

# Momentum & Energy Review Checklist

## Impulse and Momentum

3.1.1 – Use equations to calculate impulse; momentum; initial speed; final speed; force; or time.

An object with a mass of 5 kilograms is moving at 3.0 meters per second. Determine its momentum.

15 kg·m/s

An object with a mass of 3 kilograms begins with a speed of 2.0 meters per second and increases its speed to 5.0 meters per second in 10.0 seconds.

a) Determine the starting and final momentums.

Start: 6 kg·m/s    End: 15 kg·m/s

b) Determine the impulse experienced by the object.

9 kg·m/s or 9 N·s

c) Determine the net force acting on the object as its speeds up.

0.9 N

A 2.0 kilogram object at rest is subjected to a force of 20 newtons for 4.0 seconds. What final speed will the object reach?

40 m/s

A 4.0 kilogram object moving east with a speed of 8.0 meters per second is subjected to a force to the west for 1.5 seconds, slowing it down to a speed of 2.0 meters per second. Determine the amount of force applied.

16 N

A 50 kilogram object moving at 6.0 meters per second slows down and comes to a stop while being subjected to a force of 10 newtons. How long does it take for the object to come to a stop?

30 s

## Conservation of Momentum

3.1.2A – Determine the outcome of an elastic collision.

A 3.0 kilogram object moving at 2.0 meters per second collides with a 1.0 kilogram object and comes to a stop. Determine the speed of the 1.0 kilogram object after the collision.

6 m/s

A 2.0 kilogram object moving east at 3.0 meters per second collides (with no sticking) with a 4.0 kilogram object moving west at 1.0 meters per second. If the 2.0 kilogram object moves west at 0.5 meter per second after the collision, determine the direction and speed of the 4.0 kilogram object.

0.75 m/s east

3.1.2B – Determine the outcome of an inelastic collision.

A 2.0 kilogram object moving east at 4.0 meters per second collides with a 5.0 kilogram object moving west at 6.0 meters per second. The two objects stick together after the collision. Determine the speed of the two objects after the collision.

3.1 m/s

A 5.0 kilogram object moving east at 4.0 meters per second collides with a 3.0 kilogram object moving east at 2.0 meters per second. If the two objects stick together, what is their final speed?

3.3 m/s

3.1.2C – Determine an unknown in a system in which the starting or ending momentum is zero.

A 1000 kilogram car moving east collides with a 3000 kilogram truck moving west and both come to a stop. Before the collision the truck is moving at 2.0 meters per second. What speed was the car moving with before the collision?

6 m/s

A 4.0 kilogram cart and a 3.0 kilogram cart are pushed up against opposite sides of a spring and held motionless. When the carts are released, the 3.0 kilogram cart moves west at 10 meters per second. What is the direction and speed of the 4.0 kilogram cart after the release?

7.5 m/s

A pair of lab carts, A and B collide and come to a stop. Before the collision, cart A, which has a mass of 2.5 kilograms was moving at 4.0 meters per second. What is the mass of cart B if its speed before the collision was 2.0 meters per second?

5 kg

### Work/Energy Principle

3.2.1A – Use equations to determine the work, force, distance, or kinetic energy gained in a frictionless, horizontal motion system.

How much work is done on an object if 35 newtons of force are applied to it as it is moved 10 meters?

350 J

What amount of kinetic energy does a 4.0 kilogram object have when moving at 3.0 meters per second?

18 J

A 30 newton force is applied to an object at an angle of  $30^\circ$  above horizontal. If the object is moved a distance of 10 meters horizontally along a frictionless surface using this force, what amount of kinetic energy is gained by the object?

259.8 J

A 5.0 kilogram object is moved 4.0 meters across a frictionless surface with a force of 20 newtons.

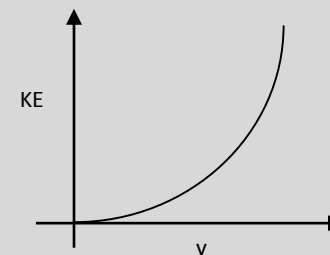
a. What amount of kinetic energy does the object gain?

80 J

b. What final speed will the object have?

5.7 m/s

Sketch a graph of kinetic energy vs. speed.



3.2.1B – Use equations to determine work; force; distance, or gravitational potential energy gained in a frictionless, vertical system.

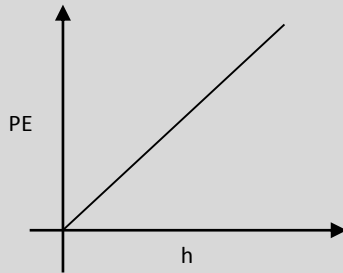
A force of 30 newtons is used to lift an object from the ground to a shelf that is 2.0 meters high. What amount of gravitational potential energy did the object gain?

60 J

75 joules of work are done in lifting a 2.5 kilogram object. What change in height will the object experience?

3.1 m

Sketch a graph of gravitational potential energy vs. height.



3.2.1C – Use equations to determine the work, force, distance, or spring potential energy gained in a frictionless system.

How much energy is needed to compress a spring with a spring constant of 100 newtons per meter a distance of 0.05 meter?

0.125 J

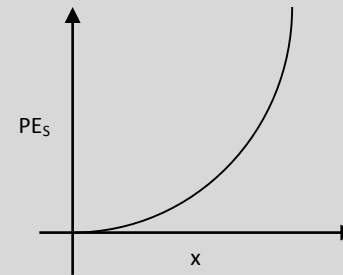
What is the spring constant of a spring that requires 500 joules of work to be compressed a distance of 0.01 meter?

$1 \times 10^7 \text{ N/m}$

A spring with a spring constant of 200 newtons per meter is stretched using 1000 joules of work. What distance will the spring stretch?

3.2 m

Sketch a graph of spring potential energy vs. stretch distance.



### Conservation of Energy

3.2.2A – Use the principle of Conservation of Energy to determine changes in kinetic energy; internal energy; and/or speed in horizontal motion systems.

How much work is needed to accelerate a 5.0 kilogram object moving at 3.0 meters per second on a frictionless surface to a speed of 10.0 meters per second?

227.5 J

How much work is needed to accelerate a 5.0 kilogram object moving at 3.0 meters per second on a frictionless surface to a speed of 10.0 meters per second?

227.5 J

A 4.0 kilogram object moving at 15 meters per second is slowed down to a speed of 6.0 meters per second by a friction force of 20 newtons.

- a. How much internal energy is produced during this change?

378 J

- b. What distance will the object travel during this motion?

18.9 m

*3.2.2B – Use the principle of Conservation of Energy to determine changes in potential energy; internal energy; and or height in vertical motion systems.*



500 joules of energy are used in lifting a 10 kilogram object a distance of 3.0 meters. What amount of work is done by friction in this system?

205.7 J

A 6.0 newton object is lifted a distance of 10 meters. If 100 joules of work are done by friction during this lift, what is the total amount of energy expended as the object is lifted?

40 J

*3.2.2C – Use the principle of Conservation of Energy to determine changes in potential energy; kinetic energy; internal energy; speed; and/or height.*



A 2.0 kilogram object at rest at the top of a frictionless 4.0 meter high hill is allowed to slide to the bottom. What speed will the object reach at the bottom of the hill?

8.9 m/s

A 3.0 kilogram object is thrown upward with an initial speed of 10 meters per second. What maximum height will the object reach?

5.1 m

A 5.0 kilogram object at the top of a 2.0 meter high hill gains 15 joules of kinetic energy as it slides to the bottom of the hill. How much work was done by friction as the object slid down the hill?

83.1 J

A spring with a spring constant of 1000 newtons per meter is used to launch a 3.0 kilogram object vertically. The spring is compressed 0.10 meter before the launch.

- a. What amount of energy will be stored in the spring before launch?

5 J

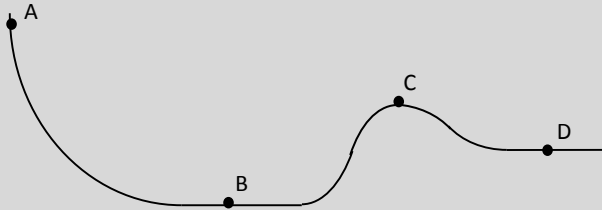
- b. How high will the object go?

0.17 m

How much kinetic energy must a 3.0 kilogram object have to slide up a frictionless, 5.0 meter high hill?

147.15 J

A ball slides down from rest starting at point A on the frictionless track shown below.



a. At which point is gravitational potential energy a maximum?

b. At which point is kinetic energy a maximum?

c. Compare the ball's speed at point C to its speed at point D.

It is greater at D

A 500 newton per meter spring is compressed a distance of 0.06 meter then used to shoot a 0.02 kilogram object along a horizontal surface. The object is launched with a speed of 6.0 meters per second.

a. Determine the amount of energy stored in the spring.

0.9 J

b. Determine the kinetic energy of the object at launch.

0.36 J

c. What amount of internal energy is generated in this system?

0.54 J

## Mechanical Power

3.2.3 – Use equation to determine power; work; energy; time; force; and/or distance.

What amount of power is generated in a system that uses 35 joules of energy in 10 seconds?

3.5 W

What is the power output of a motor that applies 75 newtons of force in lifting an object 5.0 meters in 2.5 seconds?

150 W

What is the power generated by a person who pulls a rope with a force of 100 newtons, lifting an object with an average speed of 3.5 meters per second?

350 W

A 3000 watt motor is used to drive a boat. How long will it take the motor to use  $6.0 \times 10^7$  joules of energy?

$2 \times 10^4$  s