“Motion in a Straight Line: Crash Course Physics #1”:

1. The ______________________ use physics to figure out how fast you’re moving through the world.

2. Time, position, velocity, and acceleration are all linked together via the ________________ equations.

3. Driving on a straight highway is an example of __________ dimensional motion.

4. ______________ tells you how long you were driving for. Position lets you know where you are or where you were. It can be _____________________________.

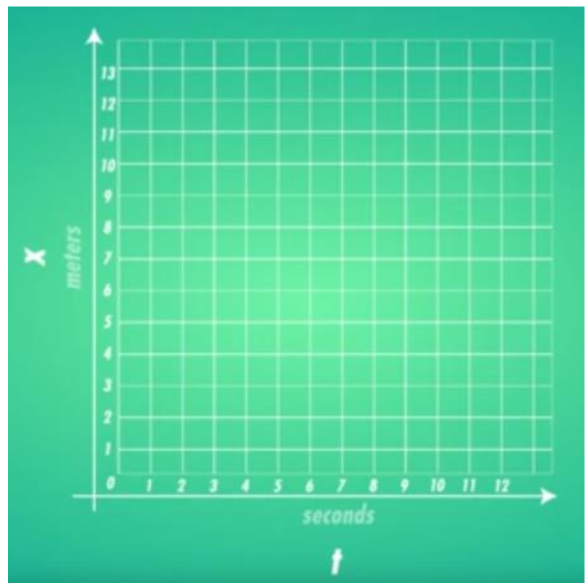
5. ___________________________ is the way your position changes over time. It’s like speed, but it tells you which ______________________________ you’re moving in.

6. Draw and label the graph of the three different scenarios given:

A) You sat for 3 seconds, 4 meters away from the light.

B) You coasted at 1 m/s for 3 s.

C) You are standing still, 4 m away from the light, you hit the gas so that after 1 s you had gone 1 m, 4 m after 2 s, and 9 m after 3 s.



7. Velocity is the change in _______________________ over time and acceleration is the change in ___________________ over time.

8. The equation known as the “definition of acceleration” is ____________________________________, where V_0 is the initial velocity, and V is the instantaneous velocity.

9. When something is falling, the force of gravity is making the object accelerate at _________________m/s^2.

10. The second kinematic equation, the displacement curve equation is __________________________________.

11. Determine whether or not you were speeding when the cops pulled you over. Show your work.

12. Did you deserve that ticket? **YES** **NO**

“Derivatives: Crash Course Physics #2”:

1. ____ is the language of physics.

2. We describe change in mathematics through ____.

3. In the new scenario, you don’t know your acceleration, only how much your position is changing over time. In this instance your position is equal to amount of time you’ve been driving square, written as the equation ______________________.

4. Limits are based on the idea that if you have an equation on a graph, you can often __________________ what it’s going to look like at one point, just by knowing what it looks like at the __________________________ points.

5. Limits are useful because they can help predict what happens as we make intervals _______________________. An interval is just a _____________________________ on a graph. The space between two points on the horizontal axis.

6. The idea of derivatives is that you can use infinitely ________________ intervals to figure out exactly how an equation is changing at any moment.

7. Velocity is the derivative of ____________________ and acceleration is the derivative of __________________.

8. The “**power rule**” is used for equations with variables raised to powers or exponents, as long as the exponent is a __________________________. The power rule says that for these kinds of equations, to calculate the derivative all you need is one weird trick: take the number of that exponent and stick it _________________ of the variable, then subtract one from the exponent, and that’s the derivative. So the derivative of $x = t^2$ is just ___________.

9. What is the derivative of $x = 7t^6$? _________________ $x = t^{1/2}$? ________________ $x = t^{-2}$? _______________

10. The derivative of sin (x) is _________________________. The derivative of cos (x) is ______________________. The derivative of –sin (x) is _______________________. The derivative of –cos (x) is ____________________.

11. The derivative of e^x is ______________________...no matter what.

12. We can take a derivative of your velocity and find your ____________________________________.

"Integrals: Crash Course Physics #3":

1. Integrals are basically the ______________________________ of derivatives.

2. The force of gravity (g) accelerates the ball downward at ______________________.

3. Velocity is the derivative of ____________________ and acceleration is the derivative of __________________. Inversely, velocity is the integral of acceleration and position is the integral of position. On a graph, velocity is equal to the area ___________________ the acceleration curve and position is equal to the area ______________ the velocity curve.

4. If you know that v = 2t, then you know that's the derivative of the position. To find the equation for your position, you just need to find an equation whose derivative is 2t like **x = 2t** is the integral of ________________.

5. What is the integral of v = $42t^5$? _______________________

6. A _________________________ is just a number…ANY number. The derivative of a constant is _____________. A derivative is a rate of _______________, so a constant, by definition, doesn't change, and so will always have a derivative of ____________________.

7. The integral of x = 2t is _________________________. Whatever the constant is equal to is where the curve will intersect with the vertical axis.

8. The ________________________________ gives you the point where the graph intersects the vertical axis, which is the value of 'C'.

9. What is the velocity of the tennis ball? ____________________________

10. We can get rid of the 'C' if we can figure out the velocity when time equals ________________________. If we write out our equation with V_0 in it we get __________________________________.

11. Using the power rule, the integral of '**at**' is ___________________ and the integral of **V_0** is _______________. Put them together and you'll end up with ______________________________.

12. How high is the window? Show your work.

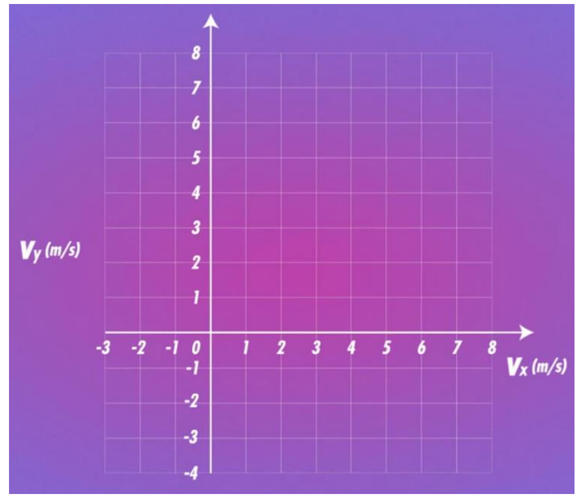
“Vectors and 2D Motion: Crash Course Physics #4”:

1. In real life, when you need more than one direction, you turn to _____________________________.

2. Vectors are kind of like ordinary numbers – which are also known as **scalars** – because they have a

_______________________, which tells you how big they are. Vectors have another characteristic as well:

_________________________.



3. Draw a vector that shows a baseball launched at a 30° angle from the horizontal with a starting velocity of 5 m/s in the space to the right.

4. Draw a vector to represent the scenario Shini gives you if the catcher were to drop the ball.

5. When you draw a vector, it’s a lot like the

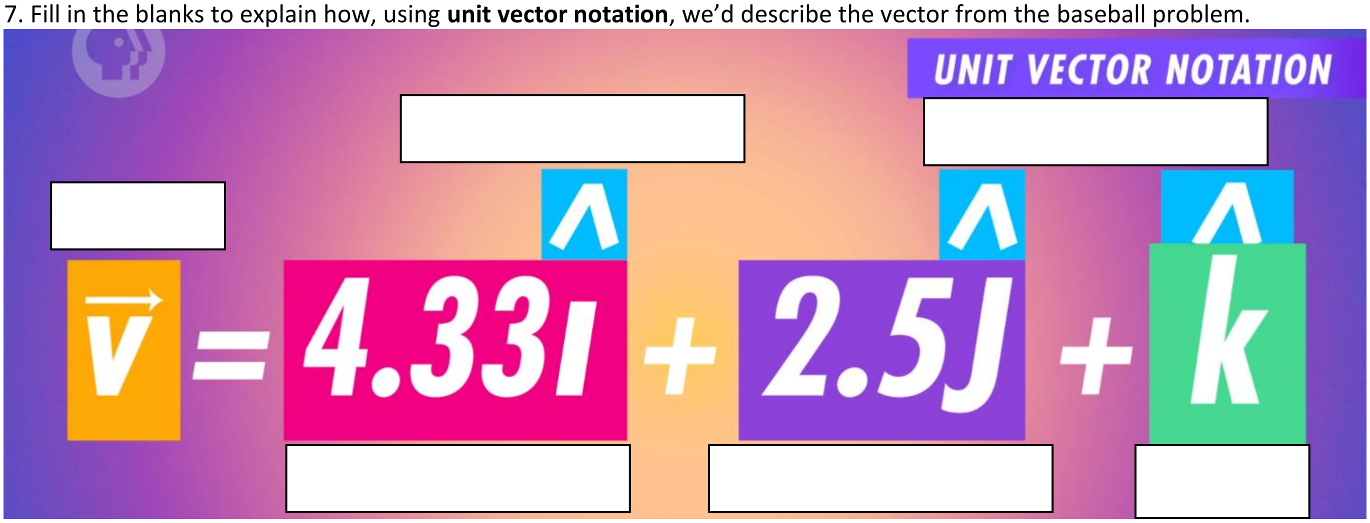
___________________________ of a right triangle.

6. You can describe a vector by writing the lengths of the two other

sides. They are so good at describing a vector that physicists call them

its ______________________.

7. Fill in the blanks to explain how, using **unit vector notation**, we’d describe the vector from the baseball problem.



8. If you want to add or subtract two vectors, you just separate each of them into their ______________________ parts and

add or subtract each component separately.

9. Changing a horizontal vector **WILL** **WON’T** affect its vertical component and vice versa.

10. We can figure out how long it takes the pitched ball to hit the ground by ignoring the ____________________ component.

We use the ____ equation. The ball took ____________ to hit the ground.

11. If we talk about the ball’s highest point, the vertical velocity HAS to be __________________. By using the

____ equation we learn that it took the ball _____________ to reach its

maximum height.

"Newton's Laws: Crash Course Physics #5":

1. Newton's 1st law is all about ________________________________, which is its tendency to keep doing what it's doing. The 1st law is stated that "an object in motion will remain in motion, and an object at rest will remain at rest, unless acted upon by a ________________________________. Essentially, to change a way something moves, to give it ______________________________________, you need a **net force.**

2. Newton's 2nd law states that "_____________________________ is equal to mass times acceleration", or, as an equation, F_{net} = ________________________.

3. The most common case of a net force making something move is the _________________________________.

4. The value of "g" ("small g") is ________________________.

5. We measure weight in __________________________.

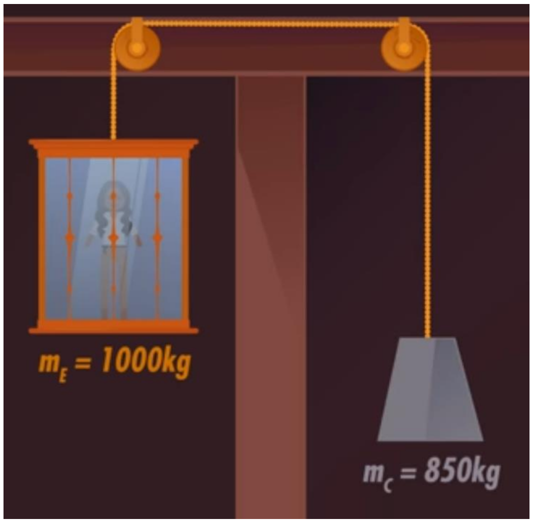
6. Newton's 3rd law states that "for every action there is an equal and _________________________ reation." This just means that if you exert a force on an object, it exerts an ______________________ one back on you. This is known as the **normal force**. "Normal", in this instance, just means _______________________________. And the normal force is always perpendicular to whatever surface your object is resting on.

7. Things can _________________ because there's more going on than just the action and reaction forces.

8. Draw and label a free body diagram for the box sitting on the ground:

9. The counteracting upward force that comes from the rope attached to the box is called the _______________.

10. On the picture to the right, draw in the forces at work.



11. How quickly is the elevator accelerating downward?

____

“Friction: Crash Course Physics #6”:

1. Without ________________________________ it would be tough to do almost anything.

2. There are two kinds of friction: ____________________________ friction, which is the force that slows the bookcase down as it slides and _____________________________ friction, the force that you have to overcome to get the bookcase moving in the first place.

3. The force of kinetic friction is in the **SAME** **OPPOSITE** direction of the movement of the object.

4. Rougher materials have **MORE** **LESS** surfaces to catch on each other, which is why the bookcase will be **HARDER** **EASIER** to slide on the wood floor than if you'd tried it on carpet. The way this roughness affects kinetic friction is called the **coefficient of kinetic friction**.

5. How hard the materials are pressed together puts **MORE** **LESS** of their surfaces in contact with each other. That's where the _________________________ force comes in.

6. The coefficient of kinetic friction is expressed as __________. The equation for kinetic friction is __________________.

7. Like kinetic friction, static friction is also a resistive force. But not only can its direction change – its ____________________ can change too.

8. The coefficient of static friction is expressed as _______________________. The equation for the maximum force of static friction is ______________________.

9. Draw the free body diagram for the box on the ramp on the picture to the right.

10. To figure out if the box will slide down the ramp, we need to find out if the part of the gravitational force pushing it down the ramp, _________________________, is greater than the maximum static friction resisting it.

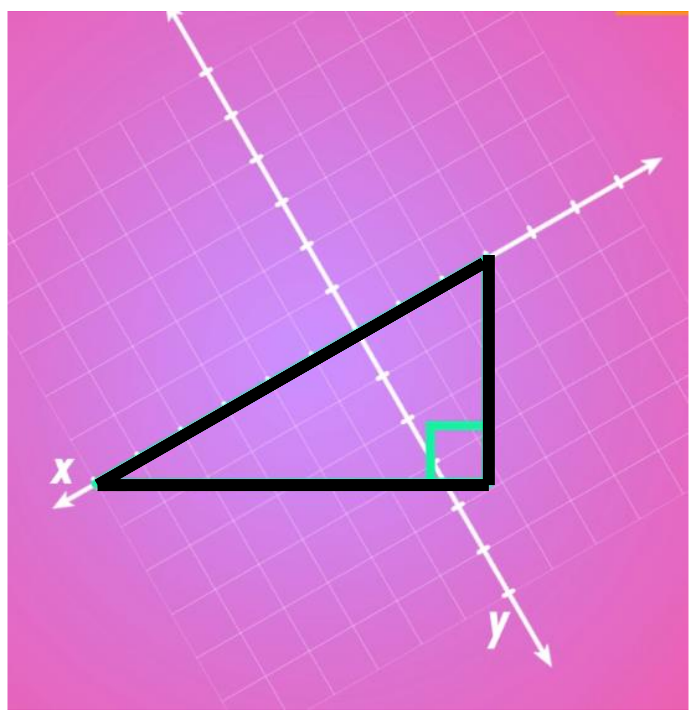
11. What is the net force pushing the box down the ramp?

____

12. What is the maximum static friction?

____

13. Will the box slide down the ramp? **YES** **NO**



“Uniform Circular Motion: Crash Course Physics #7”:

1. **Uniform circular motion** is what happens when anything moves along a circular path in a ______________ way.

2. Things accelerate **INWARD** **OUTWARD** as they move in a circle. This is known as centripetal acceleration.

3. Centrifugal acceleration **IS** **IS NOT** real.

4. Most people can withstand an acceleration of _______________________ for 10 minutes.

5. Uniform circular motion has four main quantities: ________________, velocity, acceleration, and __________.

6. Velocity is never along the path of a circle, but rather perpendicular to the radius of the circle along a line called a _________________________.

7. Something moving in a straight line is going to ____________________________ to move in a straight line unless a force – one that **IS** **ISN’T** balanced out by other forces – turns it.

8. Centripetal acceleration is always directed towards the ______________________ of the circular path.

9. The _______________________ of the motion in a circle is the amount of time it takes to come back around to a starting point. It is represented as __________. The period of the motion of the centrifuge is ________.

10. How many revolutions the ride makes in one second is its ___________________________. The equation for frequency is ___________________.

11. Circumference (C) = _____________________________. The circumference of the ride is ________________.

12. The speed equation for uniform circular motion is:

13. The magnitude of centripetal acceleration will be equal to the change in __________________ over the change in ______________ at any given moment, or its derivative. This equation turns out to be: _____________.

14. If you increase the speed around the path or decrease the radius of the circle, you will ___________________ the acceleration.

15. The acceleration of the riders would be ________________________.

16. According to NASA, is the ride safe? **YES** **NO**

“Newtonian Gravity: Crash Course Physics #8”:

1. When Newton was starting out, there was already a concept of gravity in place. **TRUE** **FALSE**

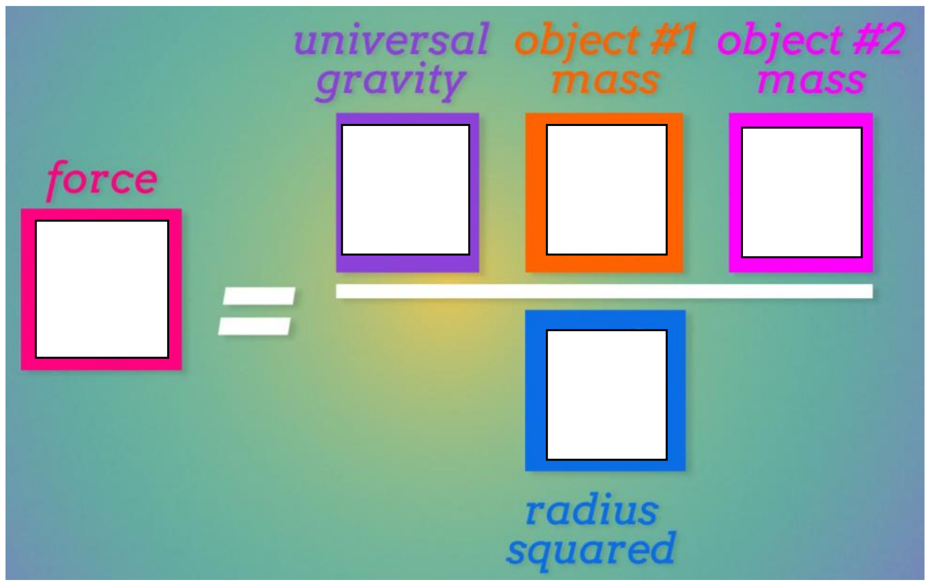
2. Newton’s Law of Universal Gravitation works well on a _______________________________ scale.

3. Newton new that however the gravitational force worked, it would probably behave like __________________ net force on an object. It would be equal to that objects mass times its acceleration.

4. When an object is close to the Earth’s surface, like an apple in a tree, gravity makes it accelerate at about ____.

5. Newton figured that the gravitational force between two objects must get smaller the further apart they are. More specifically, on the distance of the two objects ______________________________.

6. The equation for the law of universal gravitation is



7. It was Henry Cavendish that figured out that G was equal to __________________ Nm^2/kg^2.

8. Newton took his law of universal gravitation and applied it to _____________________ laws. According to Kepler, the orbits of the planets are _________________________________ (1st law). In Kepler’s 2nd law, he tells us that two “pizza” slices swept out of Earth’s orbit will have the exact same _______________.

9. From Newton’s law of universal gravitation, the gravitational acceleration at Mars’s surface should be _______.

“Work, Energy, and Power: Crash Course Physics #9”:

1. A ____________________________ is whatever section of the universe you are talking about at the time.

2. The amount of **work** that you are doing is equal to the _____________________ you are using times the ___________________________ that you move it. Work is most often expressed in units of _________________.

3. Physicists often write the equation of work as _________________________________ because it will fit any scenario that involves a **constant** force over any distance.

4. Joules are often used as the units for ______________________. Work is just a change in energy. One of the ways to define energy is as the ability to do ____________________________.

5. Kinetic energy is the energy of ____________________. The equation for it is _______________________.

6. Potential energy is energy that ___________________________ be used to do work. A common type is **gravitational potential energy**: energy that comes from the fact that _____________________ exists.

7. Gravitational potential energy can be calculated using the equation _______________________________.

8. Use this equation find the force of a spring using Hooke’s law: ______________________________. To find the potential energy of a spring you’d use the equation ____________________________________.

9. When someone does work on a system, its _________________________ changes.

10. A ______________________________ system is one that doesn’t lose energy through work.

11. **Average power** is defined as _________________________ over time and is measured in Watts (J/s).

12. If we change the power equation around we can say that power is the ______________________ applied to something with a particular average velocity.

13. Power is the best way to calculate how __________________________ moves around in a circuit.

<u>“Collisions: Crash Course Physics #10”:</u>

1. To figure out what happens when objects collide we’ll need to take into account two main qualities:

_____________________ & ______________________.

2. What Newton really said in his second law was that an “object’s ‘quantity of motion’ was equal to its mass times its ______________________________________”.

3. Momentum is often described as an object’s ________________________________ to remain in motion, however it is technically it’s mass times its ______________________________.

4. ____________________________, represented by a ‘J’ is the integral of the net force on an object over time, or the ____________________________ in momentum.

5. In elastic collisions, ______________________________ energy is neither created nor destroyed.

6. When kinetic energy isn’t conserved in a collision you have an _____________________________ collision.

7. No matter the collision, _________________________________ will always be conserved.

8. A perfectly inelastic collision is what happens when objects _________________________ together.

9. The center of mass is basically the average ____________________________ of all the mass in a system.

10. To calculate the center of mass, first pick a starting point where x = _______. Then, the center of mass will be equal to the ____________ of each individual mass times its distance from the starting point, all divided by the total _______________________ of the system.

11. What is the center of mass of the system shown in the video? ______________

“Rotational Motion: Crash Course Physics #11”:

1. Translational motion descries when an object moves through space but doesn’t ______________________.

2. Rotational motion isn’t all that different from translational motion, however instead of positions there are ____________________________.

3. In translational motion, we tend to talk about position in terms of _____ and _____. In rotational motion we really want to know the object’s angle, what we call ____________________.

4. The primary unit that physicists use with rotational motion is the _________________________. This unit describes angles by telling us how much of that circumference is covered by a given angle. To convert any number of degrees to radians you just ______________________ the number of degrees times pi and then divide that by 180.

5. Rotational velocity is the measure of an object’s change in angle. This is known as ____________________ (ω).

6. Tangential velocity is equal to the _____________________________________ times the radius.

7. Like circular motion, rotational motion can also be _______________________...when the rotation repeats itself after a set amount of time, which is represented by capital ‘___’, also called the period.

8. _______________________________ and angular velocity are really just two different ways to describe the same thing, just with different units. 1 revolution = 2π. In order to convert from frequency to angular velocity, all you need to do is multiply the frequency by ____________.

9. The bottom of the wheel isn’t moving at all because its total velocity is equal to the translational velocity ___________________ the tangential velocity, since they are moving in opposite directions. If the bottom of the wheel is moving relative to the ground we would call that ______________________________.

10. Angular acceleration (α) is the derivative of the ______________________________. As an object rotates each point on it can accelerate in two different ways. Radial acceleration is another term for _____________________ acceleration and can be found as a_r = __________________. There is also tangential acceleration which describes whether an individual point on a rotating object is speeding up or slowing down. It depends on the _______________________ between the point and the center of the rotating object. It is found with the equation a_{tan} = _____________________.

“Torque: Crash Course Physics #12”:

1. Torque changes an object’s ____.

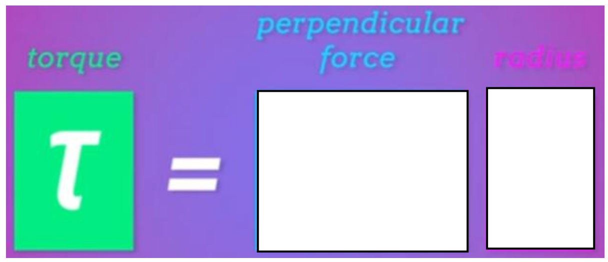
2. A lot of the relationships and equations that apply to forces apply to torque in a ___________________ way.

3. When you open a door, the ________________________ you pull on the handle, the _____________ torque you will generate and the more you’ll change the door’s angular velocity.

4. The distance (radius) between the force and the axis of rotation also affects torque. A longer radius means __________________ torque.

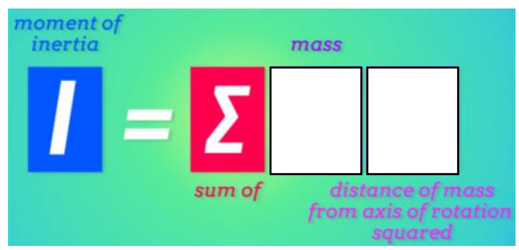
5. The ________________ between the applied force and the radius also affects torque.

6. The equation for torque (τ) is such that



7. In translational motion, the inertia of an object depends on ____________________.

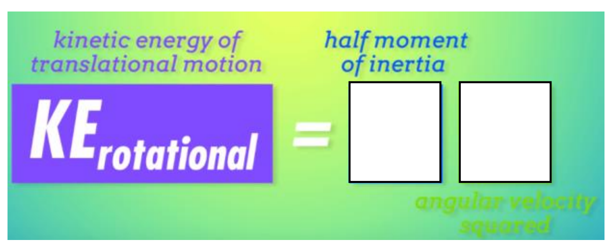
8. In rotational motion, the moment of inertia is such that:



9. Torques, like forces, have the ability to do _____________.

10. The more torque you apply while rotating an object, the **MORE** **LESS** work you do.

11. Calculating the kinetic energy is pretty easy:



12. Angular momentum (L) is just: L = ______________

13. You can’t create or destroy angular momentum. It always has to go ___________________________.

14. Which object makes it to the bottom of the ramp first? _________________________

15. Which object makes it to the bottom second? ______________________ why? ____________________________ ______________________________________

<u>"Statics: Crash Course Physics #13":</u>

1. Statics is the science of how objects behave when they're not ______________________________.

2. Objects that aren't accelerating are said to be at **equilibrium**. This means that there can be _______________ on an object, but there can't be _____________________________ on it. Otherwise, that net force would make the object accelerate. For an object to be in equilibrium, all of the forces and torques on it have to ________________________________.

3. Since the ladder isn't moving, we know that the net torque on the ladder from the wall is ___________________.

4. The force of the ladder from the wall is _________________.

5. The horizontal component of the force from the floor on the ladder is **THE SAME AS** **DIFFERENT FROM** the force of the wall on the ladder.

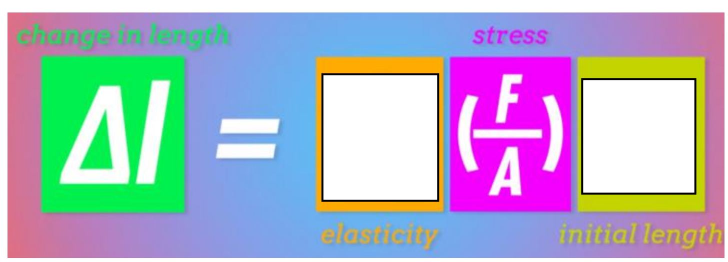
6. The ______________________________ zone is where enough force is added so that the object will stretch or compress, but still bounce back. If you apply too much force, the object may become permanently deformed. The force has reached the _______________________________.

7. The amount that an object stretches or compresses depends on:

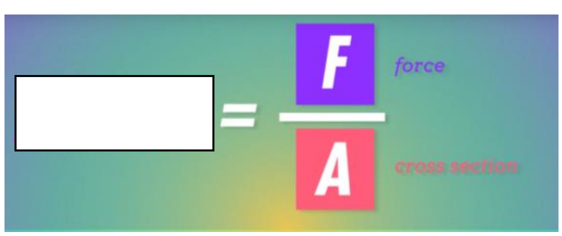
- The original ___________________ of the object.
- The strength of the applied force.
- The area of a cross-section of the object: the __________________ it is, the less it will stretch or compress.
- The type of material itself.

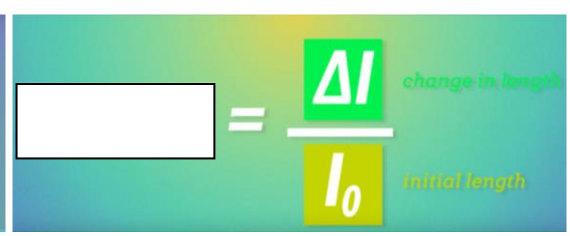
8. _________________ Modulus (E) is a number that tells you how hard it is to stretch or compress a material based on its stiffness. The higher the number, the __________________ elastic it is.

9. All of these factors (7 and 8) combine into one equation:



10. Stress and strain can be found by:





11. Shrinking is what happens to an object when you apply a force to __________________ parts of it.

12. The ____________ modulus (B) measure the stiffness of different materials in water.

“Fluids at Rest: Crash Course Physics #14”:

1. Anything that flows, liquid or _________________, is a fluid.

2. When it comes to fluids, we mostly use __________________________ in units of ___________.

3. We can define pressure as P = __________________. We measure it in units of ___________, or __________.

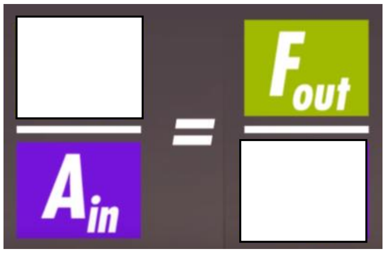
4. The average air pressure at sea level is __________________________________ Pa.

5. There’s an easy way to find the pressure at a certain depth:

6. If you are swimming at the bottom of a 3 m deep pool, you feel _______________ Pa more pressure than at 0.25 m below the surface.

7. __________________________________ states that if you apply pressure to a confined fluid, the pressure in every part of the fluid increases by that amount.

8. If you apply 10,000 N of force to the side of a piston with an area of 1 m^2, you would apply _________________ of force to the right side piston that has an area of 2 m^2. In mathematical terms:



9. A manometer is a _____-shaped tube with a fluid inside.

10. The difference between atmospheric pressure and the pressure inside the tire is called _______________________________ pressure.

11. Archimedes figured out that the volume of the water displaced by an object is _____________ to that object’s volume.

12. The force pushing up on an object in a fluid that counteracts the force of gravity is the ______________ force.

13. According to **Archimedes’ Principle**, the buoyant force (F_B) = ___________________________.

14. If the buoyant force is greater than the force of gravity, the object will **FLOAT** **SINK**

“Fluids in Motion: Crash Course Physics #15”:

1. The study of the flow of fluids is called ____.

2. If we assume that fluids are incompressible, we are assuming that their ____________________ won’t change.

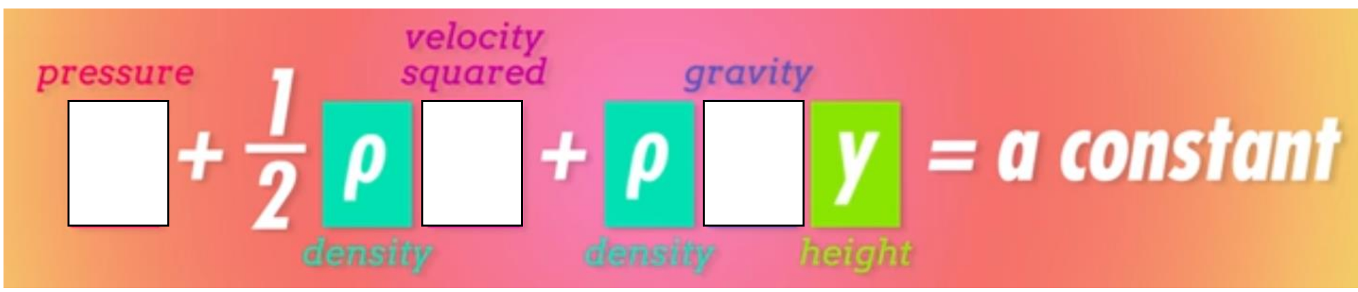
3. One thing that doesn’t change as the size of a pipe changes is the ______________________ of the water passing through any given area over a given time. This is call the _____________________ flow rate and is the same everywhere in the pipe.

4. Write the “equation of continuity”:

5. You can rewrite the equation from #4 in terms of density, area, and volume as: __________________________. Since we are assuming the water is incompressible, the density is the same everywhere, thus we are looking at it just in terms of area and velocity.

6. **Bernoulli’s Principle** states that the _____________ a fluid’s velocity is through a pipe, the _____________ the pressure on the pipe’s walls and vice versa.

7. Fill in the boxes to complete Bernoulli’s equation:



8. When a fluid applies pressure and moves a volume of fluid that’s downstream, it’s doing _________________.

9. The second term of Bernoulli’s equation is called ________________________ energy density.

10. When you look at his equation piece by piece, you can see that Bernoulli was really just putting ____ into a special form that would be useful for fluids.

11. **Torricelli’s Theorem** says that the ____________________ of a fluid coming out of the spout is the _________ as the velocity of a single droplet of fluid that falls from the height of the surface of the fluid in the container. In other words, the pressure that’s pushing the fluid out of the spout gives it the same velocity that it would get from the force of ___________________________________.

12. In the barrel problem, if you get rid of the terms that you don’t need, you end up with another ____________________ equation that relates velocity, acceleration, and displacement, without considering time.

"Simple Harmonic Waves: Crash Course Physics #16":

1. The answer to the problems with the Millennium Bridge lies in _______________________________.

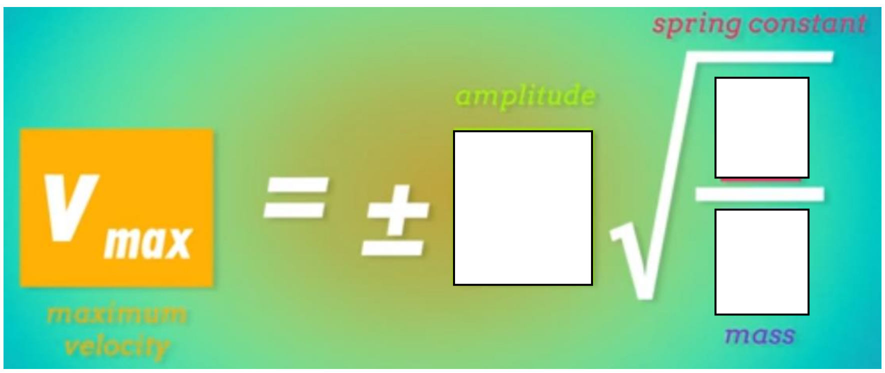
2. ________________________ harmonic motion is when oscillations follow a particular, consistent pattern.

3. The points where the ball is not moving are the turning points. The distance from one turning point to where the system is at equilibrium is the _________________________.

4. The equation for the "moment of turning point", when all of the energy is potential energy is: ______________. The energy is one half the spring constant times the amplitude squared.

5. At the equilibrium point, the potential energy is _______________ and it kinetic energy is at a maximum. This amount of energy can be calculated as __________________________.

6. Fill in the blanks to complete the equation for the maximum velocity of the ball on the spring:



6. Mathematically speaking, simple harmonic motion is very similar to ______________________________ motion.

7. The __________________________ is the number of revolutions the marble makes around the ring per second.

8. Fill in the blanks to complete the equation for finding the horizontal position of the ball on the spring:

9. For an object in simple harmonic motion, the graph of its position versus time is a ______________________.

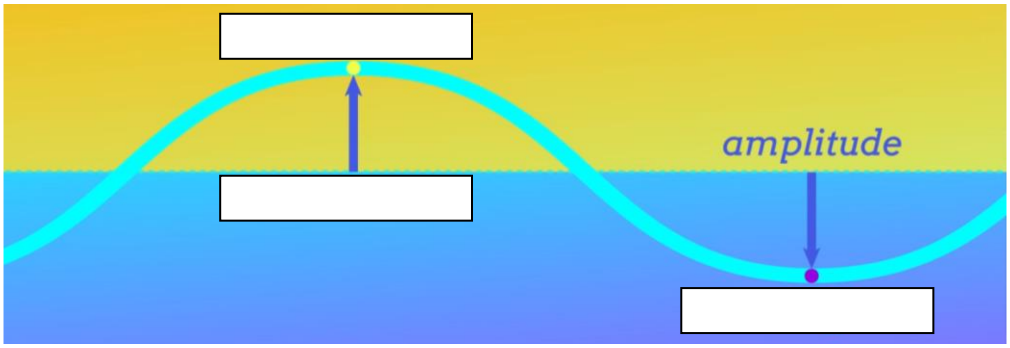
10. Resonance can increase the amplitude of an oscillation by applying force at just the right _________________.

11. The designers of the Millennium Bridge didn't account for **VERTICAL** **HORIZONTAL** oscillations.

“Traveling Waves: Crash Course Physics #17”:

1. Often, when something about the physical world changes, the information about that disturbance gradually moves ___________________________, away from the source, in every direction. As the information travels, it makes a ____________________________ shape.

2. Label the wave below with the following: crest, trough, amplitude.



3. If you multiply the wavelength (λ) by the frequency you get the wave’s speed: V = _______________

4. The wave’s speed only depends on the _________________________ its travelling through.

5. A ______________________________ wave is what happens when you move the end of the rope back and forth one time. One lonely crest travels through the rope.

6. A _______________________________ wave is what happens when you keep moving the rope back and forth.

7. Sinusoidal waves are such that if your put them on a graph they’d look like the graph of ________________.

8. In ____________________________ waves, the oscillation is perpendicular to the direction the wave is travelling.

9. In ____________________________ waves, the oscillation is parallel to the direction the wave is travelling.

10. All waves transport _______________________________ when they travel.

11. A wave’s energy is proportional to its ____________________________ squared.

12. When the end of a rope is fixed, the wave will be reflected back, but as a _________________, not a crest.

13. If you send two identical pulses along a rope, one from each end. When the two pulses overlap, they combine to make one crest with a higher amplitude. This is ________________________________ interference.

14. If you do the same thing as #13, but this time one wave is a crest and the other is a trough, when they overlap the rope will be flat as the waves cancel each other out. This is _______________________________ interference.

“Sound: Crash Course Physics #18”:

1. Sound is a ___________________________ that travels through a medium, like air or water.

2. Sound is a __________________________________ wave.

3. Physicists sometimes describe sound waves in terms of the movement of particles in the air, what’s known as a ________________________________ wave. Sounds waves also cause the air to expand and compress, so they are also referred to as ______________________________ waves.

4. Pitch can be high or low, and it corresponds to the ‘________________________________’ of the wave. Air that’s vibrating more times per second will have a **HIGHER** **LOWER** pitch.

5. Sounds that are too high in pitch for humans to hear are called _______________________________.

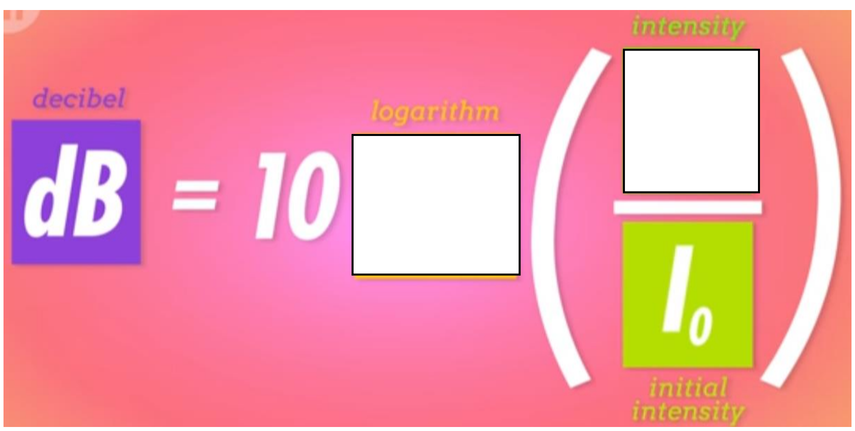
6. If you increase the ____________________________ of a sound, you increase its loudness.

7. Below __________ picowatt per square meter, sounds are just too soft for us to detect them. And although we will hear sounds above a watt per square meter, they tend to ___________________ our ears.

8. Generally a sound wave needs to have ____________ times the intensity to sound twice as loud to us.

9. We use units called ____________________________ to measure sounds. It is a logarithmic scale, so each notch on the scale is ________________ times more intense than the notch below it.

10. Fill in the boxes for the equation for determining how many decibels a sound is:



11. The rock concert (standing near the speakers) is _____________________dB.

12. As a source of a sound moves toward you, the pitch increases. This is known as the ______________________. This effect isn’t only observed in sound, but ___________________________ as well.

“The Physics of Music: Crash Course Physics #19”:

1. String instruments work when a string is pulled and ___________________________ the air.

2. Sound is a wave, a longitudinal wave. String, wave, and brass instruments use a different kind of wave, a _____________________________________. This is a wave that looks like it isn’t moving. Its ________________ may change, but it isn’t travelling anywhere. They are the result of reflection and __________________________.

3. Standing waves with different ________________________ correspond to different musical notes.

4. Label the nodes and antinodes:

5. The nodes **DO** **DON’T** oscillate.

6. The nature of the standing waves depends a lot on what the ______________ of these strings or pipes look like.

7. The most basic kind of standing wave, with one peak that moves from crest to trough is known as the ______________________________ (1^{st}) harmonic. It’s the simplest standing wave you can have, with the fewest nodes. Other, more complex standing waves, ___________________________, build on the fundamental, adding a node and an antinode.

8. The fundamental and the overtones make up _____________________________. Every node and antinode pair added increases the harmonic.

9. A standing wave’s frequency is expressed as f= _____________________. The frequency of the fundamental wave is best expressed as f = ________________________.

10. The frequency of middle C on a piano is _____________________________.

11. A standing wave with two loose ends is different from one with two fixed ends in that it has _____ antinodes and _________ node.

12. In a standing wave with one fixed and one loose end (like in a pan flute) has a ____________ at one end and an _______________________ at the other. Because of this, a pipe with one open end and one closed end can’t have ____________________ numbered harmonics.

“Temperature: Crash Course Physics #20”:

1. The cracks and grating that you see in bridges are called ________________________________. Why they are there has to do with ____.

2. At its most basic level, temperature is a measure of how much _____________________________ is in a system.

3. The easiest way to figure out if there’s a temperature difference between two systems is through **heat transfer**. The ____________________________ will ALWAYS transfer heat to the ________________________ system.

4. Usually an increase in temperature will make a solid _________________________________.

5. The equation used to describe linear expansion is: ____.

6. The value of the coefficient of linear expansion depends on the ____________________ the object is made of.

7. The equation used to describe volume expansion is: ____.

8. An ideal gas is made up of lots of molecules that move around __________________________________.

9. According to **Boyle’s Law**, as you increase the pressure of a gas, while keeping the temperature constant, the volume of the gas will _____________________________ and vice versa.

10. According to **Charles’ Law**, as you increase the temperature of a gas, while keeping the pressure constant, the volume of the gas will _____________________________ and vice versa.

11. According to **Gay-Lussac’s Law**, as you increase the temperature of a gas, while keeping the volume constant, the pressure of the gas will _____________________________ and vice versa.

12. All three of these laws can be combine into one, the **ideal Gas Law**, which is _____________________________.

13. If you have 1 mole of a gas then you have ___________________________________ molecules of it. ‘R’ is the universal gas constant. It is ___________________ J/(K mol).

14. Solve the ideal gas law for the number of moles. _____________________________________

15. How many moles of air did you lose from your car, just because it got warmer outside? ___________________

"Kinetic Theory and Phase Changes: Crash Course Physics #21":

1. At very low pressures water can't exist as a liquid, no matter the pressure. This has to do with ______________________.

2. The kinetic theory of gases is based on the idea that if you have all of these gas molecules bouncing around, you can calculate the ______________________________ of each particle. When you do the math, the equation for finding the average kinetic energy (KE_{ave}) of the ideal gases in a container is __________________________, where 'k' is the **Boltzmann constant** which can be determined as k = _____________________.

3. This equation (#2) tells you how kinetic energy and temperature are related in an ideal gas: as the kinetic energy of the gas increases, temperature _______________________________ proportionately.

4. We've been talking about the velocities of these ideal gas molecules as _________________________. To get the average kinetic energy we didn't just take the average velocity and square it, but rather we squared ________ the individual velocities and then took the average of those squared velocities.

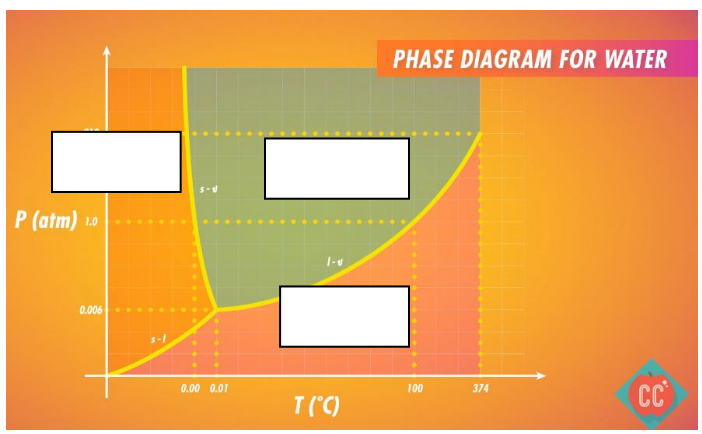
5. The square root of the average squared velocity is known as the "______________________ square speed". We write it as V_{RMS} and it is **THE SAME AS** **DIFFERENT FROM** the average speed.

6. If you want to know the speed of a typical molecule, we can use the equation $\frac{1}{2}mv^2_{ave}$ = _________________

7. The molecules in an ideal gas can have a variety of different speeds, but they are mostly near the ____________________________________ speed.

8. High pressure is a problem for gases because it forces molecules _______________________ to the point where they start to interact. At a certain pressure, gases stop acting like gases and turn into ________________.

9. Label the phase diagram for water with solid, liquid, and vapor.



10. The point at the top right is the **critical point**: the maximum temperature and pressure where a gas can be a ___________________.

11. The point where the two lines intersect is the **triple point**: it's the temperature and pressure at which a substance coexists as a ______________, __________________, and a _____________.

12. Below the triple point a substance cannot exist as a liquid. It can only go directly from a gas to a solid, a process called _______________________.

13. As far as we know, life needs ____________________________________.

“The Physics of Heat: Crash Course Physics #22”:

1. _______________________________ is the measure of the average kinetic energy of each individual molecule in a substance.

2. _________________________________ (U) is the kinetic energy of all the molecules in a system added together – as opposed to temperature, which was a measure of the average kinetic energy for each molecule.

3. To find the thermal energy of a system, you multiple the average kinetic energy by the number of molecules. This equation looks like this: ____

4. The amount of thermal energy added to or removed from a system is __________________________. It’s the energy that’s transferred between systems when they’re at different temperatures. In equations, it’s represented as ‘______’. In the official International System of Units, it is measured in units of ____________________.

5. How much the flow of heat changes the temperature of a system depends on two things: how much _________ it has and the substance’s ___________________________________, which is a measure of how well the substance stores heat.

6. Write the equation that determines the amount of heat transferred: ____

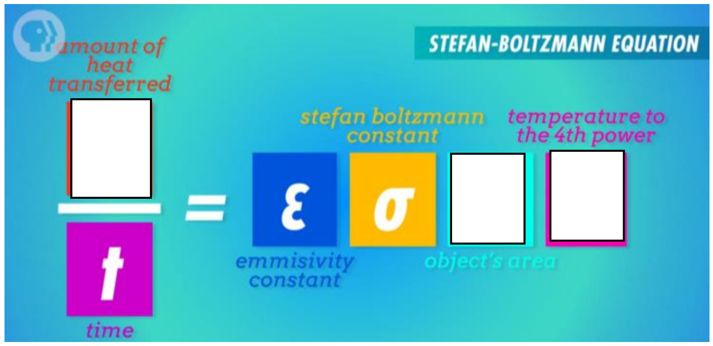
7. We don’t use the equation for #6 to determine the amount of heat while the substance is going through a phase change. Instead, the amount of heat that gets transferred (Q) = ___________. ‘L’ is the **latent heat**. It’s the heat required to change the __________________________ of a substance.

8. There are three main ways for heat to spread:

- In **conduction**, heat flow depends on ____ between molecules.
  - The thermal conductivity of a material is represented by the letter ‘________’.
- In **convection**, warmer molecules move **TOWARD** **AWAY FROM** the heat source and are replaced by cooler molecules.
- In **radiation**, heat is transferred by ____ waves.
  - The amount of heat an object radiates over time is proportional to its temperature to the ________________ power. If you double the temperature, you multiply the heat it radiates over time by ___________.
  - Radiation also depends on the material’s _____________________________________ constant, which is based on the material’s inherent ability to radiate heat.

9 The Stefan-Boltzmann equation describes how heat is radiated over time. Fill in the blanks to complete the equation.

10. One of the main ways we lose body heat is via ____________________________.



“Thermodynamics: Crash Course Physics #23”:

1. Perpetual motion is impossible. **TRUE** **FALSE**

2. The goal of thermodynamics is to describe the ________________________________ of energy. As a thermodynamic system does work, it **LOSES** **GAINS** heat. As work is done on the system, it **LOSES** **GAINS** heat.

3. The idea that the change in internal energy is equal to the change in work plus heat is known as the _________ law of thermodynamics. We write this law with this equation: ___________________________________. It’s important to remember that if heat transferred into the system, heat is **POSITIVE** **NEGATIVE** If work is done by the system, then work is **POSITIVE** **NEGATIVE**

4. The first law of thermodynamics is just another way to describe the ____________________________________.

5. In **isovolumetric processes**, _______________________ is kept constant while heat is added or removed. As you add heat, temperature and pressure **INCREASES** **DECREASES** The gas doesn’t do ___________.

6. In **isobarometric processes**, _________________________ is kept constant while heat is added or removed. Since the volume of the container can change, this process can do work. The work done by an isobarometric process can be calculated as _______________________________________.

7. In **isothermal processes**, ______________________________ is kept constant while the heat or volume is changed very slowly. They are similar to isobarometric processes, however they are calculated differently because the pressure changes. Instead you need to take the _______________________________ of the pressure with respect to the volume.

8. In **adiabatic processes**, no _______________________ is allowed to flow into or out of the system, but the gas can expand or be compressed.

9. According to the **second law of thermodynamics**, heat will spontaneously flow from something _____________ to something __________________, but it won’t flow from something colder to something hotter because of ________________________, which is often described as the inherent disorder of a system – the more disordered the system, the _____________________________ its entropy. In real life, entropy can only _____________________________ overall.

10. If the entropy of the system decreases, then the entropy of the environment around it must _______________________.

11. Entropy’s tendency to increase has to do with _____________________________________.

12. In thermodynamics, entropy is related to _____________________________, because when heat flows between systems, their entropy increases. Heat spontaneously flows from warmer systems to cooler ones because that leads to an ______________________ in entropy.

“Engines: Crash Course Physics #24”:

1. Heat engines, like steam engines, turn _________________________ energy into mechanical work.

2. In the case of a heat engine, the change in thermal energy is ______________________, because it always returns to the temperature it started at.

3. As a steam engine runs, it releases exhaust heat. The more exhaust heat it produces, the less _______________ the engine is, and the more ______________ you have to put in for the same amount of work.

4. The efficiency of an engine can be found using the equation _______________________________.

5. In terms of input heat and exhaust heat, we can simply use the equation ____________________ for efficiency.

6. An ideal engine would be ________________________ - meaning you could run it backward, putting in work to transfer heat from something with a lower temperature to something with a higher temperature. This kind of hypothetical engine is called a _______________________ engine.

7. In the Carnot Cycle, the heat **WILL** **WON'T** flow between areas of different temperatures.

8. In a Carnot engine, the first process is _____________________________. The temperature is constant, but heat is slowly added, allowing the gas's volume to expand and the pressure decrease. The second process is ____________________________. The temperature drops while the heat remains constant, which also allows the volume to expand while the pressure drops. The third process is the opposite of the first one, but is also isothermal. The gas is ______________________________ while the temperature is held constant. It releases heat and its pressure increases while its volume decreases. The last process is the opposite of the second and is _____________________________ again.

9. The ideal efficiency can be found using the equation _______________________________________.

10. Carnot engines are very ___________________________ because during those isothermal processes, the temperature has to be kept constant while heat is transferred – which only works if the heat is transferred super slowly.

11. For refrigerators, efficiency is looked at via the coefficient of performance (COP), which equals ____________

12. For an ideal fridge, the COP = ___________________________________

“Electric Charge: Crash Course Physics #25”:

1. ____ occurs when an object obtains a net amount of positive or negative electric charge, creating an imbalance that wants to be returned to equilibrium.

2. Like charges **REPEL** **ATTRACT**

3. Moving electrons are called _____________________ electrons. They reside in an atom’s outer shell as _______________ electrons and are easily plucked off and carried around when acted upon by an ‘outside force’.

4. Materials that are ___________________________ let free electrons move freely around the solid.

5. An overall negative charge means that the object has **TOO MANY** **TOO FEW** electrons.

6. In the process of charging by friction, no new charges were created. This is known as the law of conservation of _____________________________. It says that you can never create a net electric charge. Instead, charge can only ______________ from one place to another.

7. In the process of polarization, we’ve ___________________ the charge in order to create an imbalance of charge within in object.

8. Connecting a charged object to the ground creates a way for the charged object to leak that charge into the Earth. This is called _______________________________________.

9. The force on charged particles is measured in ________________________. To find it, we need to know the charge (q) in units of _________________________ (C). The charge (q) can have both positive and negative values. 1 electron has a charge of -1.6×10^{-19} C. This value is known as the ________________________ charge (e).

10. The equation for Coulomb’s Law is ____.

11. Coulomb’s constant (k) depends on medium surrounding the charges. This is mostly air, or maybe a vacuum, making the constant ___________________________________.

12. What is the force between two negative charges that are 1 nanometer apart? ___________________________. The answer is positive, meaning that the charges **REPEL** **ATTRACT** each other.

<u>“Electric Fields: Crash Course Physics #26”:</u>

1. Coulomb’s law tells us the ______________________ generated by two charged particles on one another.

2. An _________________________________ is a measurable effect generated by any charged object.

3. What is the equation for an electric field created by a charged object that relies solely on the point charge (‘Q’)?

____

4. Electric field lines are vectors that show the magnitude and _______________________ of the force exerted on any nearby positive test charge.

5. One positively charged particle and one negatively charged particle that are a distance apart with an equal and opposite magnitude of charge is known as an _____________________________________. We can add their fields together to create a total electric field. This is the principle known as ______________________________.

6. Four important properties of electric field lines:

1. The field lines must be ___________________________ to the direction of the field at any point.
2. The greater the line density, the greater the ___________________________ of the field.
3. The lines always start from ____________________ charged objects and end on negatively charged objects.
4. The lines must never __________________________.

7. The pair of plates shown in the model make up what is known as a ______________________. They are integral in electronic systems partly because they can _______________________ an electric charge.

8. When the net force is 0, the ____ must also be 0.

9. In the model with the hollowed out shell with a single positive particle, there **IS** **ISN’T** an electric field inside the shell.

"Voltage, Electric Energy, and Capacitors: Crash Course Physics #27":

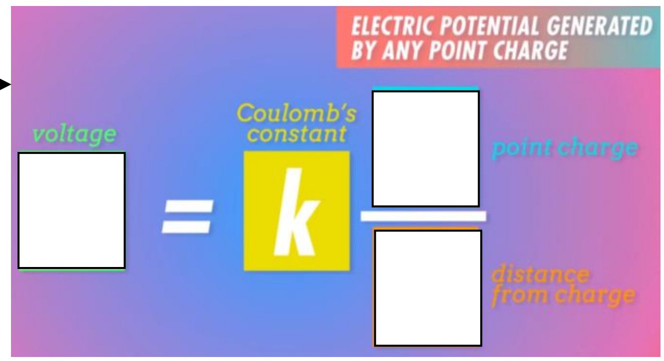
1. Defibrillators work because of two main electrical principles: electric potential energy and ________________.

2. A charged object can have electric potential energy when it's held in an ________________________________.

3. We can determine the amount of work done on a test charge via the equation _________________________.

4. Electric potential can be found via the equation V = ________________. It depends on the electric field and the position, but it does not depend on the ____________________ of the test charge. The units are Joules over coulombs, or _________________________. The electric potential difference is also known as **voltage**.

5. Fill in the blanks for the equation provided: →



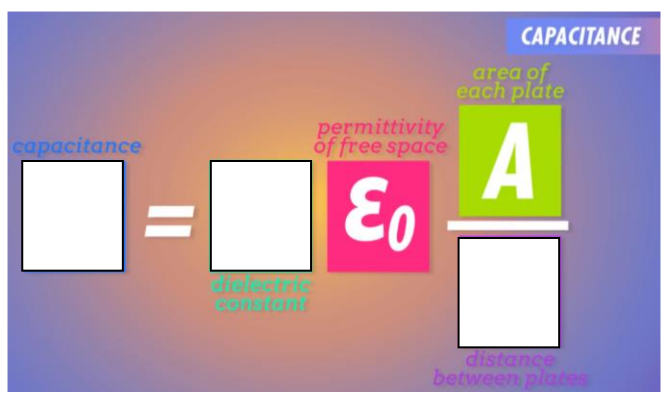
6. When a capacitors plates store electric charge, they are actually storing ___________________

7. Capacitance, how much __________________ a capacitor is able to hold, is measured in units called _____________________________.

8. A dielectric is typically an ____________________________ material, like plastic or glass, that is used to increase capacitance.

9. By inserting an insulating material into a capacitor, we **INCREASE** **DECREASE** capacitance and can now hold **MORE** **LESS** charge, and thus energy, for the same amount of voltage.

10. Fill in the blanks for the full equation for capacitance:



11. We can calculate the potential energy stored in a field with the equation _________________________

12. The amount of energy stored in the electric field is known as ___________________________.

“Electric Current: Crash Course Physics #28”:

1. _______________________________ is the total amount of charge passing through a wire over a period of time.

2. Electric charge flows from ____________________ voltage to _____________________ voltage.

3. The voltaic cell uses chemical reactions to create an electric potential difference between two pieces of different metals known as ________________________________. When the two electrodes are connected, **current** begins to flow. Today ____________________________ operate under the same principle as the first voltaic cell.

4. We can determine the current with the equation _________________________. It is measured in coulombs per second, or _______________________________.

5. In a circuit, the flow of negatively charged electrons in one direction is ________________________ the flow of positively charged particles in the opposite direction.

6. Conventionally speaking, current flows from the _______________ terminal to the _______________ terminal.

7. The impedance of the flow of electrons in a circuit is known as ________________. It is measured in Ohms (Ω).

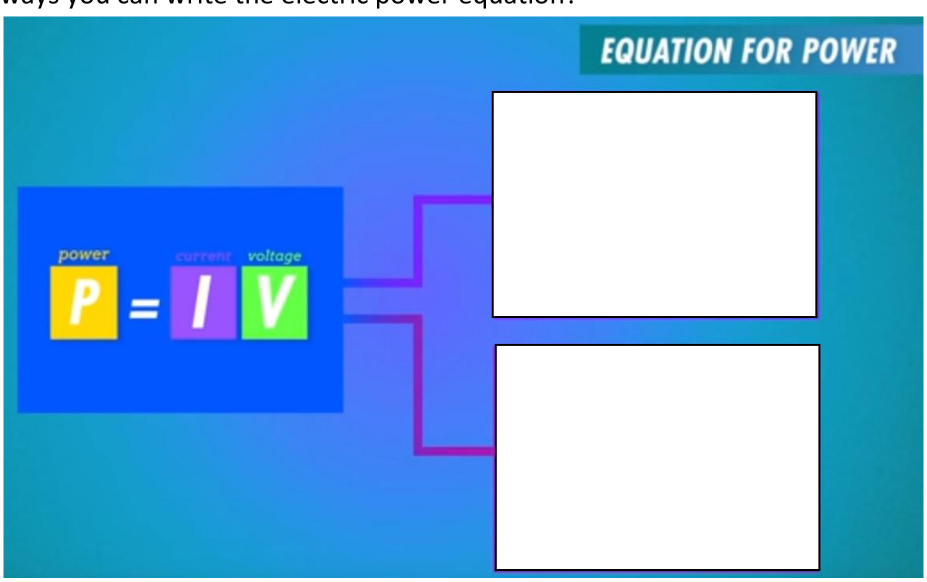
8. Ohm’s Law assumes that resistance is constant and expresses voltage in the equation ____________________.

9. If you can make certain conductive materials extremely cold, you can bring their resistance to zero. These materials are known as _________________________________.

10. Write the equation for electric power: _________________________________. These units are in _________.

11. Power is a function of current through and _____________________ across a resistor.

12. What are two ways you can write the electric power equation?



"DC Resistors & Batteries: Crash Course Physics #29":

1. In direct current circuits, current flows constantly out of a battery in ____________ direction.

2. An ideal battery provides a _________________________ voltage to a circuit, powered by its conversion of stored chemical energy to electrical energy. Scientists say that the battery is a source of ________________ force.

3. ___________________________________ is the real voltage you get when you measure the actual voltage between the terminals of the battery, getting a value that's less than our ideal EMF potential. You calculate this voltage with the equation ____.

4. When at least two resistors are connected in the same path, they are connected in **series**. Any devices connected in series have **THE SAME** **DIFFERENT** current flowing through them, however they each have **THE SAME** **DIFFERENT** voltages dropping across them. According to the conservation of energy, the total voltage supplied to the system is equal to the sum of ____________ the voltage drops across the circuit.

5. When multiple resistors are configured so that the current splits into many branches from a single source, they are said to be connected in ___________________________.

6. The principle known as the **conservation of charge** states that all the current flowing to the junction where the path splits is _________________________ all the current flowing out of the same junction.

7. For every branch in a parallel connection, the voltage is _________________ no matter what the resistance is.

8. For a series connection, the current is **THE SAME** **DIFFERENT** for all resistors and the voltage drop changes. For a parallel connection, the voltage is **THE SAME** **DIFFERENT** for all resistors and the current changes.

9. The equivalent resistance for a parallel setup of resistors will be _________________ than any one of the resistors in the circuit.

10. Any additional branch in the parallel system will serve to **INCREASE** **DECREASE** the total resistance of the system and **INCREASE** **DECREASE** the amount of current through the entire circuit.

11. As you add more bulbs in series, the brightness **INCREASES** **DECREASES** with each additional bulb.

12. The outlets in your house are connected in **SERIES** **PARALLEL**.

"Circuit Analysis: Crash Course Physics #30":

1. One of the best ways to understand how electricity works in a system is through _________________________: the process of breaking down a circuit into its key components and studying each one to see what it can tell you about the others.

2. When you have a large system, the goal is to simplify everything down to _____________ resistor which will have the equivalent resistance of _________ these resistors combined.

3. The 1st step is to find the resistors in a series. You can collapse them down to a single resistor by ___________________ their resistances.

4. To find the equivalent resistance of the resistors in parallel, use the equation ____________________________.

5. What is the current in the circuit shown? _____________________________

6. If two resistors are in series, then the current flowing through them is **THE SAME** **DIFFERENT**.

7. Any two resistors in parallel have **THE SAME** **A DIFFERENT** voltage drop. The current through each branch, though, is **THE SAME** **DIFFERENT**.

8. To measure voltage, use a tool called a ____________________________ and attach it in ___________________.

9. To measure current, use a device called an _________________________ and attach it in ___________________.

“Capacitors and Kirchhoff: Crash Course Physics #31”:

1. The design of a circuit depends on the ___________________ of the system it operates, and we need tools to take any configuration into account.

2. **Kirchhoff’s Junction Rule** states that the ______________ of all currents entering into a junction is equal to the _____________ of all currents leaving a junction. What goes in must come out.

3. **Kirchhoff’s Loop Rule** states that the sum of all changes in potential around a loop equals ______________.

4. The first step in using the junction rule in circuit analysis is to _________________ all the junctions. Then you label all the different _______________________ in the diagram.

5. In circuit analysis, you can draw a loop around any part of a circuit where you can imagine a charged particle heading around a circuit in a _____________________ and returning to where we started. Wherever there’s a loop, we can use the ________________________________.

6. If you want to know any of the voltage drops across the resistors, all you’d have to is _________________ the resistance in question by the current running through that resistor.

7. In a DC circuit, a capacitor is useful for _________________ charge temporarily, then releasing it again later on.

8. With capacitors, we deal with **transient conditions**, or circuit responses that _________________ over time.

9. If you connect multiple capacitors connected in parallel, the overall capacitance in the circuit ______________.

10. Capacitors connected in series will have a **LOWER** **HIGHER** overall capacitance.

11. For series capacitors, the combined capacitance is **LESS** **GREATER** than the weakest capacitor.

“Magnetism: Crash Course Physics #32”:

1. In 1820, Orsted demonstrated the connected between _________________________________ and magnetism.

2. Only certain materials, especially those containing _________________________, can be magnets.

3. Magnetic field lines point from the ___________________ pole to the ___________________ pole.

4. A fundamental principle of electromagnetism is that an electric current produces a _____________________ field.

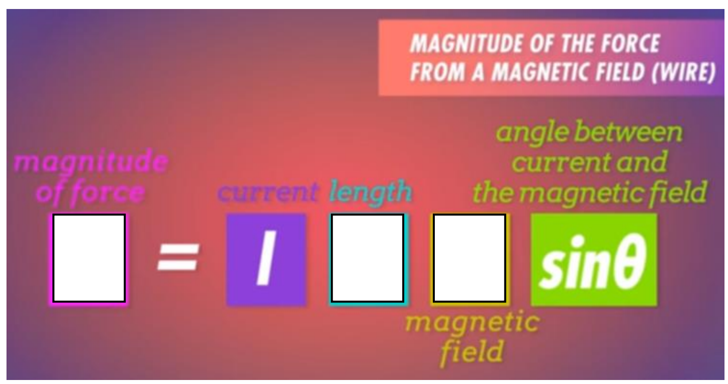
5. When a current runs through a wire, a magnetic field runs _________________________________ it.

6. The **first right hand rule** tells you that the direction your _____________________ are pointing when curled around a wire (with the thumb of your right hand pointing in the direction of the electric current) is the direction of the magnetic field lines.

7. The direction of the force from a magnetic field on a current running through a wire will be ________________ to both the magnetic field and the current.

8. The **second right hand rule** lets you keep track of 3 directions: the direction of the magnetic field, the current, and the force. Point your right ___________________ in the direction of the current, then point your fingers so they are perpendicular to your palm – this represents the direction of the _________________________. Your ___________________, perpendicular to your fingers, is the direction of the force on the wire.

9. Fill in the blanks for the equation for finding the magnetic force on a wire.



10. The longer the wire, the __________________ the force.

11. If the current is _______________________ to the magnetic field lines, there won’t be any force on the wire at all.

12. Currents are made up of __________________ electric charges, so a magnetic field will exert a force on single electric charges that pass through it. This is the concept that explains why Earth’s magnetic field protects us from charged particles from the __________________.

13. For a single charge, the force is **WEAKER** **STRONGER** the closer to perpendicular the charge’s velocity is to the magnetic field lines.

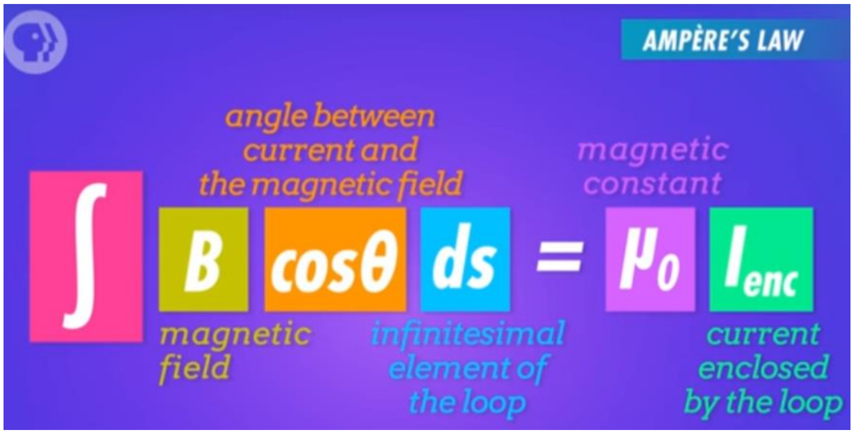
14. For the **third right hand rule**, if the charged particle is _________________________, then your thumb is point in the direction of the force. If the charge is ____________________________, then your thumb is pointing in the direction opposite the force.

“Ampère’s Law: Crash Course Physics #33”:

1. If you wrap a current-carrying wire into a coil, the inside of the coil will act like a ___________________.

2. The basic logic behind Ampere’s law is that the stronger the electric current, the _________________ the magnetic field is around it.

3. The equation for Ampere’s law (to the right), basically means that he total magnetic field along a loop is equal to the ________________ running through the loop times a constant number.



4. If we apply Ampere’s Law to a long, straight wire, the total magnetic field along a circle surrounding the wire is equal to _______________________.

5. When two wires running parallel to each other had current running through them in the same direction, they were **ATTRACTED TO** **REPELLED BY** each other.

6. A coil of wire is called a ___________________________. When it has a current running through it, it generates a ___________________________.

7. When a loop of wire is placed within a magnetic field, the loop of wire turns because a ________________ acts on it. Those moving loops of wire can be used to do mechanical _________________________.

“Induction – An Introduction: Crash Course Physics #34”:

1. Magnetic fields only crate electric currents when the magnetic field is _____________________ with time.

2. **Faraday’s Law of Induction** states that a changing magnetic field will induce an EMF – also known as a ___________________________________ in a loop of wire.

3. Changing the _____________ of the loop of wire induced a current, too, and so did changing the ___________ between the loop and the magnetic field. This was because of a property called _______________________, which is a measure of the magnetic field running through a loop of wire.

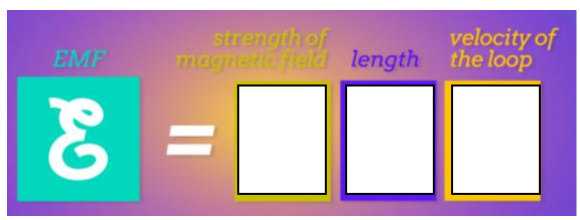
4. There are three factors that affect the magnetic field, and therefore the magnetic flux through the loop: the ________________ of the magnetic field (B), the ____________ of the loop (A), and the ____________ (θ) between the magnetic field and a line perpendicular to the face of the loop. Putting all of these factors together, we find that the magnetic flux (Φ_B) = __________________________________. If the magnetic flux increases over time, the EMF __________________________________.

5. A change in the magnetic flux through the coil, induces **THE SAME** **A DIFFERENT** EMF in each loop of the coil.

6. Faraday’s Law of Induction lets us calculate how much EMF – and therefore how much __________________ - will be induced in a loop of a wire by a change in magnetic flux.

7. **Lenx’s Law** states that the magnetic field generated will be in the direction ______________________ the change in magnetic flux.

8. When you move a loop of wire in or out of a magnetic field, the strength of the EMF can be found with the equation:



9. Your computer stores information on your hard drive by ______________________ small sections of the disk.

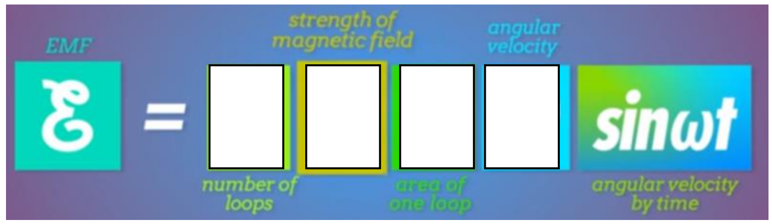
“How Power Gets to Your Home: Crash Course Physics #35”:

1. Two of the most important steps in getting electricity to your house involve ______________________________ and ______________________________.

2. Electric generators take mechanical energy and use __________________ to convert them to electrical energy.

3. Because the coil is rotating, the direction of the flow of the current changes every _______________ rotation. This creates a type of flow of electricity known as ________________________________ current (AC).

4. The EMF induced in a coil rotating in a magnetic field can be found with the equation:



5. Transformers only work with __________ power. They are necessary because a problem with transporting electricity over long distances is that if the voltages are low, a lot of electricity is wasted as ________________.

6. In the U.S., the power coming out of your walls is _________________________ volts.

7. **Mutual Inductance** is where a change in the current in one coil leads to a change in EMF in a nearby coil and EMF is the same as ______________________________.

8. In transformers, the power running through the first coil is _____________.

9. The voltage in the secondary coil divided by the voltage in the primary coil is equal to the number of ________ in the secondary coil divided by the number of loops in the primary coil.

10. A Telsa coil is a fancy version of a _________________________ transformer.

11. Mutual inductance is also used in ____.

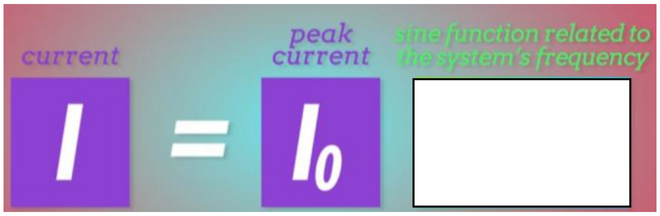
“AC Circuits: Crash Course Physics #36”:

1. We couldn’t keep the lights on without ____.

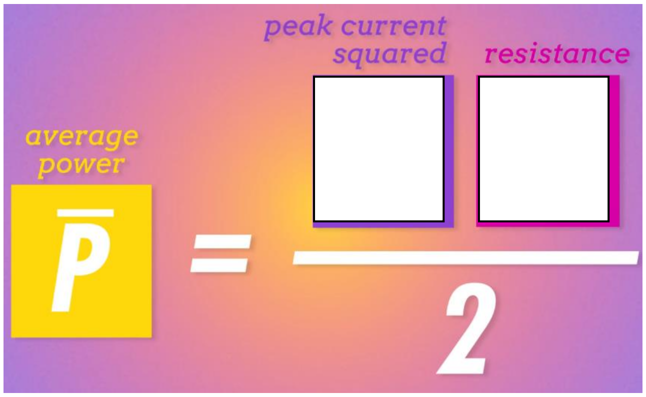
2. Typically the ____________________ source in a DC circuit is unchanging, so the ________________________ will be unchanging too.

3. ___________________________ means either maximum or minimum, positive or negative, since the flow of current has the same magnitude.

4. Fill in the boxes for the equation for current:



5. Fill in the boxes for the equation for average power in an AC circuit:



6. Power in AC circuits can better be described using the _________________________ squared values for current and voltage.

7. The constant ______________________________ signifies how well a specific coil induces an opposing current depending on its shape and size. It’s expressed in a unit called a ________________________.

8. As time goes to infinity you get closer to the ___________________________ current value.

9. Inductors _______________________ a change in current, whether it’s an increase or a decrease.

10. When the current is zero there is _____________ voltage and when current is maximum voltage is ________.

11. When an AC circuit has an inductor, the current and voltage are out of phase, which means they don’t _______________ at the same time.

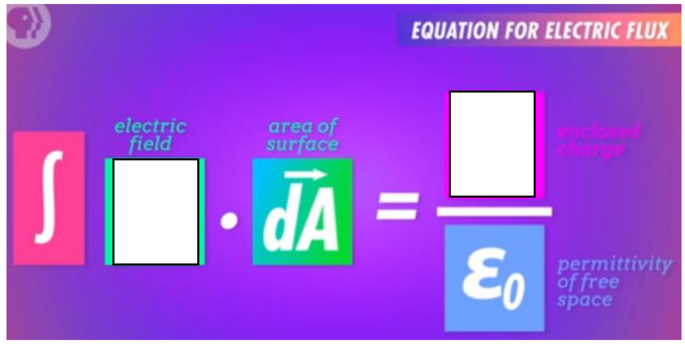
12. In summary: current in inductors ______________ voltage; current in resistors __________________________ voltage; current in capacitors _____________________ voltage.

13. The only thing in an AC circuit that dissipates power as heat are the _______________________________.

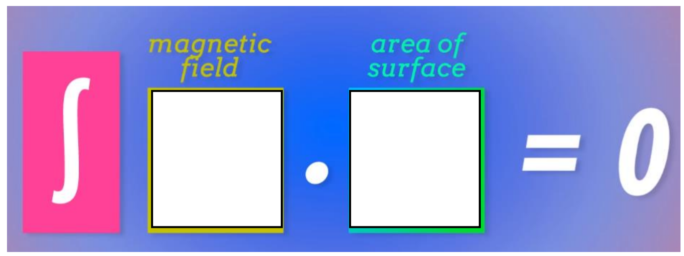
“Maxwell’s Equations: Crash Course Physics #37”:

1. While coming up with his equations, Maxwell predicted the existence of _______________________________.

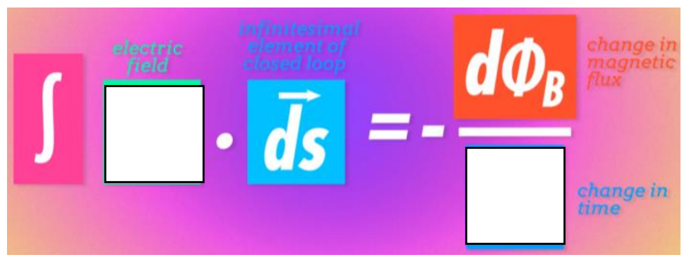
2. Maxwell’s First Equation is a form of Gauss’s Law which states that the electric flux through a closed surface is proportional to the ____________________________ enclosed by that surface. Mathematically, this equation looks like this (fill in the boxes):



3. Maxwell’s Second Law is also a form of Gauss’s Law, only with ________________________________ instead of electric flux. Mathematically, this equation looks like this (fill in the boxes):



4. Maxwell’s Third Equation is Faraday’s Law, just in a more general format. Mathematically, this equation looks like this (fill in the boxes):



5. Maxwell’s Fourth Equation tweaks Ampere’s Law by adding the ______________________________ current.

6. If a changing electric field is generated, then a _____________________ field is induced, which results in a changing magnetic field that induces an ___________________ field and the cycle continues. These oscillations are called _______________________________.

7. The electric and magnetic fields always act _________________________________ to each other.

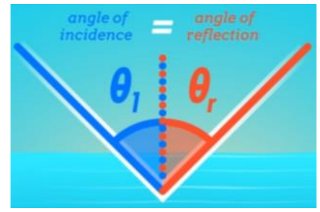
8. The speed of every electromagnetic wave is _________________________________, which is the speed of light.

9. Our knowledge of electric and magnetic fields is thanks to Maxwell alone. **TRUE** **FALSE**

“Geometric Optics: Crash Course Physics #38”:

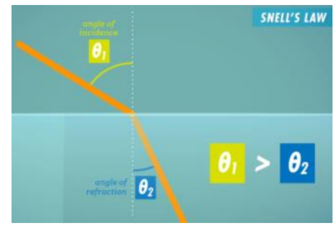
1. The core tenet of the **ray model** is that light travels in ____________________ line paths called ‘rays’.

2. If you view something in a reflection you see its image in ______________________________.



3. The **law of reflection** states that the angle of incidence is _____________________ the angle of reflection.

4. When light rays change from one medium to another they bend in a process called ________________________.



5. When a ray moves from air to water, the ray’s angle after passing into the water will be _____________________ than the incident angle.

6. **Snell’s law** says that the angles of refraction are determined by the _________________ of refraction for each medium and the angle of incidence. The higher the index of refraction, the ______________ the angle.

7. An image is considered to be a _______________ image if the rays from an object converge at some **location**, such as your eye or some other surface, like film. A ______________________ image is one where the light rays don’t actually converge, so your eyes construct an image as if the diverging rays started from a single point, like when you are looking in a mirror.

8. Warped pieces of material that form images of objects are called ________________.

9. In a convex lens, rays that leave the lens are angle toward the ______________________ axis, eventually converging at a single point called the ____________________ point. The distance between the lens and this point is called the _________________ length.

10. When rays converge at a point, that means a **REAL** **VIRTUAL** image has been formed.

11. The ____________________ distance in the location where the image forms on the other side of a converging lens.

12. Converging Lenses have **THE SAME** **A DIFFERENT** focal length on both sides.

13. For convex lenses, the image is always _______________________________.

14. Diverging lenses have a __________________________ shape and generate ________________________ images.

15. Magnification is the ratio of the _______________________________ height to the height of the actual object.

“Light is a Wave: Crash Course Physics #39”:

1. We know that light is both a ______________________ and a _____________________.

2. **Huygens’ Principle** states that you can predict a wave’s position in the future by analyzing its _______________ position.

3. When waves are reshaped by obstacles, ________________________ occurs.

4. Waves interact __________________________ when the crests (and troughs) of both waves end up in the same spot. Waves interact _________________________ when one wave’s crest run into another wave’s trough.

5. When light waves line up, they interfere **CONSTRUCTIVELY** **DESTRUCTIVELY**

6. The path difference is equal to the ____________________ between the center of each slit (d) multiplied by the _____________________ between the point on the screen and the slits.

7. In waves, the intensity is proportional to the ________________________________ squared. If you triple the amplitude, the light gets ___________ as bright.

8. Light with a higher wavelength and shorter frequency is on the ______________ side of the spectrum while light with a higher frequency and shorter wavelength is on the ______________________ side.

9. A total path difference of a full wavelength means that for each light ray coming through the slit at that angle, there’s a corresponding light ray that’s shifted by _________________ a wavelength. When this happens, _____________________________ interference is created.

10. The places where the waves interfere destructively create _________________________. The places where the waves interfere constructively create ______________________________.

<u>"Spectra Interference: Crash Course Physics #40":</u>

1. The pattern of lines that appear when you shine a light through a pair of thin slits depends on the spacing of the slits and the light's ____________________________________.

2. The more slits in a diffraction grating, the more ________________________________ interference you can get.

3. The patterns created using a diffraction grating are called _______________________________.

4. A ____________________________ spectrum is a distinct pattern of lines at certain wavelengths that correspond to the elemental composition of the cloud.

5. When objects like the sun are heated up, they emit a __________________________ spectrum that covers a wide range of wavelength. These things also contain ____________________________ lines – characteristic wavelengths of light that have been absorbed by the same elements that emitted them.

6. Different colors undergo constructive interference at different _________________________.

7. When light reflects off a surface that has a ___________________ index of refraction that the medium it travels through, there is no phase shift and constructive interference occurs.

8. Light is a _______________________ wave, meaning that the wave travels in one direction and oscillates back and forth in a direction that's perpendicular to the direction of travel.

9. When a wave strikes an object, the effects of the changing electric field are felt in a direction that's ___________________________________ to the direction in which the wave is moving.

10. The filtering of light depending on its oscillation direction is called _______________________________.

11. Polarized sunglasses have lenses that work as _____________________________ polarizers.

“Optical Instruments: Crash Course Physics #41”:

1. Your eyes function much like a camera. The ____________________ controls how much light enters the eye. The _____________________ is controlled by muscles that alter the focal length in order to focus on objects at varying distances. The ________________________ is the sensor that captures the image, sending it to the brain.

2. Your _________________________ is the closest distance at which your eye can focus on an object. If this point for you is farther than average (25 cm), you have hyperopia, also known as ______________________________. This can be remedied with corrective lenses that are ________________________________ lenses.

3. Any simple magnifying glass consists of a single, ________________________________ lens.

4. In order to find the magnifying power of a lens, you divided the angle subtended by the ________________ by the angle subtended by the ______________________ (by your unaided eye).

5. The standard refracting telescope uses a ________________________, converging lens for both the objective lens and the eyepiece. Any objects viewed through a refracting telescope are ___________________________.

6. The Hubble Space Telescope is a _____________________________ telescope, using mirrors as the objective lens. The mirrors are __________________________ in shape.

7. Since lenses have edges, the incoming rays will always _______________________ and produce slightly blurred images.

8. The ability of a camera to produces images of points very close together is called _________________________. For telescopes and microscopes, the ability to resolve an image becomes more difficult as the magnification becomes **HIGHER** **LOWER** because the diffraction patterns they create are magnified too.

“Special Relativity: Crash Course Physics #42”:

1. If your friend, Bob was travelling on a train through a vacuum at half the speed of light, and his train had a headlight that, to him, was travelling at the speed of light, how fast would that light appear to be moving to you, standing at the train station? ____________________________

2. But that (#1) can’t happen because light is always travelling at the speed of light in a vacuum from any perspective. So, from your point of view, that light from the train would look like it is moving at ____________ the speed of light.

3. **Special Relativity** is special because it only applies to specific situations where the different frames of reference aren’t ________________________________. They are called **inertial reference frames**.

4. Special relativity is governed by two main postulates:

    1. The laws of physics are the ______________________ in all inertial reference frames.
    2. The speed of light in a vacuum is the _____________________ for all observers.

5. Special relativity tells us that when it comes to light, speed is always ______________________, so time and distance must change. When time changes it’s called ______________________________ and when distance changes it’s called length contraction.

6. From your perspective on the platform, the light has travelled a	**LONGER**	**SHORTER**	distance.
Since speed is constant, then the light must’ve been travelling for a	**LONGER**	**SHORTER**	time.

7. **Length contraction** means that if something is moving relative to you, its length in the direction that it’s moving will seem _____________________ than it would if it wasn’t moving.

8. Length contraction happens for things moving at regular speeds. **TRUE** **FALSE**

9. Special relativity tells us that because light always travels at the same speed, time dilates and length contracts to compensate. ____________________ and ____________________ are directly connected to each other.

“Quantum Mechanics – Part 1: Crash Course Physics #43”:

1. Light behaves like a ________________________. It also behaves like a __________________________.

2. A ________________________________ is the idealized version of a radiating object. They ________________ all incoming light without reflecting any and radiate energy accordingly. You can predict the intensity of the energy coming from a blackbody (blackbody radiation) based on its _________________________.

3. The **Rayleigh-Jeans Law** predicted that the higher the frequency, and therefore the shorter the wavelength, the _________________________ the intensity. That matched up with experimental results really well, until the frequency of light got into the _______________________________ range or higher. Blackbodies had a peak intensity based on their temperature and at a certain frequency the light would be at its most intense. After that, the intensity would ________________ as frequency increased. The warmer the object, the ________________ the frequency of the peak intensity.

4. The problem was solved with an equation now known as **Planck’s Law** which says that electromagnetic energy takes the form of tiny, discreet packets called ________________________. The energy of each quantum is equal to the frequency of the light times Planck’s constant. This looks like E = __________________.

5. Einstein argued that light energy traveled in packets that we now call ______________________ which would essentially make light behave like a particle.

6. The ____ describes what happens when you shine a beam of light on a metal plate. Electrons leave the plate and hit a nearby collector, creating a current.

7. Both the wave theory and the particle theory of light predict that light knocks ____________________ out of the metal.

- The wave theory says that when a light wave hits an electron, it exerts a _____________________ on the electron that ejects it out of the metal. According to wave theory, the ______________________ of light shouldn’t make a difference, only the intensity matters.
- The particle theory says that electrons get ejected from the metal when they are hit by individual ___________. The photon transfers its energy to the electron, which pops out of the metal. The photon is destroyed. The photon has a minimum energy that it needs to transfer in order to get the electron to overcome it’s attraction to the metal. This energy is called the _____________________(W_0).

8. There is a cutoff frequency. The higher the frequency is above the cutoff, the ________________ the maximum kinetic energy of the ejected electrons. Increasing the intensity of the light only affects the ____________________ of electrons ejected.

9. Photons really exist. Light travels in discrete packets and behaves like a _________________________________.

10. In certain circumstances, light can behave like a particle. In others, it can behave like a wave. This is known as the ____________________________________.

<u>"Quantum Mechanics – Part 2: Crash Course Physics #44":</u>

1. Applying the wave-particle duality to _______________ led to the development of a way to analyze the behavior of tiny particles more accurately than ever before.

2. According to De Broglie, you can find the _____________________ of any bit of matter, as long as you know its momentum. The easiest way to test this is by using ___________________________.

3. If all objects can have wavelengths, why don't we see them?

____

4. What would be the wavelength of a 0.2 kg ball flying through the air? ___________________________

5. When quantum mechanics looks at the wave nature of matter, it's mostly concerned with the ______________ that particles, like electrons or even atoms or molecules, will be in certain places at certain times.

6. You can use Schrödinger's equation to predict the probability of finding a particle at any given point in space, known as the ____ function. The diagrams of electron clouds show the probability of finding an atom's ______________________ in the space around the nucleus.

7. Many physicists think that the electron is ___________________ in a specific place, unless you stop to look at it. Instead, it's in all these _________________________ places at once. Once you observe or measure the electron in some way, it's only in one place. Somehow, you measuring it forces it to be in one spot. The idea that a particle can be in more than one state at one time is an example of quantum ____________________________.

8. The **Heisenberg Uncertainty Principle** states that no matter how good your measuring instrument is, you can only know the position or momentum of a particle up to a certain level of __________________. After that, you could get a better measurement of your electron's position, but you'd have a much less precise measure of its ________________________. Likewise, you could get a better measurement of the electron's momentum, but then you'd have to sacrifice some knowledge of its ________________________.

9. Quantum physicists try to make the best of both worlds by describing things like electrons using what's known as a __________________________ - a collection of waves all added together.

10. There will always be an uncertainty that's at least equal to _______________________ constant divided by four times pi.

11. Quantum mechanics tells us that there's a built in limit to how much we can learn about _________________.

“Nuclear Physics: Crash Course Physics #45”:

1. E = mc^2 essentially means that matter can be converted into _____________________ and vice versa.

2. The process by which an element turns into an entirely different element is called _______________________.

3. The atomic nucleus contains positively charged particles called __________________________ and electrically neutral ______________________________. Together, these particles are called ________________________.

4. Any two nuclei that have the same atomic number but different mass numbers are called _________________.

5. It’s important to know the masses of different nuclei, since nuclear interactions are all about _______________ conversion.

6. The total mass of a stable nucleus is always __________________ than the total mass of the individual protons and neutrons put together. That difference in mass is equal to the total ___________________ energy of the nucleus. That is the amount of energy you’d have to apply to the atom to break up the nucleus. This amount of energy peaks around iron – very large nuclei **ARE** **ARE NOT** held as strongly together as smaller ones.

7. The _______________________________________ force is the attractive force that acts between protons and neutrons in a nucleus.

8. When a nucleus is unstable, it can breakdown into a more stable state. This decay of unstable nuclei, accompanied by the emission of energetic particles is known as ______________________________.

9. There is three different types of decay:

- ____________________ decay is released when an unstable nucleus loses **two protons and two neutrons**, becoming a different element in the process.
    - This decay occurs because the parent nucleus is too **LARGE** **SMALL**
- ____________________ decay is when an unstable nucleus releases a beta particle, which is just an electron.
    - In this decay, a neutron changes into a ______________________, and an electron is emitted in response.
    - This type of decay is caused by the ________________ force. This force alters ____________: the fundamental particles that make up protons and neutrons.
- ____________________ decay is what results when a nucleus emits high-powered photons in what are known as gamma rays.
    - Gamma rays have the **LOWEST** **HIGHEST** penetrating power.

“Astrophysics and Cosmology: Crash Course Physics #46”:

1. ________________________________ study the physics of celestial bodies, such as planets, stars, and galaxies.

2. ________________________________ study the universe overall and ask questions about the origin of everything, as well as its future.

3. A light-year is a unit of ______________________, with one light year equaling the distance that light would travel in a vacuum in one year. Light that comes from the sun is __________________________ old.

4. When we observe the stars, we are seeing what they look(ed) like in the **PAST** **PRESENT** **FUTURE**

5. The phenomenon by which the wavelength of light from sources that are moving away from us in known as ___________________________ because light waves that are longer are closer to the red part of the visible spectrum.

6. Edwin Hubble noted that galaxies that were farther away from us were moving away **FASTER** **SLOWER** than those that are closer to us. It was also found that no matter where you are, all distant galaxies appear to be moving **TOWARD** **AWAY FROM** you.

7. Cosmic Microwave Background Radiation, first discovered by Penzias and Wilson, is the leftover radiation from the ________________________. It provides support for the Big Bang Theory and it tells us a lot about the ____________________ of the early universe.

8. If the universe were filled with only matter and radiation, then the rate of expansion would slow down. That’s not the case. Space is filled with a constant form of energy known as __________________________.

9. By current estimates, dark matter makes up __________% of the matter in the universe.