CHAPTER 3 Relative Motion, Vectors, 2-dimensional (projectile) motion

Relative motion:
        Explain the concepts of
                Reference frames
 The idea of point of view, constant speed.
                Relative velocity
 Velocities measured relative to another object's reference frame..
                Special relativity
The idea that light is NOT relative, so then objects moving close to the speed of light slow down (time dilation) and shrink (length contraction).

Sketch the path of a ball thrown on a moving train from the point of view of the train, the ball, an observer on the ground, an observer on another train… both for a normal train and one moving close to the speed of light.
Train… ball goes up and down, ball… all is still, observer on ground.. parabola!, other train.. some type of parabola… width depends on the difference in speeds…. For moving close to the speed of light, parabolas are narrower.
                How to find the velocity of one object with respect to another if you know the velocity of each with respect to the ground…
V12=V1g-V2g

Vectors:
                Relative motion with 2 dimensions instead of one.
Add vectors

What is a vector?
Property that has a number, unit, and direction….. arrow, length of arrow is the magnitude.

How to add vectors to find the resultant (head to tail: graphical method, right triangles… (law of sines??)).
Graphical method, add head to tail, draw a resultant arrow vector from start to finish and complete the triangle. Measure length and direction angle.
With right triangle… change each vector hypotenuse into x and y components, using x=Hcos(angle), y = H sin (angle). Add all the x's and y's, make one big right triangle and solve for new hypotenuse using pythogorean theorem and inverse tangent for angle

What properties are vectors?
Things like displacement, velocity, acceleration, force, weight. And which are scalars? Things like distance, speed, mass, energy.

How and why there are 6 ways to add three vectors.
Draw head to tail: A+B+C, A+C+B, B+C+A, B+A+C, C+A+B, C+B+A

How to find the angle of the resultant. *Measure, or do inverse tangent of big right triangle…*

How to find the x/y, horizontal/vertical, north/east, components of a vector at an angle.
With right triangle… change each vector hypotenuse into x and y components, using x=H cos(angle), y = H sin (angle). Add all the x's and y's, make one big right triangle and solve for new hypotenuse using pythogorean theorem and inverse tangent for angle

Projectile motion:
                Why and how do we separate motion into x/y perpendicular components? *Well, because it makes the math easier (right triangles), because forces that are perpendicular do not affect each other, and because gravity only acts in one direction.*

What is projectile motion?
An object moving through the air (with no air resistance),starting with some velocity at an angle, with no force acting on it except for gravity.

What is the path of a projectile and how does this explain why you CAN'T make a vector of displacements in projectile motion? *A parabola !*

What property is the same in the x and y direction for projectile motion? *Time!!!*
                What is the angle of maximum range for a projectile and why?
45 degrees because the same component of velocity in the y as in the x.

What information do you know about a projectile while it is at the top of its arc?
Its velocity in the y is zero.(Ay is – 9.8, Vx=Vx, time is half of the total time of the trip)

What information do you know about a projectile fired horizontally?
Its velocity in the y starts at zero.(but Vx = Vx, Ay =-9.8, etc..)

What information do you know about a projectile fired from the ground that lands on the ground?
Its starting velocity Vx=Vx, and Viy=Vfy, and the Dy = 0, (Ay=-9.8, etc..)
                Draw a strobe diagram of the vertical and horizontal components of a projectile's motion.
. . . . (horizontal is constant)

vertical is accelerated:
. .   .   .

What formula is always used in the x direction and why?
Since Ax=0, Dx=VxT is all you need…
Vx = V cos (angle)

What formulas are usually used in the y direction?
Viy=V cos (angle)
And
Dy=ViyT+1/2AyT²
Vfy=Viy + AyT
Vfy²=Viy²+ 2AyDy
Ay = -9.8 m/sˢ

Why can you never answer "how fast are you going"?
You always are moving different relative to something else…there is no one true fram of reference, you are the center of your universe!

A passenger on a train going east is skateboarding towards the back, while throwing a spear towards the front, while there is an ant walking towards the point of the spear.
Describe the path of the spear as seen from the: passenger, ground, ant, train.

How would you calculate the velocity of the ant?

A piece of chalk is dropped by a teacher walking at a speed of 1.5 m/s. From the teacher's perspective how does the chalk appears to fall? How does it fall from the ground's point of view?
Down, parabola

Why are there two answers to the question: How far did you travel?
Distance travelled, displacement

Two vectors acting at right angles to each other having the magnitude 6 and 8 have a resultant with a magnitude of
10 (Pythagoreas)

What are quantities that are given as scalar or vectors? *Things like displacement, velocity, acceleration, force, weight.* And which are scalars? *Things like distance, speed, mass, energy.*

What does a vector mean?
Property that has a number, unit, and direction….. arrow, length of arrow is the magnitude.

How would parabolic motion be different at speeds close to the speed of light?
…. For moving close to the speed of light, parabolas are narrower.

Describe the two ideas (postulates) that lead to the theory of special relativity:
All frames of reference equal, you are the center of your universe, speed of light is constant for all observers, not relative, nothing goes above c!

What are the consequences of special relativity? (How do the properties we know change at speeds close to the speed of light?)
Time dilates, length contracts

A small airplane flies at a velocity of 145 km/h toward the south as observed by a person on the ground. The airplane pilot measures an air velocity of 170.0 km/h south. What is the velocity of the wind that affects the plane?
Vpg= 145, Vpw=170m Vwg=??
Vpg=Vpw+Vwg, so Vwg=145-170=-25 south or 25 km/hr North=Wind

While following directions on a treasure map, a person walks 75.0 m south, then turns and walks 4.50 m east. Which single straight-line displacement could the treasure hunter have walked to reach the same spot?
75.13 m at 86.6° S of E

A boat crosses a 30 meter wide river with an initial speed of 20 m/s aimed straight across (perpendicular to the current). If the current is 5 m/s, where and when will the boat reach the other side?
1.5 sec later, 30.9 m at an angle of 75.96° to the bank, or 7.5 m downstream.

If a plane is pointed due east, but the path it takes from the ground is due south, the wind must be blowing
SW
If I take a journey and walk three different legs to my journey, describe how to calculate the total displacement.
Graphical method, draw head to tail,: A+B+C, A+C+B, B+C+A, B+A+C, C+A+B, C+B+A draw a resultant arrow vector from start to finish and complete the triangle. Measure length and direction angle.

Or With right triangle… change each vector hypotenuse into x and y components, using x=H cos(angle), y = H sin (angle). Add all the x's and y's, make one big right triangle and solve for new hypotenuse using pythogorean theorem and inverse tangent for angle

What are the conditions necessary for projectile motion? Describe the change in vertical and horizontal velocity

What does a strobe diagram seen from above (projected horizontally) look like for an object that is thrown in the air?

What does a strobe diagram seen from head on (projected vertically) look like for an object that is thrown in the air?

An arrow is shot in the air with a velocity of 61 meters per second at an angle of 20 degrees. How high will the arrow go?
22.2 m

A stone is thrown at an angle of 30.0° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stopwatch measures the stone's trajectory time from the top of the cliff to the bottom at 5.6 s. What is the height of the cliff?
120.1 m

A model rocket flies horizontally off the edge of the cliff at a velocity of 50.0 m/s. If the canyon below is 100.0 m deep, how far from the edge of the cliff does the model rocket land?
225.9 m

Where would a baseball pitcher have to aim a fastball to have it pass at the height of a batter's chest? Why?
Above

In projectile motion, the rising and falling times are equal if the landing position is related how to the launching position?
=
A firefighter 60 meter away from a burning building directs a stream of water from a fire hose at an angle of 30 degrees above the horizontal. If the velocity of the stream is 20 m/s, at what height will the stream of water strike the building?(on earth with no air resistance)
10.48m
** Honors: at what angle should you hold the hose in order to hit the building level with you?
No answer! Max range is 40.8 m
** Honors: Calculate the journey of a man who walks 50 miles at 76 degrees west of south, then 40 miles at 65 degrees north of east for 3 hours in each leg. What is the velocity of a plane that wants to catch him exactly, that is being blown by a 12 mph north wind?
39.7833 miles away at 37.3869' n of w

plane aim 9.56 mph at 56 ' s of w