## Virtual Learning

## Physics

Problem Solving Using Newton's Laws
April 17, 2020

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Problem Solving Using Newton's Laws: April 17,2020

## Objective/Learning Target:

Students will practice solving a variety of problems using Newton's Laws of Motion.

## Quick Review \#1

Dale does gymnastics, suspended by one rope in A, and by two ropes in position $B$, C , and D. Rank the tensions in the ropes from greatest to least.


Quick Review \#1 Answer
Dale does gymnastics, suspended by one rope in A, and by two ropes in position B, $C$, and D. Rank the tensions in the ropes from greatest to least.

From greatest tension to the least: D, C, A, B.
The larger the angle the smaller
 the vertical component.

## Quick Review \#2

Suppose that two carts, one twice as massive as the other, fly apart when the compressed spring that joins them is released. What is the acceleration of the heavier cart relative to that of the lighter cart as they start to move apart?


## Quick Review \#2 Answer

The amount of force is the same on each cart, but the masses are different. The heavier cart would exhibit $1 / 2$ the acceleration of the lighter cart since it has twice the mass.

$$
m a=F=2 m(1 / 2 a)
$$



## Problem Solving Using Newton's Laws

## Link:Problem Solving Strategies

## Directions:



- Read through Problem Solving Strategies.
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem \#1
A 4600 kg helicopter accelerates upward at $2.0 \mathrm{~m} / \mathrm{s}^{2}$. What lift force is exerted by the air on the propellers?

## Practice Problem \#1 Answer

Use Newton's Second Law: F = ma

Lift Force = Mass * Acceleration
$=4600 \mathrm{~kg} * 2.0 \mathrm{~m} / \mathrm{s}^{2}$
$=9200 \mathrm{~N}$


Practice Problem \#2
A sign in an elevator states that the maximum occupancy is 20 persons.
Suppose that the safety engineers assume the mass of the average rider is 75 kg . The elevator itself has a mass of 500 kg . The cable supporting the elevator can tolerate a maximum force of $30,000 \mathrm{~N}$. What is the greatest acceleration that the elevator's motor can produce without snapping the cable?


## Practice Problem \#2 Answer

Use Newton's Second Law: Acceleration = $\underline{F}$
m

The mass is equal to 20 people and the elevator.

$$
\text { Total mass }=20(75 \mathrm{~kg})+500 \mathrm{~kg}=2000 \mathrm{~kg}
$$

So...
Acceleration $=\frac{\mathrm{F}}{\mathrm{m}}=\frac{30,000 \mathrm{~N}}{2000 \mathrm{~kg}}=15 \mathrm{~m} / \mathrm{s}^{2}$

"Could you take me back to the eighth floor to get my stomach?"

## Practice Problem \#3

During a head-on collision, a passenger in the front seat of a car accelerates from $13.3 \mathrm{~m} / \mathrm{s}$ ( $\approx 30 \mathrm{miles} / \mathrm{hour}$ ) to rest in 0.10 s .
a. What is the acceleration of the passenger?
b. The driver of the car holds out his arm to keep his $\mathbf{2 5} \mathbf{~ k g}$ child (who is not wearing a seatbelt) from smashing into the dashboard. What force must he exert on the child?
c. What is the weight of the child?
d. Convert these forces from N to pounds. ( $1 \mathrm{lb}=4.45 \mathrm{~N}$ ).
e. What are the chances the driver will be able to stop the child?


## Practice Problem \#3 Answer a-c

a. $a=\left(\underline{v}_{\mathrm{f}}-\mathrm{v}_{\mathrm{i}}\right)=\frac{0 \mathrm{~m} / \mathrm{s}-13.3 \mathrm{~m} / \mathrm{s}}{0.10 \mathrm{sec}}=133 \mathrm{~m} / \mathrm{s}^{2}$
b. Use Newton's Second Law

$$
\begin{aligned}
F=m a & =25 \mathrm{~kg}\left(133 \mathrm{~m} / \mathrm{s}^{2}\right) \\
& =3,325 \mathrm{~N}
\end{aligned}
$$

c. Weight $=\mathrm{mg}$

$$
\begin{aligned}
& =25\left(9.8 \mathrm{~m} / \mathrm{s}^{2}\right) \\
& =245 \mathrm{~N}
\end{aligned}
$$



## Practice Problem \#3 d-e

d. This is a simple conversion.

e. Unlikely that a person could apply 747 lbs of force one armed in a backhand fashion to hold someone still. Unlikely that anyone could supply 747 lbs even holding the child double armed in their lap. Hence seatbelts.

## Additional Practice

For additional practice check out the conceptual questions and the problems and exercises in the table of contents from the online text linked above.

