1. The Enterprise has entered a standard orbit (circular orbit 500 km above the surface) about Earth.
   a. what is her constant speed? (15)
   b. what is the period of her orbit? (10)
   c. from this orbit how fast would she need to be moving to reach escape velocity? (10)

2. Kirk and Spock have the opportunity to take a tour of an ancient space station that was built before gravitational field generators were developed. The space station is shaped like a giant wheel with a radius of 100 m and a moment of inertia of $5.00 \times 10^8$ kg•m$^2$. The space station rotates so that the crew on the inside of the outer rim experiences an apparent acceleration of 1g. The normal complement of crew is 150 people with an average mass of 65.0 kg. The tour begins with a meeting with 50 of the senior members of the crew in the docking hub at the center of the station (on the rotation axis). What is the apparent acceleration experienced by the crew remaining on the rim? (15)

3. The shuttle Galileo has experienced engine trouble on her approach to Star Fleet Command and has landed in San Francisco bay. She floats with $\frac{1}{4}$ of her volume submerged. What is her average density? (5)

4. McCoy, being a doctor, has his own definitions for pressure, stress, and strain. Help Scotty explain to him what these mean in physics—define:
   a. pressure (5)
   b. stress (5)
   c. strain (5)

5. A simple pendulum consists of a small object of mass 3.0 kg hanging at the end of 2.0 m long light string that is connected to a pivot point. Calculate the magnitude of the torque (due to the force of gravity) about this pivot point when the string makes a 5.0° angle with the vertical. (10)

6. It has been proposed to use the energy stored in a massive rotating flywheel to “power” a small car. How would you orient the axis of the flywheel in the car and why? (5)

7. A solar powered robotic airplane to explore the Martian atmosphere has wings, each with area 10.0 m$^2$, designed so that air flows over the top of the wing at 245 m/s and underneath the wing at 222 m/s. The density of the Martian atmosphere is 0.013 kg/m$^3$, and the acceleration due to gravity on Mars is 3.8 m/s$^2$.
   a. what is the pressure difference between the top and the bottom of the wings? (10)
   b. what mass of plane will this lift support? (10)
G = 6.67x10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2

M_{\text{sun}} = 1.989x10^{30} \text{ kg} \quad M_{\text{earth}} = 5.974x10^{24} \text{ kg}

R_{\text{earth}} = 6.38x10^6 \text{ m}

1 \text{ furlong} = \frac{1}{8} \text{ mile} \quad 1 \text{ year} = 365.25 \text{ days}

1 \text{ inch} = 2.54 \text{ cm} \quad 1 \text{ fortnight} = 2 \text{ weeks}

1 \text{ foot} = 12 \text{ inches} \quad 1 \text{ week} = 7 \text{ days}

1 \text{ mile} = 5280 \text{ ft} \quad 1 \text{ hp} = 746 \text{ W}

1 \text{ lb} = 4.448 \text{ N}

Note: there are 105 points possible on this test—you may earn up to 100.

Bernoulli's Equation

\[ P + \rho \frac{v^2}{2} + \rho g y = \text{constant} \]