HOMEWORK #10 (due start of class Feb 10)

LEARNING GOALS for this assignment:

1. To understand the physical principles and implications of Kepler's Laws.
2. To understand some concepts relating to orbital energetics.
3. To apply this understanding in practical situations in modern astronomy.

TO RECEIVE FULL CREDIT:

1. Staple multiple pages and identify yourself by Messier Object (worth 5 points!).
2. You must **show how** you derived your answer by writing all the logical steps that led you to it.
3. All sentence responses must be typewritten and in complete sentences. You may handwrite any arithmetic. Use good English grammar.
4. **If you work more than three hours on this assignment, you should stop, record your work here, and contact Dr. McCarthy for help.**

Kepler's Laws, Orbital Mechanics, and Implications

Part I. Review

In Ryden and Peterson's textbook, re-read pp. 50-53 and sections 3.1-3.4 relating to Gravity, Kepler's Laws, and Orbital Mechanics.

Part II. Apply concepts of orbital mechanics to asteroid 'Oumuamua (A/2017 U1)

On October 18, 2017, a fast-moving, faint (V=19.7) object was discovered ~40 days after it had passed perihelion (0.26 AU). The object's speed, together with the eccentricity, inclination, and direction of its orbit, indicate it originated from outside our Solar System. 'Oumuamua is the first clear detection of an interstellar asteroid or comet, now designated as 1I/2017 U1.

a. Using the table of measured distances and velocities below, show that 'Oumuamua is moving faster than the escape speed of the Solar System and therefore cannot be on a bound, closed orbit around the Sun; i.e., it must have an interstellar origin.

'Oumuamua speed relative to the Sun[41]

Distance	Date	Velocity km/s
2300 AU	1605	26.34
1000 AU	1839	26.35
100 AU	2000	26.67
10 AU	2016	29.50
1 AU	9 August 2017	49.67
Perihelion	9 September 2017	87.71[7]
1 AU	10 October 2017	49.67[Note 4]
10 AU	2019	29.51
100 AU	2034	26.65
1000 AU	2196	26.36
2300 AU	2430	26.32

b. 'Oumuamua's measured orbital eccentricity is e=1.2. What is the semi-major axis (a) and generic shape of its orbit?

c. At the time of discovery, 'Oumuamua's apparent visual magnitude (V) was 19.6 at distances of 1.2 AU and 0.2 AU from the Sun and Earth, respectively. The magnitude is predicted to be V=27.7 at distances of 2.85 AU and 2.9 AU. Calculate the relative change in flux and prove that this change is, or is not, consistent with the inverse-square law of light.