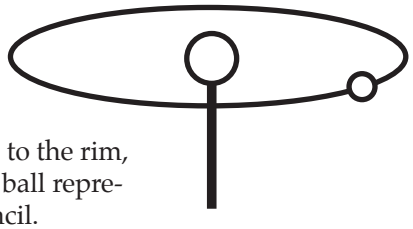
Orbits of Jupiter's Moons

Summary:
Students use a series of 31 images of Jupiter's 4 Galilean moons to find their orbit periods and orbit radii. They compare their results with known data for those moons. Finally they test various mathematical expressions to find a "constant" relationship between orbit period (T) and orbit radius (R) to arrive at Kepler's 3rd Law.

Materials:
For each student:
- 19-day Chart of Jupiter's Moons
- optional: colored pens or pencils, calculator

For the Class
- Jupiter-moon orbit demonstrator: paper plate with a bead or ball affixed to the rim, to represent a moon, and a pencil inserted through the center into a larger ball representing Jupiter. The moon can be made to orbit Jupiter by rotating the pencil.

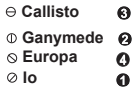
Jupiter-moon orbit demonstrator



Investigation Outline:

1. Give each student a 19-day Chart of Jupiter's Moons.
Ask if they see any patterns in the chart.

2. Let each student choose 1 moon to study, but make sure there are at least 3 students working on any given moon. If they work in teams, they can be teams of 4 with each team member taking one of the numbered moons. Challenge students to find the period (T) and the orbit radius (R). Optional: to speed up the investigation have students start with the 2nd Jupiter's Moons worksheet that has moon 2 already drawn on it.



3. Once results are found, share them with team members or with the whole class. Compare to see if results are consistent.

4. Have the students identify which moon is which using data from the the Internet or the table (right).

Periods of Galilean Satellites (in days)	
Io	1.77
Europa	3.55
Ganymede	7.15
Callisto	16.7

5. Challenge students to find a "Constant" mathmatical relationship between T and R. First give an example such as downloading a song with N = number of kilobytes downloaded and T= time elapsed. Notice how N/T is constant (K), which we might call the download speed.

N (kilobytes)	T (time)	N/T
100 kilobytes	0.5 sec	200 kilobytes/sec
200 kilobytes	1.0 sec	200 kilobytes/sec
500 kilobytes	2.5 sec	200 kilobytes/sec

N/T = K (constant) = 200 kilobytes/sec

Point out that this constant allows us to predict how long it might take to download any given song or file. E.g. how long would it take to download an 800 kb file?
[T = N/K = 800kb/200kb/sec = 4 seconds]

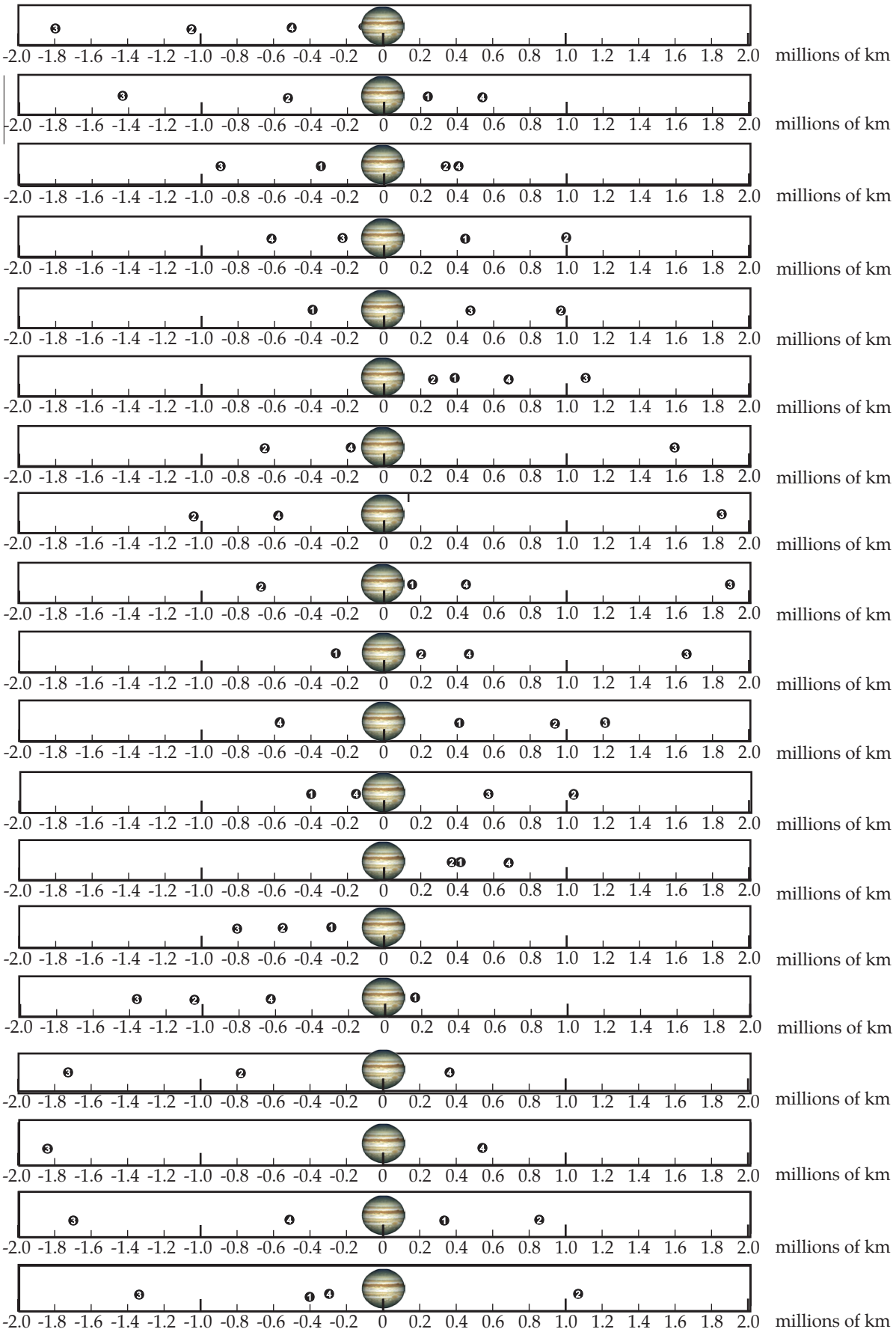
6. Challenge students to find a formula (like N/T) that will result in a "Constant" relationship between period (P) and orbit radius (R) of Jupiter's moons. Have them make a table like the kilobytes vs time table, but leave room for more columns to try out more ideas, in case P/R does not work. What else could they try? P^2/R, $P^2 \bullet R$, P^3/R^2, P^2/R^3, for example.

7. The one that comes out constant is Kepler's 3rd Law. Optional: Internet research on Kepler and his 3 laws that goven planetary motion.

Jupiter's Moons

Worksheet

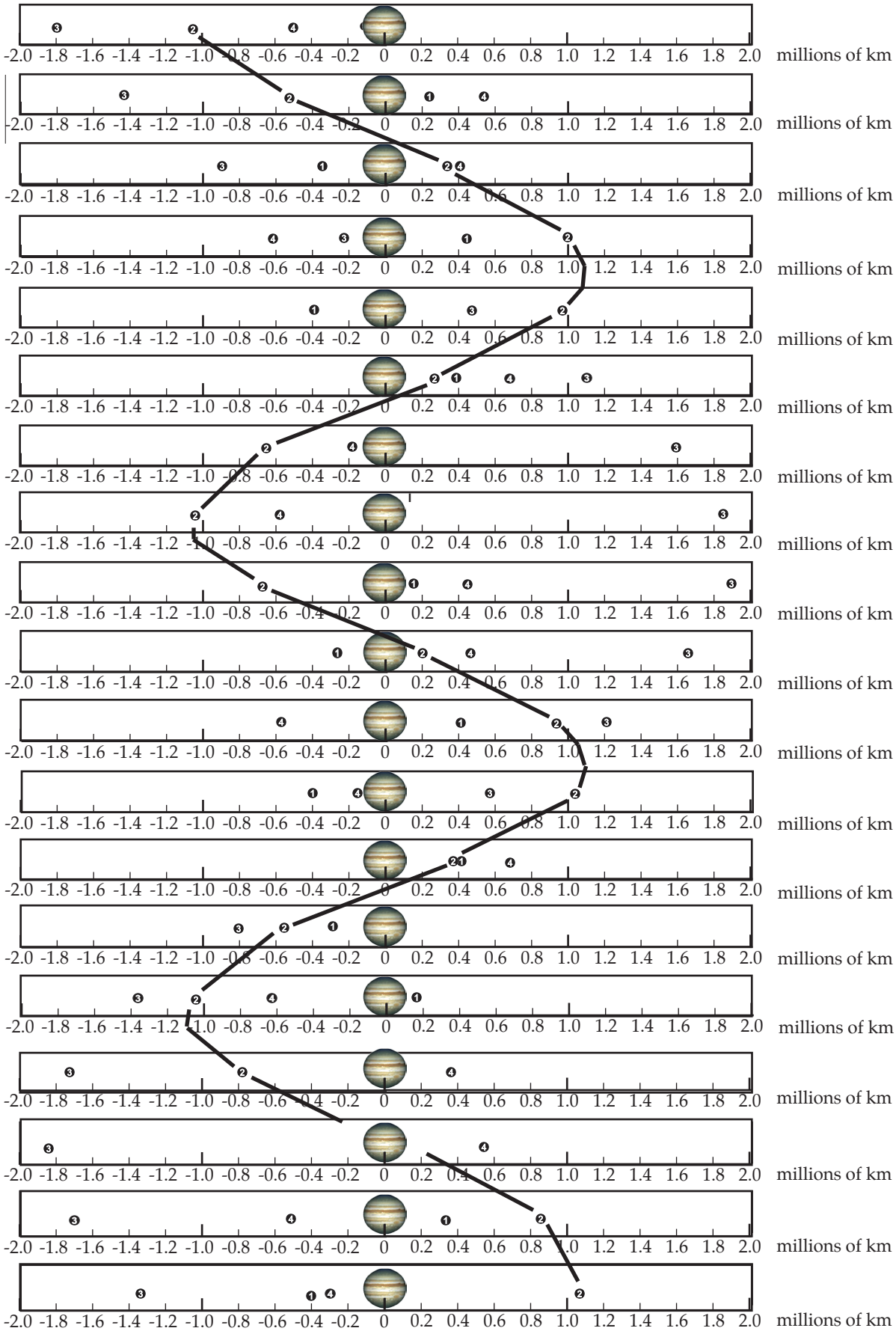
Night #



Jupiter's Moons

Worksheet

Night #



Worksheet: Kepler's 3rd Law from the orbits of moons of Jupiter

Moon	Io	Europa	Ganymede	Callisto
Period (P)				
Distance (R)				
P/R				

Write an equation using P, R, and the Constant (K) that you found.

Then calculate the distance from Jupiter of a newly discovered moon that is found to have a period of 33 days.

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