Gravity Problems II

Constants: $M_{sun} = 2 \times 10^{30}$ kg $M_{earth} = 6 \times 10^{24}$ kg 1 AU = 1.5×10^{11} m R_{sun} = 700,000 km

1. How fast would an object be going if it "fell" from infinitely far away and hit the sun?

2. How fast is the earth moving in its orbit around the sun? (Assume it's a circular orbit.)

3. How fast would the earth have to move to get infinitely far away from the sun?

4. If you throw a rock with a speed of 2500 m/s from the surface of the earth, how high above the earth would it go? (Ignore air resistance.)

5. Two objects, m_1 and m_2 are separated by a distance of d. How much work would it take to triple their separation?

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6. A satellite of mass m has a circular orbit of radius R around a planet of mass M. Show that the total energy of the satellite is given by the expression $E = -G\frac{mM}{2R}$. (If you are bored, prove the equation is true even in the case of an elliptical orbit, where R is the semi-major axis. To do this, think about the energy at perihelion and aphelion and also think about conservation of angular momentum.)

7. For some reason, a 5000 kg satellite is put into orbit around the sun with a period of 7 years. What is the total energy of the satellite in this orbit?

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8. An asteroid has a period of 2585 days around the sun. If its *maximum* speed in its orbit around the sun is 40,000 m/s, what is its closest distance to the sun (i.e. what is its perihelion?)

Answers:

1) 617,000 m/s *2) 29,800 m/s* *3) 42,200 m/s*

4) 300 km *5) $(2/3)Gm_1m_2/d$*

6) hint 1: total energy = kinetic + potential

hint 2 (elliptical): E @perihelion = E @aphelion & L is also conserved

7) -6.1×10^{11} J *8) 1.44×10^{11} m*