Physics 100 / 2025-2026 Name: ____________________________
Midterm Exam Practice

# Motion

1. After a car enters A-Lot at Essex High, it takes a car 15 seconds to reach its parking spot. The car drives 20 meters during this time. Its direction of travel is directly northward.

    - What is the car's average speed during this event?

    - What is its average velocity?

    - What is the difference between speed and velocity?

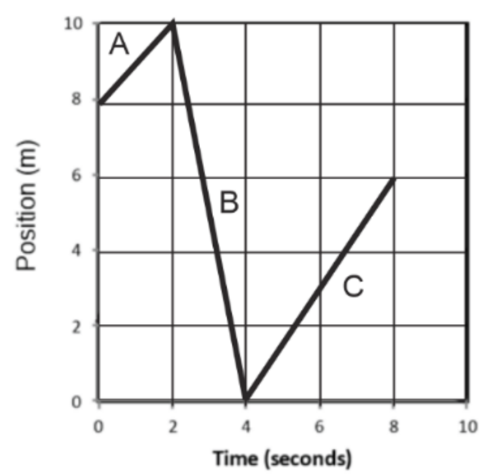
| Answer Choice | Velocity | Acceleration |
|---|---|---|
| A | Positive | Positive |
| B | Positive | Negative |
| C | Positive | Zero |
| D | Negative | Positive |
| E | Negative | Negative |
| F | Negative | Zero |
| G | Zero | Positive |
| H | Zero | Negative |
| I | Zero | Zero |

2. Match each of the following motions to the correct combination of acceleration and velocity.
    - ____ Running rightward, slowing down.
    - ____ Running rightward at a constant speed.
    - ____ Getting faster while falling downward
    - ____ Getting slower while falling downward
    - ____ Moving leftward at a constant speed
    - ____ Flying upward, getting faster

3. The graph on the right represents a moving object's position as it changes over time.

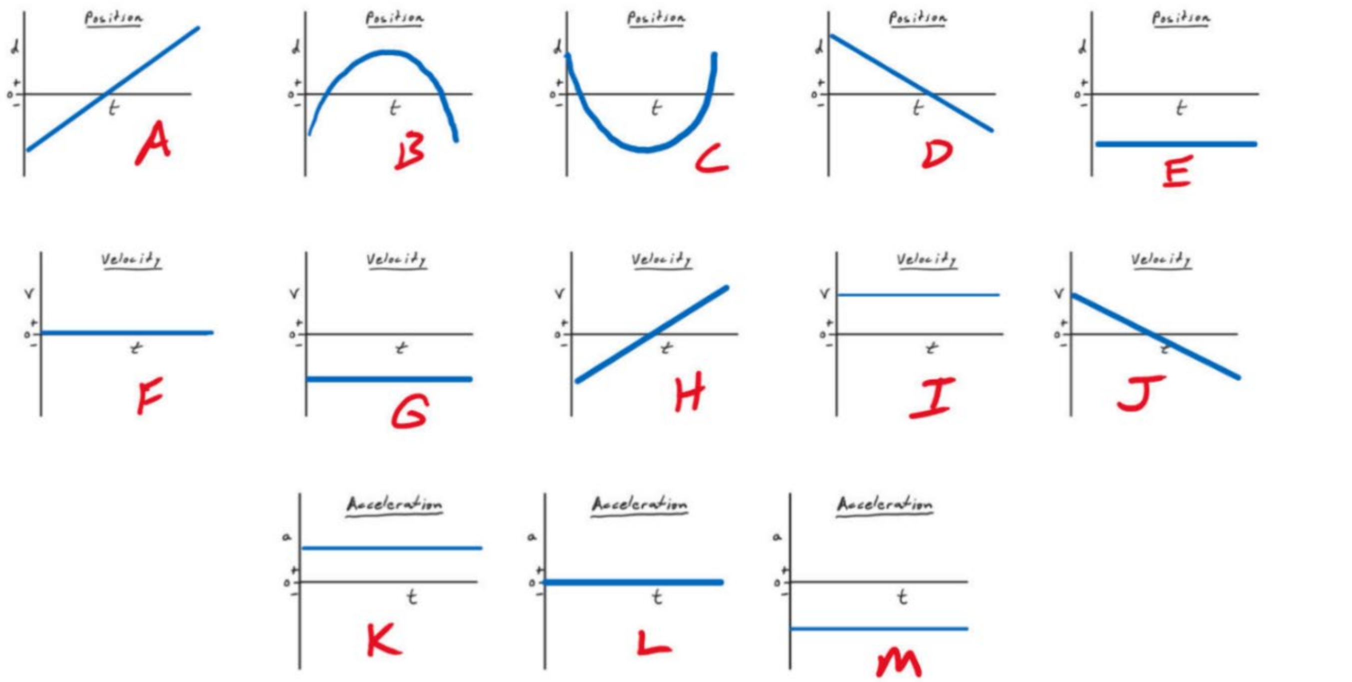
    a. What is the object's average velocity during interval C?

    b. What is the overall average velocity of the object?

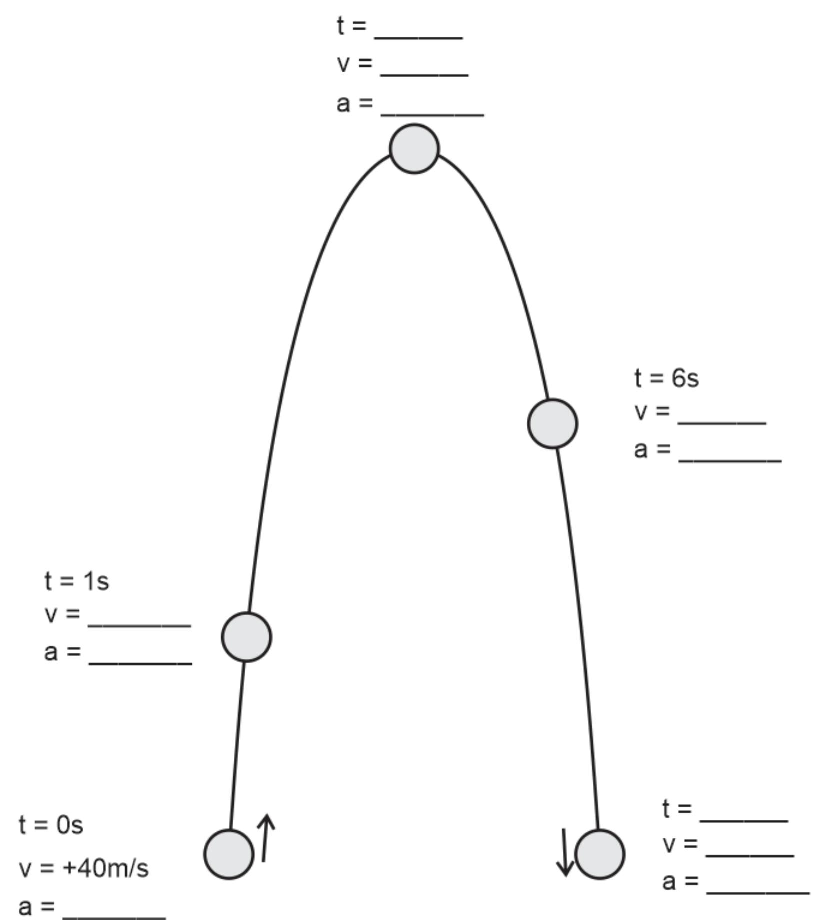



4. A car traveling at a velocity of 20m/s speeds up to 25m/s in order to pass another car. If it takes the car 2 seconds to speed up from 20m/s to 25m/s, what is the car's acceleration?

5. Match each of the position graphs below with a velocity graph and an acceleration graph that show the same motion. For example, next to letter A, write the letter of the velocity graph (F, G, H, I, or J) whose motion matches the motion in graph A. Next to that, write the letter of the acceleration graph (K, L, or M) that represents the same motion.




6. The diagram on the right shows a ball that is thrown directly upward. It goes up and it comes down. Ignoring air resistance (i.e., assume it is in "free-fall"), fill in the blanks on the diagram to the right. Also assume that g = $10 m/s^2$.



# <u>**Forces**</u>

7. a. How can you tell when the forces acting on an object are balanced or unbalanced?

   b. There are essentially two options for what an object can be doing if it is experiencing balanced forces. Describe those two options.

8. A 6 kg bowling ball is sitting motionless on the floor. It is alone. Draw <u>two</u> fully labeled force diagrams (a *system schema* and a *free body diagram*).

9. Fill in the blanks to describe a Newton's 3rd Law of Motion action-reaction pair for **a parachuter who is falling toward the ground**.

   The ____________ is __________________ the _____________ _______________ with_________________,
   (object) (pushing or pulling) (object) (direction) (force type)

   *and*

   The ____________ is __________________ the _____________ _______________ with_________________,
   (object) (pushing or pulling) (object) (direction) (force type)

10. Fill in the blanks to describe a Newton's 3rd Law of Motion action-reaction pair for **a sled that is being dragged across the snow to our left by a horse**.

The ___________ is _________________ the ____________ ______________ with________________,
(object) (pushing or pulling) (object) (direction) (force type)

*and*

The ___________ is _________________ the ____________ ______________ with________________,
(object) (pushing or pulling) (object) (direction) (force type)

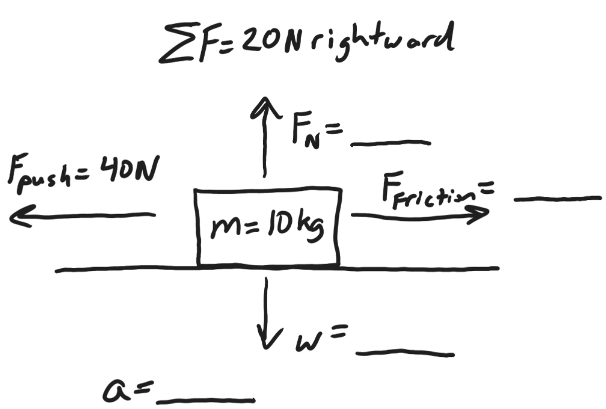
11. Consider a child pushing a toy car, causing a sideways net force that is accelerating the car.

    a. What will happen if the net force is kept the same, but the car's mass is decreased?

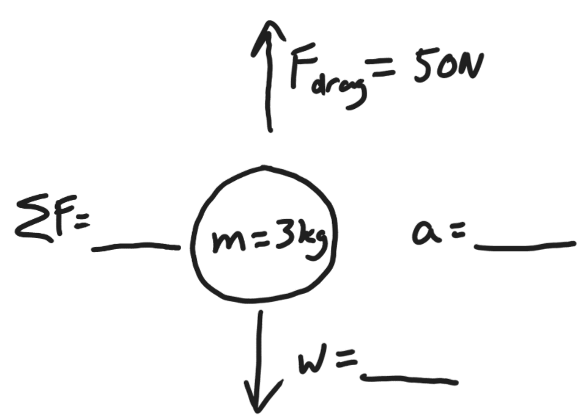
    b. What will happen if the net force is decreased, but the car's mass is kept the same?

12. How much force is needed to accelerate a 2000kg car at a rate of 6.0 m/s$^2$?

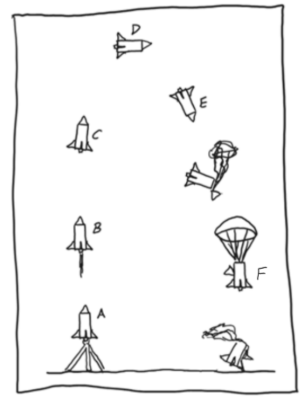
13. Fill in the missing forces and acceleration (in the four blanks) below. The box in the picture is sliding sideways across a table top. It is not moving up or down. Make sure that you indicate the correct direction for acceleration.




14. Fill in the missing forces and acceleration (three blanks) in the diagram below. Make sure that you indicate the correct direction for acceleration.



15. The diagram on the right shows stages in a rocket's flight. The boxes below describe the lettered stages.
  - Read the description in each box.
  - Then draw arrows (with names) for all of the individual forces acting on the rocket. Probably as a FBD.
  - Separately, also indicate (e.g., with word or arrows) the direction of net force and acceleration.
  - **<u>Do</u> include the force of drag whenever it would be present.**




| | |
|---|---|
| A. The rocket is sitting motionless on the launcher. | B. The rocket is accelerating upward because it is pushing water downward. |
| C. The rocket no longer has thrust. It is slowing down on its way to its highest point. | D. The rocket is at its highest point. |
| E. The rocket is falling <u>before</u> reaching terminal velocity | F. The rocket is falling <u>at</u> terminal velocity. |

# Momentum and Impulse

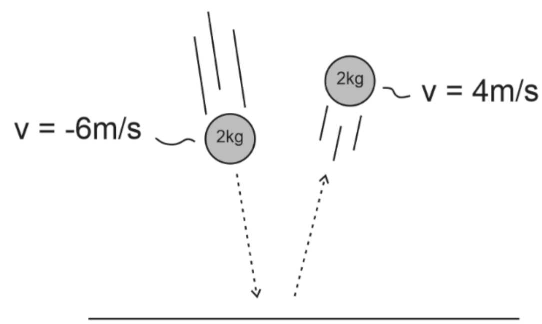
16. Give examples showing how:

    a. Two objects can have different masses but the same momentum.

    b. Two objects can have different velocities but the same momentum.

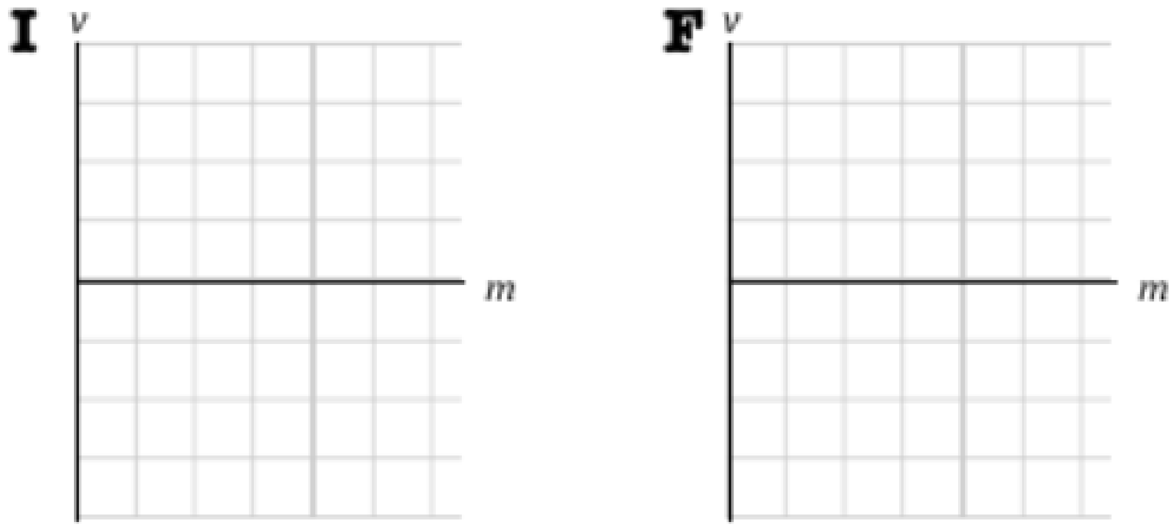
17. Calculate the momentum of a 0.3kg squirrel climbing up a tree at a speed of 3m/s.

18. A 2kg ball is dropped to the ground. It hits the ground with a velocity of -6m/s and bounces back up with a velocity of +4m/s. What **impulse** does the ball experience?

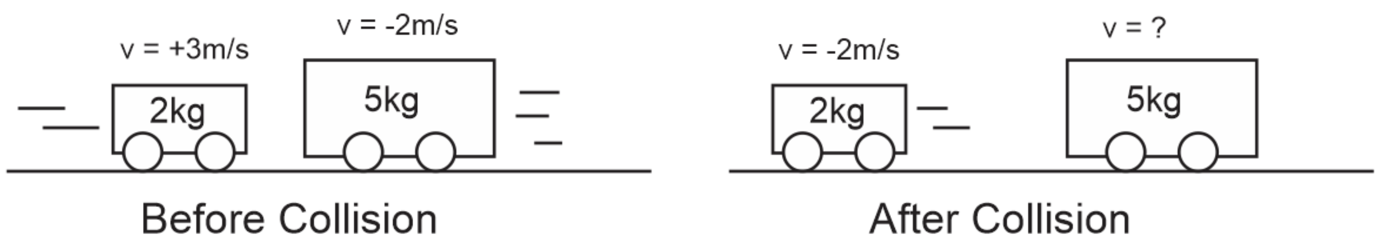



19. A 1,200 kg car drives at a speed of 30 m/s until its brakes bring it to a stop. If it take the brakes 3 seconds to bring the car to a stop, what average force are the brakes applying to the car?

#20.  (Optional blank IF chart, if you want to create a momentum bar chart for this problem)




20. Shown below two carts before and after their collide.  Their masses and velocities are shown – except for the velocity of the 5kg cart after the collision (which you must figure out).




a. Find the momentum of the 2kg cart, before the collision:

b. Find the momentum of the 5kg cart, before the collision:

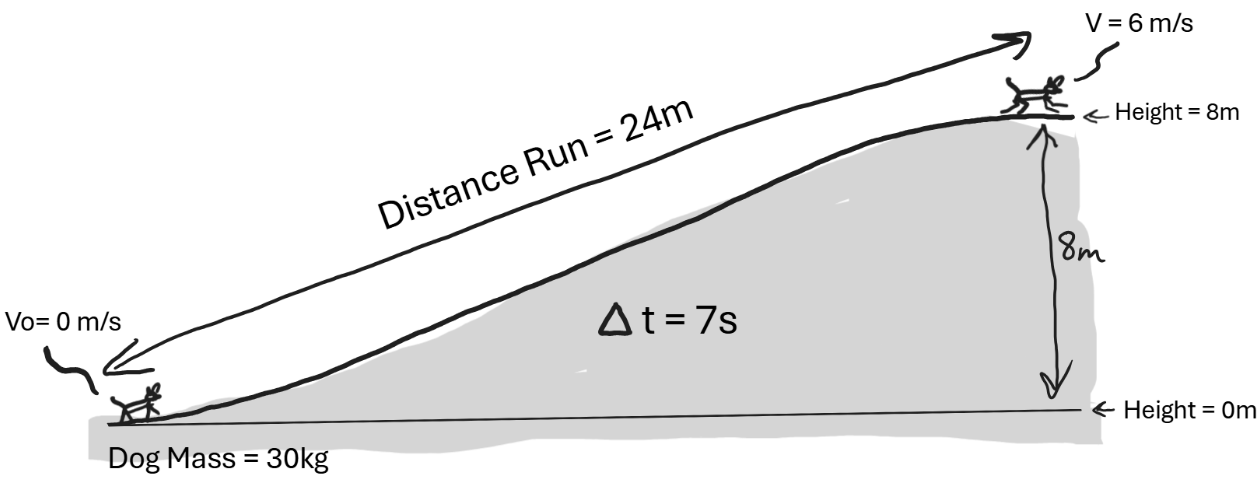
c. Find the **TOTAL** momentum of the two carts, before the collision:

d. What is the **TOTAL** momentum of the two carts, after the collision?

e. What is the **velocity** of the 5kg cart, after the collision?

# Energy, Work, and Power

21. Starting from rest (Vo = 0m/s) a dog with a mass of 30kg runs a distance of 24m to get to the top of a hill. The trip up the hill takes the dog 7 seconds, and when it reaches the top the dog's speed is 6m/s. The height at the dog's starting point is 0m, and the height at the top of the hill is 8m.




a. How much gravitational potential energy does the dog gain during this climb?

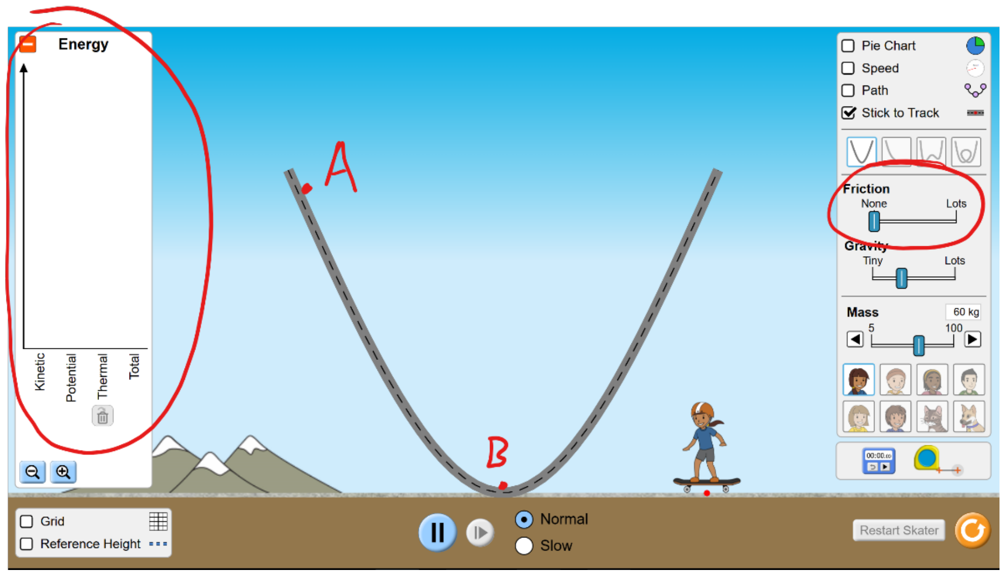
b. Does the dog gain or lose kinetic energy during its run? How much?

c. How much work does the dog do during its run up the hill?

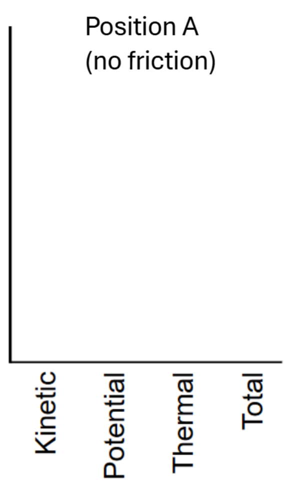
d. What average force does the dog exert during its run?

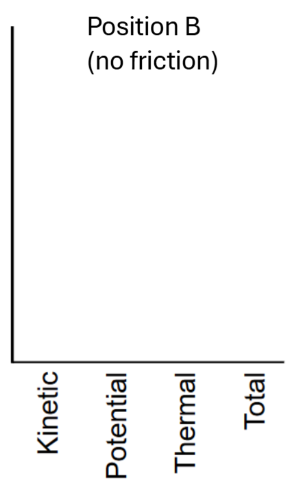
e. What is the dog's average power output during the climb?

22-23. Consider the PhET energy skate park simulation. It has a skateboarder, friction controls, an energy graph, and more…

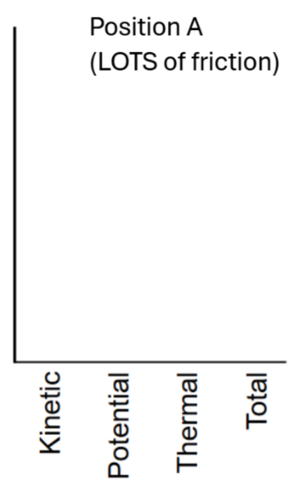


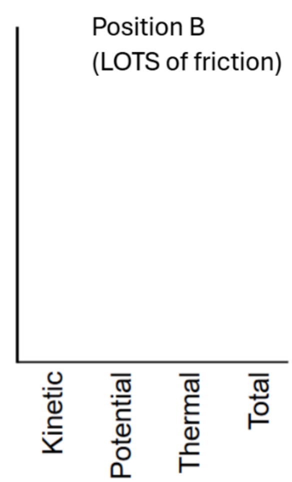

22. Notice that the "Friction" slider is set to "none." If we place the skateboarder at position A and let her go, she will roll down to position B. On the graphs below, show what the bar graphs might look like when she is at the two different positions – with NO FRICTION.




23. What will happen if we move the friction slider to "lots?" Show what the graphs might look like if we release the skater from position A and she rolls down to B – with LOTS of FRICTION.




24. [Assume for the following problem that there is NO FRICTION.] If the skater has a mass of 60 kg, and she arrives at position B with 4,000 J of kinetic energy, how much height did she lose in rolling down the slope?

# Units

25. Write the standard metric units for:

a. Speed:

b. Distance:

c. Time:

d. Weight:

e. Displacement:

f. Velocity:

g. Acceleration:

h. Force:

i. Momentum:

j. mass:

k. Impulse:

l. Energy:

m. g:

n. Work:

o. Power:

# Equations and Formulas:

$speed = \frac{d}{\Delta t}$ $v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ $\Delta v = v_f - v_i$

$g = 9.8\ m/s^2 \approx 10\ m/s^2$ weight = $F_g = -mg$ $F_{net} = ma$

$p = mv$ $\Delta p = p_f - p_i$ $\Delta p = F\Delta t$ (also written $\Delta p = F \cdot t$)

$KE = E_k = \frac{1}{2}mv^2$ $PE_g = E_g = mgh$ $W = F \cdot d$ $P = \frac{W}{\Delta t}$