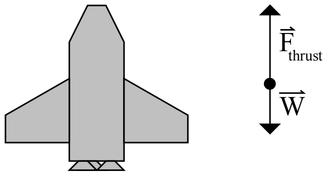
Chapter 4 Problem 32 †



Given
$m = 2.0 \times 10^6\ kg$
$a = 0.60\ g$ upward

Solution
a) Find the thrust of the shuttle.

The two forces acting on the shuttle are the thrust and the weight. From Newton's 2nd law

$$\Sigma\vec{F} = \vec{F}_{thrust} + \vec{W} = m\vec{a}$$

Solving for thrust gives

$$\vec{F}_{thrust} = m\vec{a} - \vec{W}$$

The weight vector is

$$\vec{W} = -mg\hat{j}$$

and the acceleration upward at 0.60 g is represented as the vector

$$\vec{a} = 0.60\ g\hat{j}$$

This makes the force of thrust

$$\vec{F}_{thrust} = m\vec{a} - \vec{W} = m(0.60)g\hat{j} - (-mg\hat{j})$$

$$\vec{F}_{thrust} = mg(0.60 + 1)\hat{j} = 1.60mg\hat{j}$$

Substituting the value for gravitational acceleration gives

$$\vec{F}_{thrust} = 1.60(2.0 \times 10^6\ kg)(9.8\hat{j}\ m/s^2) = 3.14 \times 10^7\hat{j}\ N \tag{1}$$

b) Find the force on an astronaut with a mass of 60 kg.

The astronaut is accelerating at the same rate as the shuttle, so formula (1) is still applicable except with a mass of 60 kg.

$$\vec{F}_{thrust} = 1.60(60\ kg)(9.8\hat{j}\ m/s^2) = 941\hat{j}\ N$$

† Problem from Essential University Physics, Wolfson