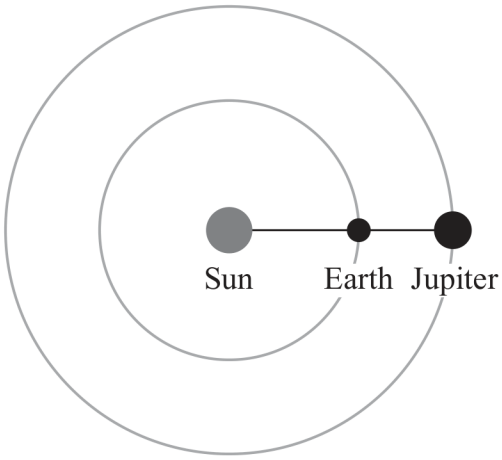
16 The planets orbit the Sun in approximately circular orbits. The orbital time T of a planet is related to the average distance r of the planet from the Sun.

(a) (i) Show that T is related to r by the expression:

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

(3)

(ii) When planets align as they orbit the Sun they are said to be 'in opposition'.
The diagram shows the Earth and Jupiter in opposition.



NOT TO SCALE

A website states that the Earth and Jupiter are in opposition every 13 months.

Deduce whether this statement is correct.

mean distance from Earth to Sun = 1.5×10^{11} m
mean distance from Jupiter to Sun = 7.8×10^{11} m
T_{Earth} = 12 months

(5)

(b) The distance of Jupiter from the Sun varies from 7.4×10^{11} m to 8.2×10^{11} m.

Calculate the change in gravitational potential energy of Jupiter as it moves from its closest distance to its furthest distance from the Sun.

mass of Sun = 2.0×10^{30} kg
mass of Jupiter = 1.9×10^{27} kg

(3)

Change in gravitational potential energy = ...

(Total for Question 16 = 11 marks)

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