Problem 4.31 An elevator accelerates downward at $2.4\ \frac{m}{s^2}$. What force does the floor exert on a 52kg passenger?

Interpret: Question relates acceleration to force - N2L likely to be useful. Object of interest here is the passenger, because the question ask for force on passenger

Forces acting on passenger are gravity ($\vec{F_g}$) & normal force ($\vec{n}$)

Develop: Use FBD to generate equation relating forces to acceleration

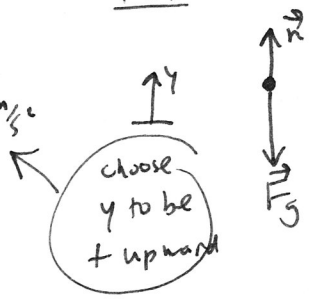
known

$m = 52kg$

$a = 2.4\ \frac{m}{s^2}$ downward $\rightarrow a_y = -2.4\ \frac{m}{s^2}$

$g = 9.8\ \frac{m}{s^2}$ (near Earth's surface)

FBD



N2L

$\Sigma F_y = ma_y$

① $n - F_g = ma_y$ from FBD

Finally, note that $F_g = mg$ ②

Check: unknowns are F_g, n → 2 equations, 2 unknowns → algebra time!

Evaluate: Plug ② into ①: $n - mg = ma_y$

Solve for n: $n = ma_y + mg = \boxed{m(a_y + g)}$

Insert values: $n = 52kg\left(-2.4\ \frac{m}{s^2} + 9.8\ \frac{m}{s^2}\right) = 384.8\ \frac{kg\,m}{s^2} = \boxed{380N}$ to 2 sig figs

Assess: Units worked out to $\frac{kg\,m}{s^2}$ - that's a Newton, appropriate for a force.

Magnitude is comparable to a person's weight, so fairly plausible

Check limiting/interesting cases:

① If $a \rightarrow 0$ in boxed formula, $n \rightarrow mg = F_g$ - the normal force equals weight, as we'd expect

② If $a > 0$, $n > mg$

If $a < 0$, $n < mg$ (this case)

} these behaviors are consistent with what one observes reading scales in elevators (if you've timed this). We also expect this result for "math" reasons