## Virtual Learning

 PhysicsGravitational Potential Energy May 19, 2020

## Physics

## Gravitational Potential Energy: May 19,2020

## Objective/Learning Target:

Students will examine gravitational potential energy and use it to solve various problems.

## Quick Review \#1

If you push a crate horizontally with 100 N across a $10-\mathrm{m}$ factory floor and the friction between the crate and the floor is a steady 70 N , how much kinetic energy does the crate gain?


## Quick Review \#1 Answer

Work $=\Delta K E$
$F_{\text {neid }}=\Delta K E$
( $\mathrm{F}_{\text {app }}-\mathrm{F}_{\mathrm{f}}$ )d $=\Delta \mathrm{KE}$
$\Delta K E=(100 \mathrm{~N}-70 \mathrm{~N}) 10 \mathrm{~m}=300 \mathrm{~J}$


## Quick Review \#2

This question is typical on some driver's license exams: A car that was moving at $60 \mathrm{~km} / \mathrm{h}$ skids 20 m with locked brakes. How far will the car skid with locked brakes if it was moving at $120 \mathrm{~km} / \mathrm{h}$ ? (use work and energy to solve)


## Quick Review \#2 Answer

Twice the speed means four times the the KE, and four times the work to reduce the KE to zero. F is constant, so four times the $\mathrm{d}, \mathrm{d}=80$ meters!


## Work

## Link: Gravitational Potential Energy

## Directions:



- Read through Gravitational Potential Energy.
- 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 65 kg skydiver jumps from a plane, which is 2000 m above the ground. What is the skydivers gravitational potential energy upon exiting the plane?


## Practice Problem \#1 Answer

$$
=65 \mathrm{~kg} \times 9.8 \mathrm{~m} / \mathrm{s}^{2} \times 2000 \mathrm{~m}
$$

$$
\begin{aligned}
\mathrm{PE}_{g} & =\mathrm{mgh} \\
& =65 \mathrm{~kg} \times 9.8 \\
& =1.3 \times 10^{6} \mathrm{~J}
\end{aligned}
$$

## Practice Problem \#2

a. How much work is done in lifting the $100-\mathrm{N}$ block of ice a vertical distance of 2 m , as shown in the Figure?
b. How much work is done in pushing the same block of ice up the 4-m-long ramp? (The force needed is only 50 N , which is the reason ramps are used.)
c. What is the increase in the block's gravitational potential energy in each case?

## Practice Problem \#2 Answer

a. $W=F d=100 \mathrm{~N} \times 2 \mathrm{~m}=200 \mathrm{~J}$.
b. $W=F d=50 \mathrm{~N} \times 4 \mathrm{~m}=200 \mathrm{~J}$.
c. In both cases the block's potential energy increases by 200 J. The ramp simply makes this work easier to perform.


## Practice Problem \#3

A 30 kg child slides down a hill on frictionless snow as shown in the diagram.
a. What is the child's gravitational potential energy at the top of the first hill?
b. How fast will she be traveling once she reaches the bottom of the hill? Use energy equations to solve.
c. How fast will she be traveling when she reaches the flat surface ( $c$ ) at the end of her run? Use energy equations to solve.


## Practice Problem \#3 Answer

a. $\mathrm{PE}_{\mathrm{g}}=\mathrm{mgh}$

$$
=30 \mathrm{~kg} \times 9.8 \mathrm{~m} / \mathrm{s}^{2} \times 15 \mathrm{~m}=4410 \mathrm{~J}
$$

b. $\quad \mathrm{KE}_{\text {bottom }}=\mathrm{PE}_{\mathrm{g}}$ top

$$
K E_{b}=4410 \mathrm{~J}
$$

$1 / 2 \mathrm{mv}^{2}=4410 \mathrm{~J}$
$1 / 2 \times 30 \mathrm{~kg} \times \mathrm{v}^{2}=4410 \mathrm{~J}$
$v=\sqrt{ }((2 \times 4410 \mathrm{~J}) / 30 \mathrm{~kg})$
$v=17 \mathrm{~m} / \mathrm{s}$
C. $K_{\text {gain }}=P E_{\text {lost }}=P E_{\text {top }}-P E_{\text {end }}$
$1 / 2 \mathrm{mv}^{2}=\mathrm{mgh}_{\text {top }}-\mathrm{mg} h_{\text {end }}$
$1 / 2 \times 30 \mathrm{~kg} \times \mathrm{v}^{2}=\left(30 \mathrm{~kg} \times 9.8 \mathrm{~m} / \mathrm{s}^{2} \times 15 \mathrm{~m}\right)-\left(30 \mathrm{~kg} \times 9.8 \mathrm{~m} / \mathrm{s}^{2} \times 5 \mathrm{~m}\right)$
$15 \mathrm{~kg} \mathrm{x} \mathrm{v}^{2}=4410 \mathrm{~J}-1470 \mathrm{~J}=2940 \mathrm{~J}$
$v=\sqrt{ }(2940 / 15)=14 \mathrm{~m} / \mathrm{s}$
Multiple ways to solve this.


## 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.

