Subject 11

Please, do not write on the exam paper

Johannes Kepler was a German mathematician, astronomer and astrologer. A key figure in the 17th century scientific revolution, he is best known for his eponymous laws of planetary motion. These works also provided one of the foundations for Isaac Newton's theory of universal gravitation.
The third law, published in 1619 captures the relationship between the distance of planets from the Sun, and their orbital periods.
Symbolically "The square of the orbital period of a planet is directly proportional to the cube of the semi-major axis of its orbit." or $\frac{R^3}{T^2}$ = Constant where R is the length of the semi-major axis of the planet orbit and T is the orbital period.

Planet	Length of the semi-major axis in million kilometres	Orbital period in days
Mercury	57.91	87.97
Venus	108.21	224.7
Earth	149.6	
Mars	227.94	686.98
Jupiter		4332.71
Saturn	1427.0	

QUESTIONS

1. According to the first two lines of the table, what is the value of the constant ? Round off the value to the thousandth. Is it still a good approximation for Mars ?
2. Express T (the period) as a function depending on R. Why can you ignore the negative root ?
3. Using the given formula or the previous function, what is the orbital period for the Earth ? Round your result to the nearest hundredth. What do you think of this result ?
4. a) Using the given formula, what is the length of the semi-major axis for Jupiter ?
   b) Knowing that one A.U. (Astronomical Unit) is equal to the distance separating the Earth from the Sun, what is the distance between the Sun and Jupiter in A.U. ?
5. a) Using the given formula or the function (question 2.), what is the orbital period for Saturn ?
   b) Convert the orbital period of Saturn into Earth years. (Use 365.26 days for one year)