Name: _____

Period: _____

4.1

Types of Energy

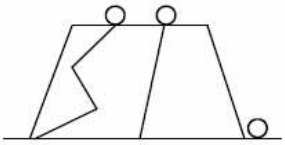
Potential Energy

Potential Energy (in Joules) → **PE = mgh**

- m: mass (in kilograms)
- h: height (in meters)
- g: acceleration due to gravity (9.8 m/s²)

Potential energy (PE) is **energy of position, due to gravity**. Any object above the ground or on a ledge has potential energy.

Both balls have equal PE because their heights are the same. How they got there doesn't matter.



PE = 0 J for the ball on the ground, since h = 0 m.

An airplane has PE because it is in the air, even though it is moving. As its altitude increases, so does PE.

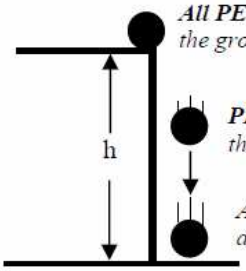
Ex: How much potential energy does a 4 kg object have that is 5 meters off the ground?	
m = 4 kg h = 5 m g = 10 m/s² KE = ?	PE = mgh PE = (4)(10)(5) = (40)(5) = 200 Joules

Kinetic Energy

Kinetic Energy (in Joules) → **KE = (½)mv²**

- m: mass (in kilograms)
- v: velocity (m/s)

Kinetic Energy (KE) is energy of motion. An object at rest has no KE.



All PE *(because it is above the ground and at rest)*

PE + KE *(because it is above the ground and is moving)*

All KE *(because it is moving and has lost all of its height)*

We never care AFTER the object hits the ground, but just before impact, at maximum velocity.

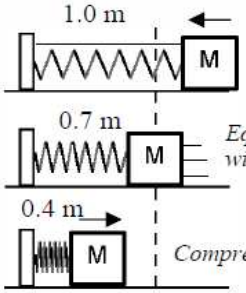
Ex: Calculate the kinetic energy of a 10 kg object traveling 3 m/s.	
m = 10 kg v = 3 m/s KE = ?	KE = ½mv² KE = ½(10)(3)² = (5)(9) = 45 Joules

Potential Elastic Energy

Elastic Potential Energy (in Joules) → **$PE_{El} = (½)kx^2$**

- k: Spring constant (in N/m)
- x: Distance stretched or compressed (in m)

Elastic Potential Energy comes from springs or elastic objects (like rubber) that push when compressed or pull when stretched. The stronger the spring constant (k), the harder it is to move the spring (more N per m).



Stretched: x = 0.3 m (1.0–0.7)

Equilibrium position: where it will eventually come to rest.

Compressed: x = 0.3 m (0.7–0.4)

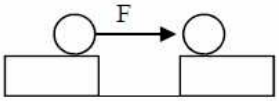
Ex: A spring has a 4 N/m spring constant and a resting position of 0.5 m. If it is stretched to 2.5 m, find its elastic potential energy.	
k = 4 N/m x_r = 0.5 m x_f = 2.5 m x = 2 m	$PE_{el} = (½)kx^2$ $= ½(4)(2)^2$ = (2)(4) = 8 Joules

Work

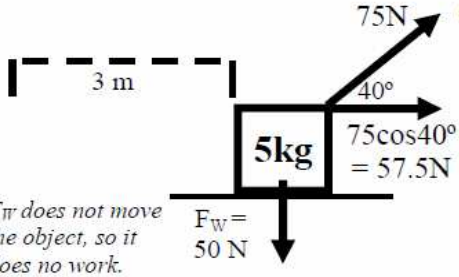
Work (in Joules) → **W = Fdcosθ**

- F: Force (in Newtons)
- θ: Angle between F and d
- d: Distance (in meters)

Work is how forces add or subtract energy from an object. You know work is done if an object's energy changes.



No net work is done on this object because it has no change of energy: PE before = PE after.



Only the x-component of 75N (57.5 N) moves the object and does work.

W = 57.5(3)
= 172.5 J

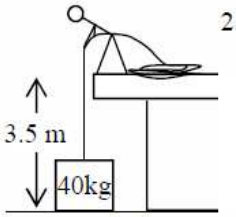
This object gains 172.5 J of energy, (probably KE).

F_W does not move the object, so it does no work.

Ex: You push with 1000 N on a car for 5 meters at 30° to the ground. How much work was done on the car?	
F = 1000 N d = 5 m W = ? θ = 30°	W = Fdcos θ W = (1000)(5)(cos30°) = 5,000(.866) = 4330 Joules

1. Potential Energy (PE), Kinetic Energy (KE), Potential Elastic Energy (PE_{el}), or Work (W)?

A. _____ A car is moving 22 m/s.
B. _____ When a spring is compressed.
C. _____ When an object is sitting on a desk.
D. _____ After a falling object hits the ground.
E. _____ The ground stopping a falling object.
F. _____ While a rock is flying thru the air.
G. _____ When a force pushes on and moves an object.
H. _____ Decreases as an object goes downhill.
I. _____ What is gained as an object goes downhill.
J. _____ Friction acting on a sliding object.
K. _____ A box on the ground at rest.
L. _____ Decreases as an object slows down.
M. _____ Provided by the engine of car.
N. _____ Pushing an object up a ramp.
O. _____ For a dropped object, as it is falling.
P. _____ Decreases as a spring is released.

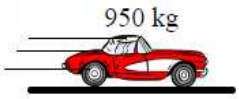


2. Slim Jim lifts a 40 kg object up 3.5m.
A. How much energy does it have before it is lifted?

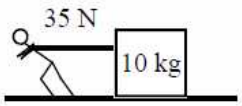
B. What kind of energy will it gain?

C. Where does this energy come from?

D. Calculate the box's energy after it is lifted.

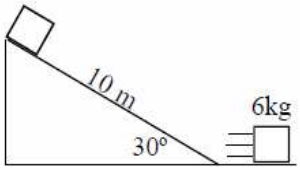


3. If the car has 30,400 J of kinetic energy, how fast is it moving?



4. Slim Jim pulls on a box for 6.5m.
A. How much work did Jim do?

B. What kind of energy does the box gain?
C. If there is no friction, how much energy does the box gain?

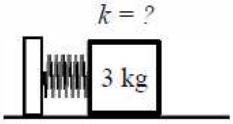


5. A 6 kg object is slides down a frictionless 10 m ramp.
A. What kind of energy does it have at the top?

B. "h" must always be vertical. Calculate "h" at the top of the ramp.

C. Calculate the energy at the top.

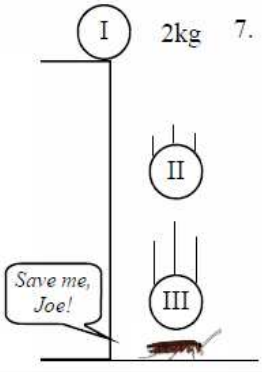
D. What is this energy transforming into as it slides down the ramp?



6. A 3 kg object compresses a spring 0.6m, giving it 8.1 J of energy.
A. What kind of energy does it have?

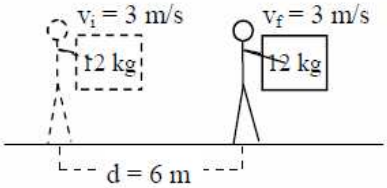
B. Calculate the spring constant for this spring.

C. What kind of energy will the object have when the spring is released?



7. A. If the ball has 120J of energy at position I, calculate the height at I.

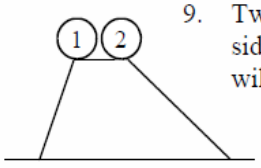
B. What kind of energy does it have at II?
C. Where does the energy go at III?



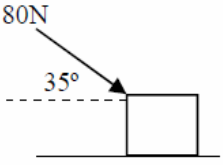
8. Slim Jim carries a box for 6m at constant speed.

A. How much energy does the box have?

B. How much work does Jim do?



9. Two identical balls roll down opposite sides of a frictionless platform, which one will be going faster at the bottom?



10. If the box moves 12m to the right, calculate the work done on the box.