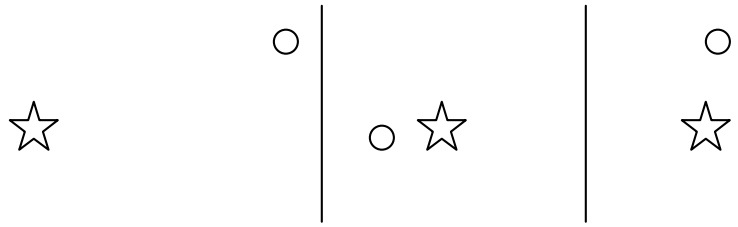
Orbits: Connecting Newton and Kepler

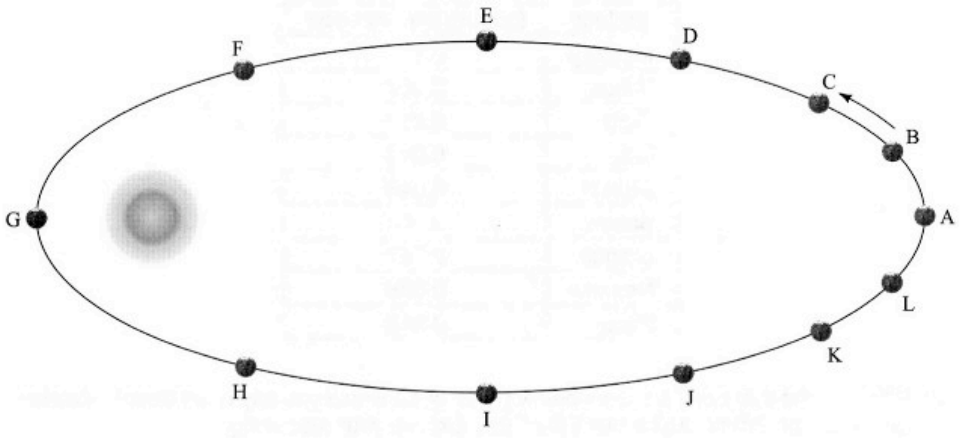
Part I: Gravity: The pictures below show the Sun and a comet. Each picture shows the asteroid (the circle) in a different point relative to the Sun (the star).



1. Newton's law of gravitation is $F = G\frac{M_1 M_2}{d^2}$ where d is the distance between the two masses. On each picture above draw an arrow that shows the gravitational force the Sun exerts on the asteroid. The arrow should point in the direction the Sun is pulling on the asteroid and should be longer when the Sun is pulling harder.

2. Explain why you drew the arrows the way you did.

Part II: Kepler's 2nd Law and speeds. The picture below shows the orbit of the asteroid with several points labeled.



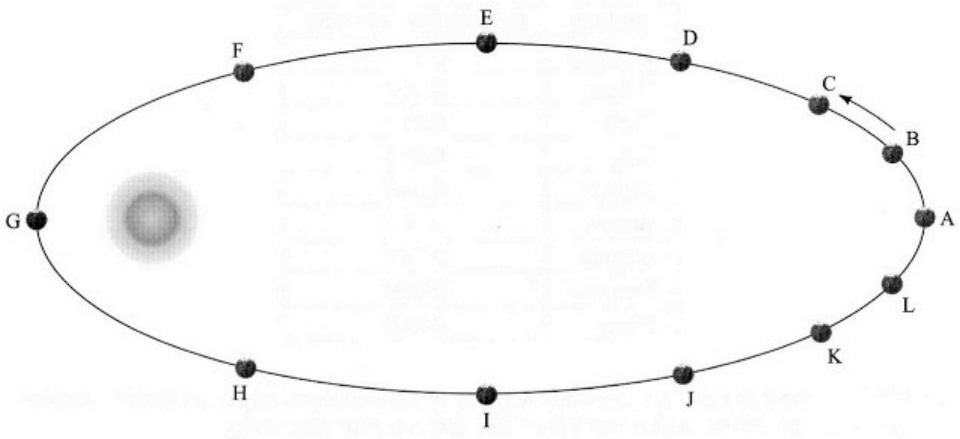
3. At which point in its orbit does the asteroid move fastest? Slowest? Explain your reasoning.

The material on the front page of this sheet is an adaptation of part of the tutorial "Kepler's Second Law", from **Lecture Tutorials in Astronomy**, 2nd Ed., by E. Prather, et al., Pearson Addison-Wesley (2007).

4. At point E in the orbit is the asteroid speeding up or slowing down? *Explain your reasoning.*

5. At point J in the orbit is the asteroid speeding up or slowing down? *Explain your reasoning.*

Part II: Connecting Gravity and Kepler



6. At each point on the orbit below draw a straight arrow showing which way the gravitational force on the asteroid points, and how big the force is. Use a bigger arrow for bigger forces and a smaller arrow for smaller forces.

7. Look back at your answer to 5. Now explain why the speed of the asteroid changes it does using your drawing of the gravitational force to explain what is pulling or pushing on the comet to change its speed.

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