Normal Forces & Apparent Weight

For each problem, draw a free-body diagram, identify the net force, and show your calculations. Give the magnitude and direction of each answer where appropriate. Use $g = 9.8\ m/s^2$. A scale reading is a normal force.

Mild

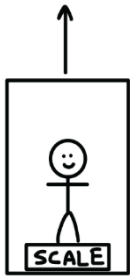
1. A 4500 kg helicopter accelerates vertically upward at $2.0\ m/s^2$. Neglect air resistance. Determine the upward lift force exerted by the air on the helicopter.

2. A grocery sack can withstand a maximum upward supporting force of 250 N before tearing. A person lifts 20.0 kg of groceries vertically upward with an acceleration of $5.0\ m/s^2$, after the sack leaves the floor. Neglect the mass of the sack. Will it hold? Justify your answer with a calculation.

Medium

3. A 62 kg passenger stands on a scale inside an elevator. Determine the apparent weight (scale reading) in each situation:
   a. The elevator moves upward at a constant velocity of $2.2\ m/s$.
   b. The elevator accelerates upward at $1.8\ m/s^2$.
   c. The elevator accelerates downward at $2.5\ m/s^2$.
   d. Explain why the scale readings differ, even though the passenger's mass is unchanged.

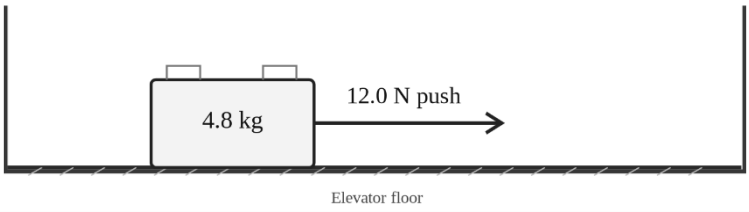
4. A 70 kg passenger is travelling upward in an elevator at $1.0\ m/s$. The elevator then slows uniformly to rest over 2.5 s.
   a. Determine the acceleration of the elevator, including its direction.
   b. Determine the passenger's apparent weight while the elevator is slowing down.
   c. Compare this reading with what the scale would show when the elevator is stationary.



Spicy

5. A 4.8 kg suitcase is sliding to the right across the horizontal floor of an elevator. The coefficient of kinetic friction is $\mu_k = 0.28$. Determine the normal force and the magnitude of kinetic friction in each case:
   a. The elevator moves upward at a constant velocity of $1.6\ m/s$.
   b. The elevator accelerates upward at $1.6\ m/s^2$.
   c. The elevator accelerates downward at $1.6\ m/s^2$.

6. The same 4.8 kg suitcase is sliding rightward. A person now pushes it horizontally to the right with a constant force of 12.0 N. The coefficient of kinetic friction is $\mu_k = 0.28$. At the instant described, determine the horizontal acceleration of the suitcase when:



   a. The elevator accelerates upward at $1.6\ \mathrm{m/s^2}$.
   b. The elevator accelerates downward at $1.6\ \mathrm{m/s^2}$.
   c. Explain why the same horizontal push produces accelerations in opposite directions.

Extra-Spicy

7. An elevator is travelling downward at $1.4\ \mathrm{m/s}$ when it begins slowing uniformly. It comes to rest after descending another 3.0 m. A 65 kg passenger stands on a scale that reads in newtons.
   a. Determine the elevator's acceleration, including its direction.
   b. Determine the scale reading as the elevator slows down.
   c. Is the scale reading greater than, less than, or equal to the reading when the elevator is at rest? Explain using the forces acting on the passenger.