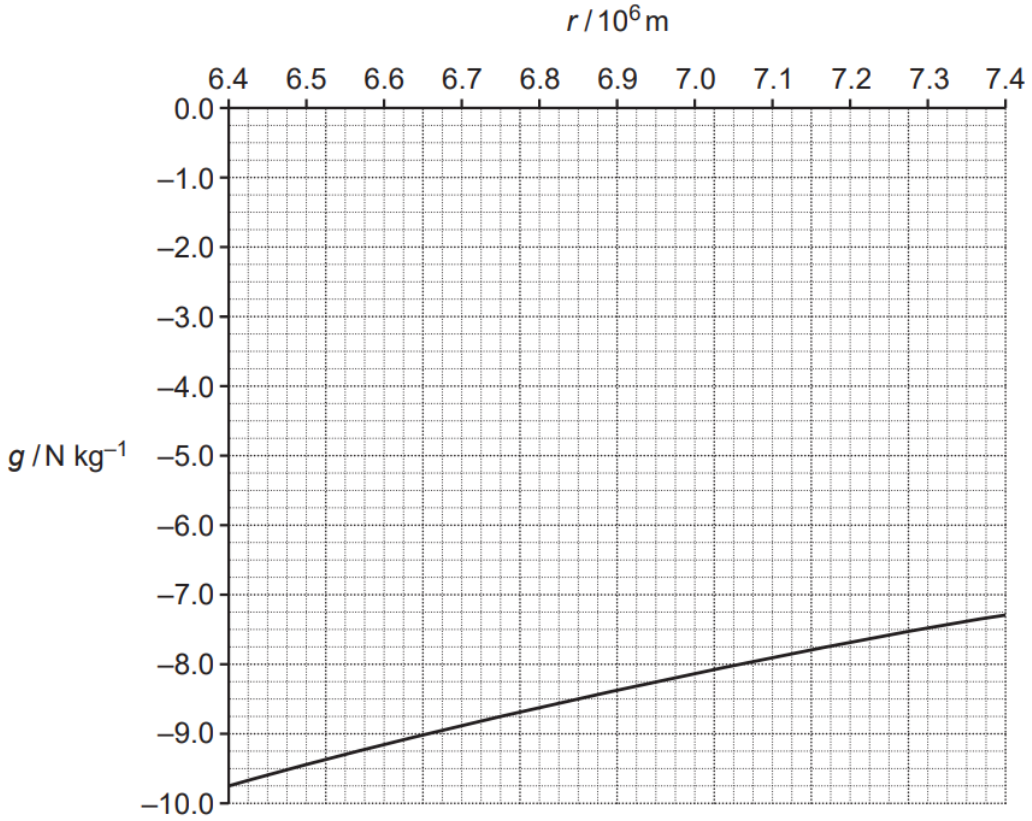

Fig. 2.3

(i) The mass of the satellite is 2300 kg. Use the graph to show that the change in gravitational potential energy of the satellite between its launch and its position in orbit is about 1.6×10^{10} J. Explain your working clearly.

[3]

(ii) Use the value for the change in potential energy from **(b)(i)** to determine the mass of the Earth.

mass of Earth = ... kg [2]

(iii) The satellite takes a polar orbit, revolving around the Earth from pole to pole, as shown in Fig. 2.4. Geostationary satellites orbit at a greater distance from the Earth.

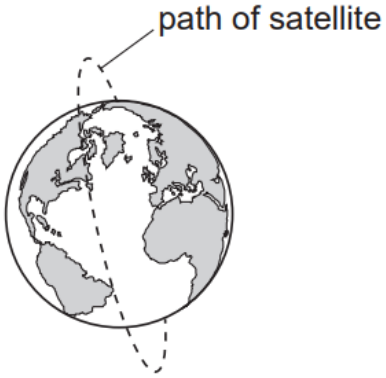

Fig. 2.4

Explain why a low, polar orbit is useful for satellites used for weather forecasting and suggest why geostationary satellites are used for telecommunications

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.....[2]