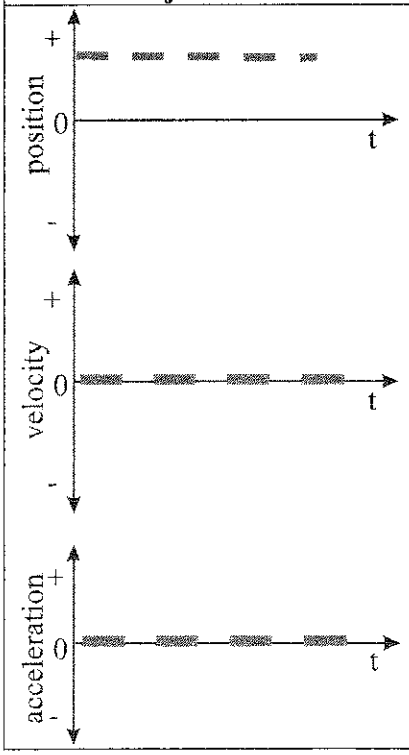
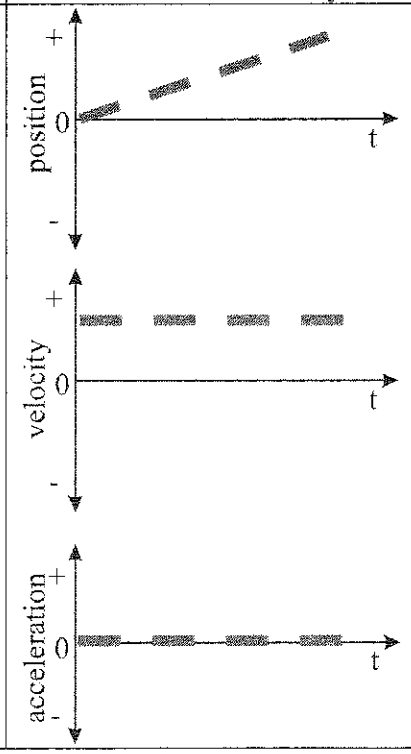
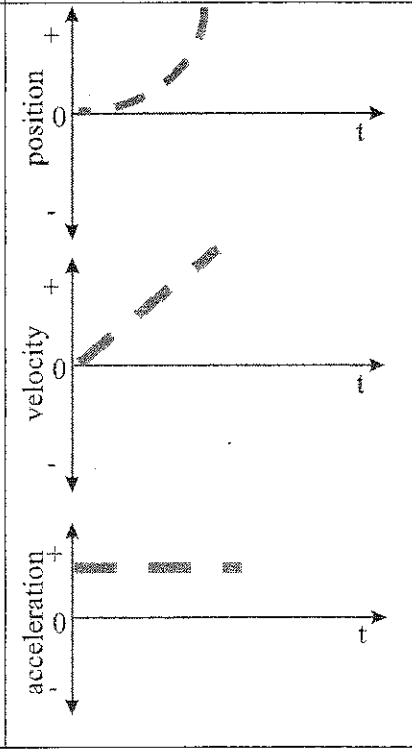
Unit 3 Dynamics (Forces)

Topic 3A: Analyzing Forces

Skill 20: Newton's 3 Laws of Motion, Inertia, Momentum and Impulse

	First Law	Second Law	Third Law
AS YOU ALREADY KNOW IT	"Law of INERTIA" Objects in motion remain in motion; objects at rest remain at rest unless acted upon by an unbalanced force (net force)	$\mathbf{F_{net}=ma}$	For every force there exists and equal and opposite force.
WHAT IT REALLY MEANS	Objects don't speed-up, slow-down or change direction unless an unbalanced force (Net Force) is present	The greater the net force applied to a fixed mass, the greater the acceleration. WHATEVER HAPPENS TO THE NET FORCE HAPPENS TO THE ACCELERATION (For a fixed mass)	You cannot be pushed without pushing back. (Note: the forces are equal, but the acceleration (action) will be inversely related to mass. $a = \frac{F_{net}}{m}$

Representing Net Force on a graph (Note: Matching motion represented in vertical)

EQUILIBRIUM: $F_{net}=0$ and $a=0$		Uniform Acceleration
Object at Rest	Constant Velocity	F_{net}=constant a=constant
		

In addition to Newton's Laws, several other terms and ideas must be mastered in order to analyze acceleration and net force.

TERM	Variable (with Units)	What you need to understand and apply...
INERTIA	**m** **(kg)**	Inertia is an object's resistance to change in motion. It is the reason you need a seatbelt (If a car stops quickly and you are not wearing a seatbelt you will continue in motion). For linear motion, **inertia is mass.**
MOMENTUM	**p** **($kg\frac{m}{s}$)**	**p=mv** Momentum is a property that takes into account an object's mass (inertia) and velocity. An object with a small mass that goes very fast can have as much impact as a large mass going slow.
IMPULSE	**J** **(Ns)**	**$J=(F_{net})t$** Impulse is equal to change in momentum. **$J=\Delta p$** A change in momentum (impulse) involves an object speeding up, slowing down or changing direction due to a net force. This is really a rearrangement of Newton's second law. $F_{net} = ma = \frac{m\Delta v}{t} = \frac{\Delta p}{t}$ **or $(F_{net})t=m\Delta v$** Impulse = change in momentum. The **rate of impulse** or the **rate of change in momentum is equal to F_{net}.**
MASS	**m** **(kg)**	Mass is inertia. Mass is also a property which causes gravitational **attraction** between objects with mass.
NET FORCE	**F_{net}** **(N)** **($kg\frac{m}{s^2}$)**	Net force is the overall (unbalanced) force acting on a mass when all force vectors are combined. Net force is the amount that one or more forces win by. For Regents Physics analyze the net force on each object separately. WHATEVER HAPPENS TO F_{net} HAPPENS TO ACCELERATION.
Acceleration	**a** **($\frac{m}{s^2}$)**	$a = \frac{F_{net}}{m}$ *or* $a = \frac{\Delta v}{t}$ rearranged $\frac{F_{net}}{m} = \frac{\Delta v}{t}$ *or* $F_{net}t = m\Delta v$ Acceleration occurs when an object speeds up, slows down or changes direction due to a net force. ACCELERATION AND NET FORCE ALWAYS AGREE IN DIRECTION.
EQUILIBRIUM	**a=0** **F_{net}=0**	An object in equilibrium experiences two or more forces that are in balance. An object in equilibrium is recognized by any of the following F_{net}=0 ; a=0 ; rest ; constant velocity

Inertia and momentum are sometimes confused in everyday language when referring to political action or ideas. Momentum is related to both mass and velocity, whereas inertia is just mass.
A large truck moving slow can have the same momentum as a small car moving fast. If the large truck (big inertia) collides with the small car (little inertia), it is likely that the small car will have less resistance to change in motion and bounce back.