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Physics-101

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Newton's First and Second Law

To understand these laws in their entirety, it is important to know the concepts that make them possible. The first concept is velocity which is the rate of change in which an object moves through space, most commonly known as speed. Isaac Newton proposed in his First Law that an object which is at rest will remain at rest until a force is acted upon it. Forces can range from a push, pull or toss and are seen as a way to transfer energy from one thing to another. All the forces acted upon an object can be expressed as net force. If an object has a total net force of zero, that means the object has a constant velocity or speed. This can be seen when an object is launched in deep space which negates the influence of gravity and air resistance, that it does not slow down. Since there is nothing obstructing the course of this given object, it will still continue move at it's given speed. Once an object is in motion, it then has acceleration which is the change in velocity in a given period of time. When the net force is not zero, the object is said to have acceleration which is stated under Newton's Second Law. This can still be applied even if the object is slowing down as it is not restricted to it being positive or negative. Acceleration can be expressed in the formula "$a = (F_{net}) / m$" where the net force and mass is needed solve. One example is that it is easier to push an empty box compared to a box full of books. Even though both boxes look identical, the difference in mass contributes to the overall heaviness of the box full of books. To understand this example in mathematical terms, let's assume that the initial mass of the box is 5 kg. When I put all of my Physics books inside the box, it brings the mass up to a whopping 35 kg. In both times I push the box, I give it a push of 10 Newtons. The acceleration of box initial is equal to 2 and 0.28 when the books are inside the box. Since the acceleration is less when the books are in the box, the overall speed of the object will be slower. Another example is if I throw a pebble and a two ton boulder of a cliff, it will take more strength for me to toss the boulder because it's mass is much greater than the tiny pebble. Now applying scaling to Newton's Second Law is actually quite simple. One scenario is if I have an object frozen in time and it is barreling down the highway. I manage to double its size from 4 kg to 8kg , quadruple its net force from 10 m/s to 20 m/s and unfreeze it. How would it's acceleration final change once I apply those changes? We can represent the mass final in terms of mass initial by saying $2m_{initial}$ and the net force final in terms of net force initial by saying $4Fnet_{intital}$. You can make these statements because it is stated that the mass is **doubled** and the net force is **quadrupled**, implying that the original mass and net force are being manipulated. The equation to use is expressed as $a_{final}/a_{initial} = m_{initial}/m_{final} * Fnet_{initial}/Fnet_{final}$ and when we plug in our values $m_{initial}/2m_{initial} * Fnet_{initial}/4Fnet_{initial} \rightarrow \frac{1}{2} * \frac{4}{1} \rightarrow 2$. Now we have solved for acceleration, we need to look back at what the question was asking for. Since this is really $a_{final}/a_{initial}$ = 2, we would need to solve for a_{final} by multiplying both sides by $a_{initial}$. This would mean that the final acceleration would be twice the initial acceleration. We can also apply Newton's Second Law to the connection between weight which is the force of gravity and the mass of an object which is how heavy it is. The acceleration of gravity is 9.8 m/s/s and is exclusive to planet Earth, where it is different on every single planet in the universe. Weight is expressed as $g*m$ and this is to convey the resistance an object has to acceleration. If an object on Earth has a mass of 100 kg, it would have a weight of 980 N which is the amount of resistance it would have against a push. One last concept in mechanical physics in which Newton's Second Law can be applied is in the form of terminal velocity. All objects, no matter their mass, will always accelerate up until a point and hang at that constant speed until otherwise changed (N1). This can even be expressed in the form of a limit as t approaches infinity, v(t) is a function of their acceleration and will eventually reach a certain number which is the limit itself.