AP Physics 1
Unit 1 1D Motion Practice Exercises

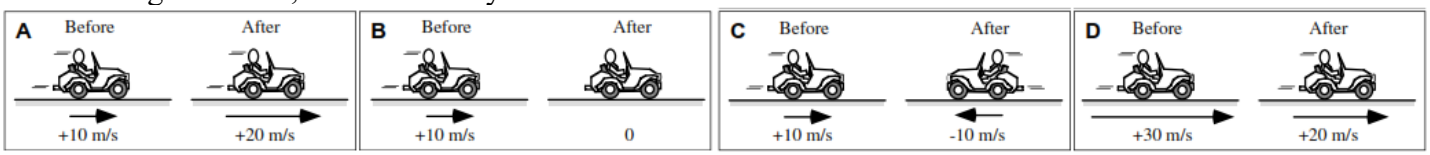
Directions: Show the steps required to arrive at the answer (if applicable). For all problems, g = 9.80 m/s^2. Work out the problems on separate page.

1.1 – Kinematics

1. Describe a situation where speed increases but velocity decreases.

2. Link walks 5 miles east, then 7 miles north, than 2 miles south.
   a) What distance did he travel? What is his displacement?
   b) Suppose Link made the whole journey in 4 hours. What was his average speed and average velocity during his journey?

3. In each figure below, a car's velocity is shown before and after a short time interval.



Rank the magnitude of the change in velocity during the time interval. Explain your reasoning.

4. A car whose initial velocity is 25 m/s is accelerated uniformly at the rate of 2.2 m/s^2 for 4.5 s.
a) What is the final velocity of the car?
b) What is the displacement of the car during the 4.5 s?

5. A plane travels a distance of 600 m while being accelerated uniformly from rest at the rate of 4.5 m/s^2
a) How long does the plane take to travel the 600 m?
b) What is the final speed of the plane?

6. A bullet leaves the barrel of a rifle with a speed of 550 m/s. The barrel of the rifle is .80 m long.
a) What is the acceleration of the bullet while it is in the barrel of the rifle?
b) For how long is the bullet in the barrel?

7. Sonic the Hedgehog travels 80 m while accelerating from 0 m/s to 40 m/s.
   a) What was Sonic's acceleration?
   b) How long did it take Sonic to go 80 m?

8. A car starts from rest and covers a distance D while accelerating. The final velocity of the car is V. Determine an expression for the car's acceleration.

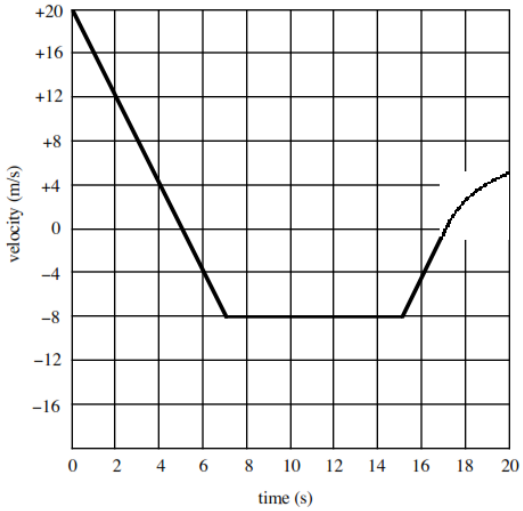
9. A race car's initial velocity is 44 m/s. The car slows down at a constant rate to a velocity of 33 m/s over an 11 s interval.
a) What is the car's acceleration?
b) What is the car's displacement during the interval?

1.2 – Kinematic Graphs

1. A car accelerates downhill from rest. Sketch graphs for the position, velocity, and acceleration of the car if it always traveling in the positive direction.

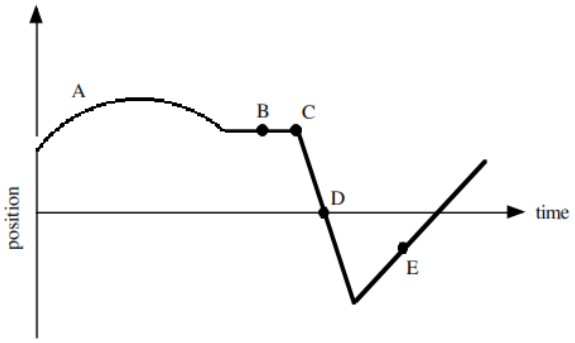
2. A ball is rolling along a flat surface at constant speed in the positive direction when it encounters a hill. It goes up the hill, then rolls back down. Sketch graphs for the position, velocity, and acceleration of the car if it always traveling in the positive direction.

3. Use the velocity vs. time to answer questions a) through m).



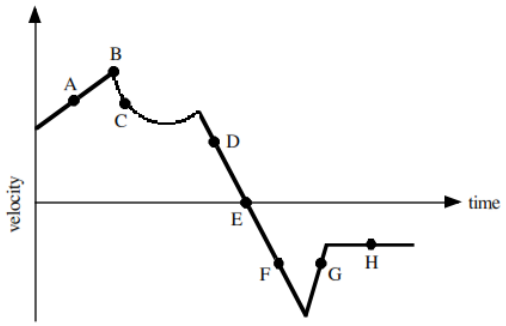
a) At what two times is the object at rest?
b) At what times is the object not accelerating?
c) What is the acceleration at t= 4 s?
d) What is the acceleration at t= 16 s?
e) At what two times is the acceleration undefined?
f) At what times is the acceleration defined and changing?
g) What is the instantaneous speed at t= 10 s?
h) At what time does the object return to the position it had at t= 0?
i) How far does the object travel from t= 2 s to t= 4 s?
j) What is the average velocity for t= 0 to t= 14 s?
k) For what values of time is the object's instantaneous speed increasing?
l) At what time is the object furthest left (left is the negative direction)?
m) What is the average acceleration of the object between t= 2 s and t= 6 s?

4. Match each description to a point on the graph (or none of these).



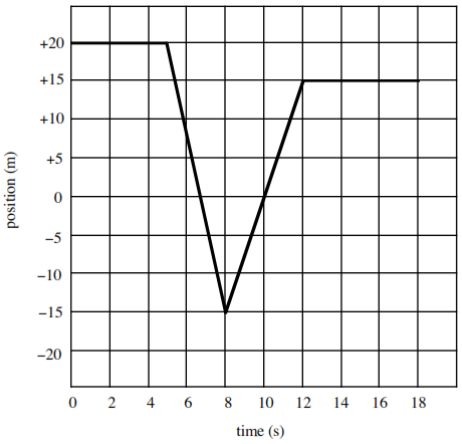
a) At which point is the object at the origin?
b) At which point is the acceleration positive?
c) At which point is the acceleration negative?
d) At which point is the instantaneous velocity not defined
e) At which point is the object at rest?
f) At which point is the velocity constant and positive?
g) At which point is the object moving to the left (the negative direction)?
h) At which point is the instantaneous speed greatest?
i) At which point is the speed of the object decreasing?

5. Match each description to a point on the graph (or none of these).



i) At which point is the acceleration defined but not constant?
ii) At which point is the acceleration undefined?
iii) Name three points at which the instantaneous speed is decreasing.
iv) Name two points at which the instantaneous speed is increasing.
v) At which point is the object at rest?
vi) At which point is the object's speed constant?
vii) At which point is the acceleration defined and largest in magnitude?
viii) At which point is the acceleration negative and the instantaneous speed increasing?
ix) At which points is the acceleration positive?

6. Use the position vs. time to answer questions a) through k).



a) What is the position of the object at t= 10 s?
b) At what two times is the position of the object x= +8 m?
c) What is the object's displacement from t= 0 to t= 16 s?
d) What total distance does the object travel from t= 0 to t= 16 s?
e) What is the instantaneous velocity of the object at t= 6 s?
f) At what times is the instantaneous speed of the object greatest?
g) At what times is the object at rest?
h) At what times other than t= 8 s is the instantaneous velocity not defined?
i) What is the average velocity over the interval from t= 5 s to t= 15 s
j) What is the average speed over the interval from t= 5 s to t= 15 s
k) At what times is the instantaneous velocity of the object greatest?

7. A jet lands on a runway going at 180 m/s. It decelerates at a constant rate of -9 m/s^2 until is stops.
   a) Calculate the stopping distance of the plane
   b) Calculate the time for the plane to stop.
   c) Graph the acceleration, velocity, and position of the jet vs. time as it rolls down the runway.

*8. Two trains collide in a messy train wreck to commemorate the year 2020. At time t = 0, the two train cars are initially 200m apart. Train A heats east at 20 m/s, and Train B is initially at rest. Train A continues at constant speed and Train B starts moving west with a constant acceleration of 4 m/s^2 at t = 0.
   a) When do the train cars collide?
   b) How fast is car B moving when the trains collide?
   c) Graph the velocity of trains A and B vs. time on the same graph from t = 0 until they collide.
   d) Graph the positions of trains A and B vs. time on the same graph from t = 0 until they collide.

1.3 – Free Fall

1. A beet is dropped of a cliff. Sketch graphs of the position, velocity, and acceleration of the beat.

2. Ball A is thrown straight down at 10 m/s outside a window. Ball B is thrown directly upwards at 10 m/s out the same window. Call C is dropped out the window.
   a) Rank the speed at which the balls hit the ground. Justify your answer.
   b) Rank the time the balls are in the air. Justify your answer.

3. A ball is thrown upward. The total time the ball remains in the air is 14 s.
a) With what speed was the ball thrown upward?
b) What is the maximum height reached by the ball?

4. A stone is dropped from a tower 150 m high. The stone's initial velocity is zero.
a) With what speed does the stone strike the ground?
b) How long is the stone in the air?

5. You are on a 5 m high rook and throw a ball upwards at 10 m/s. It lands on the ground below the roof.
   a) How long was the rock in the air?
   b) What was the final velocity?

6. A piano falls off a helicopter that is hovering at a constant height. The piano strikes the ground with a velocity of -8$\overline{\mathbf{0}}$ m/s.
a) What is the height of the helicopter?
b) For how long did the piano fall?

7. A rocket accelerates from rest at 8.00 m/s^2 for 60.0 s. The engine is then shut off.
a) What is the rocket's height when the engine is shut off?
b) What is the rocket's velocity when the engine is shut off?
c) What is the rocket's maximum height?
d) How long after the engine is shut off does the rocket strike the ground?
e) With what speed does the rocket strike the ground?
f) Sketch a graph of the rocket's acceleration for the 60 s.
g) Sketch a graph of the rocket's velocity for the 60 s.