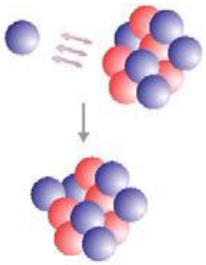
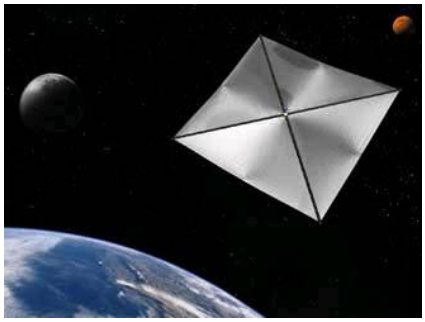
SPH3U : Newton's Second Law Problem Solving.

For each of the following questions draw a FBD (Free Body Diagram) labeling the mass and the forces acting on the body. Clearly show your calculations to arrive at your final answer.

Most questions involve both force and motion. Newton's 2nd law is guaranteed to be involved, so F_{net} = ma should be the starting point of your "Analysis" step.



1. Stopping a Neutron When a nucleus captures a stray neutron, it must bring the neutron to a stop within the diameter of the nucleus by means of the *strong force.* That force, which "glues" the nucleus together, is approximately zero outside the nucleus. Suppose that a stray neutron with an initial speed of 1.4×10^{7} m/s is just barely captured by a nucleus with diameter $d = 1.0 \times 10^{-14}$ m (the stopping distance). Assuming that the strong force on the neutron is constant, find the magnitude of that force. The neutron's mass is 1.67×10^{-27} kg.



2. Sunjamming A "sun yacht" is a spacecraft with a large sail that is pushed by sunlight. Although such a push is tiny in everyday circumstances, it can be large enough to send the spacecraft outward from the Sun on a cost-free but slow trip. Suppose that the spacecraft has a mass of 900 kg and receives a push of 20 N. (a) What is the magnitude of the resulting acceleration? If the craft starts from rest, (b) how far will it travel in 1 day and (c) how fast will it then be moving?

3. Two People Pull Two people pull with 90 N and 92 N in opposite directions on a 25 kg sled on frictionless ice. What is the sled's acceleration?

4. Take Off A Navy jet with a mass of 2.3×10^{4} kg requires an airspeed of 85 m/s for liftoff. The engine develops a maximum force of 1.07×10^{5} N, but that is insufficient for reaching takeoff speed in the 90 m runway available on an aircraft carrier. What minimum force (assumed constant) is needed from the catapult that is used to help launch the jet? Assume that the catapult and the jet's engine each exert a constant force over the 90 m distance used for takeoff.

5. Elevator Moving Upwards An elevator with a mass of 2840 kg (including passengers) is given an upward acceleration of 1.22 m/s^2 by a cable. (a) Calculate the tension in the cable, (b) What is the tension when the elevator is slowing at the rate of 1.22 m/s^2 but is still moving upward?

6. Elevator Moving Downwards : An elevator and its load have a combined mass of 1600 kg and experience a force of gravity of 15680 N. Find the tension in the supporting cable when the elevator, originally moving downward at 12 m/s, is brought to rest with constant acceleration in a distance of 42 m.

Answers: **1.** 16 N; **2.** (a) 0.02 m/s^2; (b) 8×10^{4} km; (c) 2×10^{3} m/s; **3.** 0.08 m/s^2; **4.** 8.2×10^{5} N; **5.** (a) 31 kN; (b) 24 kN **6.** 1.8×10^{4} N;