Law Three

Data from different sources varies so references were included below the following table. (4~5 sig figs)

Name	Average radius (m)	Mass (kg)	Mean Orbital Radius (m)	Period(days)	Orbital radius (AU)	Period (years)
Sun	**696.0×10^6**	**1.991×10^{30}**				
Mercury	**2.43×10^6**	**3.2×10^{23}**	**5.80×10^{10}**	**87.77**	**0.388**	**0.240**
Venus	**6.073×10^6**	**4.88×10^{24}**	**1.081×10^{11}**	**224.70**	**0.723**	**0.615**
Earth	**6.3713×10^6**	**5.979×10^{24}**	**1.4957×10^{11}**	**365.25**	**1.000**	**1.000**
Mars	**3.38×10^6**	**6.42×10^{23}**	**2.278×10^{11}**	**686.98**	1.523	1.881
Jupiter	**69.8×10^6**	**1.901×10^{27}**	**7.781×10^{11}**	**4332.62**	5.202	11.862
Saturn	**58.2×10^6**	**5.68×10^{26}**	**1.427×10^{12}**	**10759.20**	9.541	29.457
Uranus	**23.5×10^6**	**8.68×10^{25}**	**2.870×10^{12}**	**30685**	19.188	84.011
Neptune	**22.7×10^6**	**1.03×10^{26}**	**4.500×10^{12}**	60275.70	30.086	165.026
Pluto	**1.15×10^6**	**1.2×10^{22}**	**5.9×10^{12}**	90490.19	39.446	247.749

Calculate $K\left[\frac{AU^3}{y^2}\right]$ for 3 or 4

Q1. Use the data for Earth and Mars to illustrate Kepler's third law.

$T_E = 365.25\ d$

$r_E = 1.4957 \times 10^{11}\ m$

$T_M = 686.98\ d$

$r_M = 2.278 \times 10^{11}\ m$

$K = \frac{r_E^3}{T_E^2} = \frac{r_M^3}{T_M^2}$

$K_E = \frac{r_E^3}{T_E^2} = \frac{(1.4957 \times 10^{11}\ m)^3}{(365.25\ d)^2}$

$= 2.50815 \times 10^{28}\ m^3/d^2$

% diff = 0.12%

$K_M = \frac{r_M^3}{T_M^2} = \frac{(2.278 \times 10^{11}\ m)^3}{(686.98\ d)^2} = 2.5047 \times 10^{28}\ m^3/d^2$

Q2. Use the data in the table to find the period of Neptune (referenced to Earth).

$T_E = 365.25\ d$

$r_E = 1.4957 \times 10^{11}\ m$

$r_N = 4.500 \times 10^{12}\ m$

$\frac{r_E^3}{T_E^2} = \frac{r_N^3}{T_N^2}$

$T_N = \sqrt{\frac{T_E^2 r_N^3}{r_e^3}}$

$T_N = \sqrt{\frac{(365.25\ d)^2 (4.500 \times 10^{12}\ m)^3}{(1.4957 \times 10^{11}\ m)^3}} = 60275.70\ d$

Q3. Use the data in the table to find the period of Pluto (referenced to the Earth).

$r_P = 5.9 \times 10^{12}\ m$

$T_P = \sqrt{\frac{T_E^2 r_P^3}{r_E^3}} = 90490.19\ d$

Q4. Complete the AU and year columns in the table for the remaining planets.

AU = astronomical unit

$\text{ratio} = \frac{r_{body}}{r_{Earth}}$ $\text{ratio} = \frac{T_{body}}{T_{Earth}}$