Solving Motion Problems

For problems when constant motion occurs in two distinct directions –

* Create an x|y chart
* In each column, start by writing a space for d, v, and t
* Now fill in all distances, velocities, and times you are given in the problem.
  + Make sure to include *all* velocities and distances that occur in that direction. For example, if you have a boat’s velocity *upstream* and a current *downstream*, you would record *both* in Vy. It would look like this: Vy = Vby – Vc 
    - Vby is the velocity of the boat in Y and Vc is the velocity of the current. Since they are opposite directions, they are opposite signs
  + The *time* will be the same for both columns – Even though motion is occurring in two directions (x & y) it is only occurring one time, so both columns have the same t
* If one side has 2 out of the 3 variables, you can solve for the third.

Most common example: Boat problems

Bearing angle problems:

If the problem is a *bearing* problem, it asks you for an angle.

* If the problem asks you for an angle to continue moving in a particular direction despite some new velocity component (ex a pilot encountering a wind) then you need to adjust the plane to cancel out the new wind.
  + For example if a pilot is flying south and encounters a wind 20 m/s West, they need to adjust their position to cancel out that wind, so they change the plane’s velocity so it has an x component 20 m/s East – exactly opposite. Then when we sum the velocities in the X direction, they equal zero and all resulting motion continues in the Y direction (in this case due South)
  + In cases like this, when the pilot adjusts and has an X and Y component to their velocity, often the *max speed* of the plane or boat is given. This is the *hypotenuse* of the plane or boat’s velocity triangle.
  + Example: A plane has a max speed of 600km/hr flying due S. The pilot adjusts to counter a 40km/hr wind to the E. They therefore adjust the plane to have an X component 40km/hr to the W

600km/hr (max)

40km/hr W

Velocity in Y

(solve for using

Pythagorean theorem)

* + - The triangle for the plane’s velocity would look like this:

Most common example: Plane and wind

Sometimes, you will encounter problems where you need to take into account both methods (like the test problem). When in doubt, make the chart first.

Motion Equation problems will have an acceleration (units: m/s2 or any distance/time2)

Four motion equations:

* D=1/2(Vi + Vf)t
  + In problems where motion is constant (a=0, Vi=Vf) this simplifies to D=vt
  + No acceleration term in this equation
* Vf = Vi + at
  + No distance term in this equation
* D = Vit + 1/2(a)(t2)
  + No final velocity term in this equation
* Vf2 = Vi2 + 2ad
  + No time term in this equation

If you are struggling to choose which equation to use, look for what is missing from the question (not given and not asked to find) and then find an equation that is also missing that variable

Sometimes we will have a problem that has multiple parts – For example, a runner starts from rest and accelerates (part 1) then runs at a constant speed (part 2), then slows down to a stop (part 3). In this case, we can figure out where each ‘part’ is by looking for each section where the motion is different. We must approach each part individually. If you were asked to find the total distance or total time for the example of the runner above, you would have to find the distance or time for *each part*, then add them all together.

Sometimes parts will have the same values for different variables – Example a runner accelerates then travels at a constant speed, and you are asked to find the total distance The runner accelerated to their final velocity (Vf for part 1) then ran at that velocity (constant V for part 2). Even though this number is the same, we must still solve each part’s distance separately.

Key words for motion problems:

Constant velocity/speed – means a=0m/s2

“From rest” – Vi = 0m/s

“To rest” – Vf = 0m/s

Stopped/stationary – V = 0m/s

Freefall problems:

Freefall problems follow the kinematic equations, however, whenever something is moving up or down on earth you KNOW the acceleration is the acceleration due to gravity which is -9.8m/s2. The negative sign means it is towards the ground. In your answer, if you get a negative velocity, it means it is towards the ground. If you get a negative distance, it means the object ends up below where it started. See the following picture, for an object thrown upwards that then falls below where it starts:

V=0

V=+

V= - c

D = +

D = -