## Physics Concepts

Is There an
Equation?
When an object is moving, it will continue to move at constant speed in a straight line unless there is an unbalanced force to change its motion. If the object is at rest, it stays at rest unless there is an unbalanced force. This is known as Newton's first law.

The tendency of an object to resist changing its motion is called inertia. Inertia is measured in the same units as mass.

A frame of reference is the specific point of view from which a particular measurement is made. Different frames of reference yield different measurements.

The acceleration is defined as the change in velocity with respect to time.
$a=\frac{\Delta v}{\Delta t}$
A force is measured in the SI unit newtons.
The acceleration of an object (a) is directly proportional to the net force applied $\left(F_{\text {net }}\right)$, and inversely proportional to the object's mass $(m)$. This is known as Newton's second law.

The weight $\left(F_{\mathrm{g}}\right)$ of an object is equal to an object's mass $(m)$ multiplied by the strength of Earth's gravitational field $(g)$. Weight is the force of Earth's gravity

$$
a=\frac{F_{\text {net }}}{m}
$$

acting on an object.
Using significant figures ensures that any calculations made do not indicate a level of precision greater than the measurements.


The maximum range of a projectile returning to the same height as the launch point occurs when it is launched at $45^{\circ}$ degrees to the horizontal.

When an object is projected at an angle to the horizontal, the motion may be analyzed after the velocity is broken into vertical and horizontal components.

Forces come in pairs. Whenever a force is exerted on a mass $b\left(F_{a \text { on } b}\right)$, the mass $b$ exerts an equal force in the opposite direction on the mass $a\left(-F_{b \text { on } a}\right)$. This is known as Newton's third law.

The normal force is a force that acts perpendicular to a surface.
A free-body diagram is a sketch of all the forces acting on an object.
The force of friction $\left(F_{f}\right)$ equals the coefficient of friction $(\mu)$ multiplied by the normal force $\left(F_{\mathrm{N}}\right)$. Friction is a force acting between two bodies in contact that resists the relative motion of those bodies. It always acts parallel to the surfaces in contact.

The coefficient of friction $(\mu)$ is a dimensionless constant.
The coefficient of static friction $\left(\mu_{\mathrm{s}}\right)$ on an inclined plane equals the tangent of the angle the plane makes with the horizontal $(\tan \theta)$.

$$
\mu_{\mathrm{S}}=\tan \theta
$$

An object's kinetic energy $(K E)$ is proportional to the object's mass $(m)$ multiplied by its velocity squared ( $v^{2}$ ). Kinetic energy is an object's energy of motion.
Gravitational potential energy (GPE) is proportional to an object's mass ( $m$ ) multiplied by its vertical height above Earth $(\Delta h)$ and the acceleration due to gravity $G P E=m g \Delta h$ $(g)$. Gravitational potential energy is energy due to an object's vertical position above Earth's surface.
Elastic potential energy (EPE) is proportional to the spring constant of the material $(k)$ multiplied by the material's change in length $(x)$ squared. Elastic potential

$$
E P E=\frac{1}{2} k x^{2}
$$

energy is energy stored in a material due to its compression or stretch.

Work $(W)$ done on an object can increase its kinetic energy $(\triangle K E)$. When work is done on an object moving on a horizontal surface, the kinetic energy of the object increases.

Work (W) is the product of the force exerted on an object $(F)$, and the displacement

$$
W=\Delta K E
$$

$$
=\left(\frac{1}{2} m v_{\mathrm{f}}^{2}-\frac{1}{2} m v_{\mathrm{i}}^{2}\right)
$$ in the direction of the force ( $d$ ). Work done on an object increases its energy and may change an object's kinetic or potential energy.

The law of conservation of energy states that energy may change its forms, but not its amount. The total amount of energy remains the same during any changes in form.

$$
W=F d
$$

Energy $_{\text {before }}=$ Energy $_{\text {after }}$

