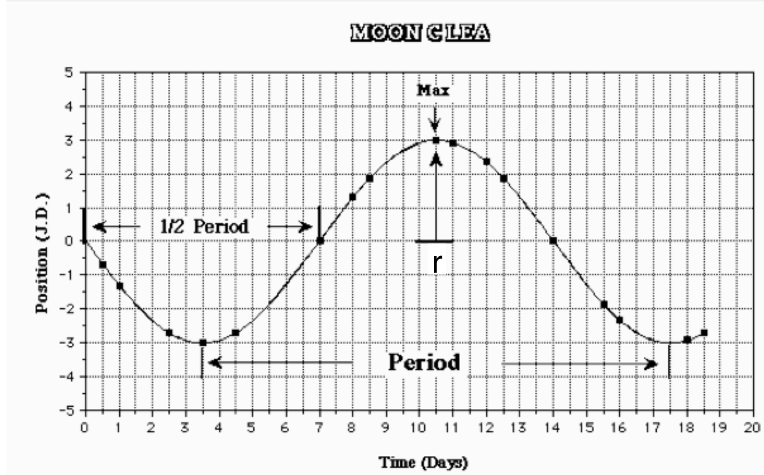
Quiz 05: Determining the Mass of Jupiter

Answer each of the following questions using your clicker. You must respond using your clicker; papers will not be marked by hand.

You may use your lab notebook and a calculator. Each question is worth **3 points**, and there is no partial credit.

You are observing a newly-discovered moon of Jupiter called Clea. Using the same methods as you used in lab, you have plotted its position relative to Jupiter over the course of several weeks. **Use the graph on the right to answer the following questions.**



1. What is the **orbital radius r** (in JD) of moon Clea? ***Answer numerically (no units)!*** r = 3 JD
2. What is the **orbital period T** (in days) of the moon Clea? ***Answer numerically (no units)!*** T = 14 days
3. Examine this data and comment on how you know it has been faked! (*Clea is not a real jovian moon!*)
   A) There is nothing on the graph to indicate false data; no one would suspect a hoax.
   B) A moon with that orbital radius should have a much shorter orbital period than the data indicate.
   C) A moon with that orbital radius ought to have a longer orbital period than the data indicate.
   D) If a moon existed at that distance, it would probably disrupt the other moons, and all the data would be incorrect.
4. From data collected for the moon Europa, you have determined that it takes Europa **T = 4.80** days to complete one orbit, and its orbital radius is **r = 3.55 JD**. Use these values to calculate the mass of Jupiter.
   A) 1.88×10^{27} kg
   B) 1.90×10^{27} kg
   C) 1.92×10^{27} kg
   D) 1.99×10^{27} kg

$$M = (2.27\times10^{26})\frac{r^3}{T^2}$$

$$M = (2.27\times10^{26})\frac{(4.80)^3}{(3.55)^2}$$

$$M = 1.99\times10^{26}\,\text{kg}$$

5. When data collected from multiple trials (for all four moons) is used, the mass of Jupiter is calculated to be **1.893×10^{27} kg**. Compare this to the accepted mass of (**1.9×10^{27} kg**) and calculate the **percent error** in this result.
   A) 0%
   B) 0.0035%
   C) 0.035%
   D) 0.35%
   E) 3.5%
   F) 35%

	Io	Europa	Ganymede	Callisto
r (JD)	3.02	4.80	7.66	13.46
T (days)	1.77	3.55	7.16	16.69
Experimentally Determined Mass	1.856E+27	1.925E+27	1.867E+27	1.840E+27
	1.860E+27	1.838E+27	2.805E+27	1.830E+27
	1.860E+27	1.884E+27	1.400E+27	1.873E+27
	1.960E+27	2.036E+27	1.839E+27	1.840E+27
	1.860E+27	2.000E+27	1.850E+27	1.830E+27
	1.852E+27	2.093E+27	1.756E+27	1.824E+27
	1.947E+27	1.752E+27	1.918E+27	1.764E+27
	1.890E+27	1.888E+27	1.871E+27	1.823E+27
	2.148E+27	1.879E+27	1.881E+27	1.797E+27
	2.006E+27	1.830E+27	1.800E+27	1.963E+27
Average	1.924E+27	1.913E+27	1.899E+27	1.838E+27
% error	-1.26	-0.66	0.07	3.24
Overall Average			1.893E+27	
Percent Error			0.349	

6. When collecting data on the four Galilean moons, why did we use a shorter interval between observations for the moon **Io**?
   A) It wasn't necessary, it was random. The decision to use a shorter interval was arbitrary.
   B) Io has a shorter orbital period than the other moons, so a shorter collection interval was appropriate.
   C) Io has a significantly *longer* orbital period, so requires a significantly *longer* collection interval.
7. True or false: Combining your data with observations made by other astronomers is a good idea, because their errors and your errors will tend to cancel out, making the overall results better than the individual observations.
8. True or false: Increasing the number of your observations (more days spent observing the same moon) should also increase the accuracy of your results.
9. True or false: The shorter the orbital period, the smaller the error in the results.
10. Predict the orbital period of Jupiter's moon Himalia, which has an orbital radius **r = 82 JD**.
    A) 129 days
    B) 256 days
    C) 16,799 days
    D) 65,536 days

$$M = (2.27\times10^{26})\frac{r^3}{T^2}$$

$$T = \sqrt{(2.27\times10^{26})\frac{r^3}{M}}$$

$$T = \sqrt{\frac{(2.27\times10^{26})(82)^3}{(1.9\times10^{27})}}$$

$$T = 256 \text{ days}$$