MECHANICS SUMMARY

Vectors

A vector quantity needs a magnitude and direction in order to describe it fully.
The size of a vector quantity is called its magnitude.
On a page, a vector quantity is represented by an arrow drawn to scale.
To add two vector quantities join the vectors tip to tail in a chain. The total is the vector that starts from the tail of the first in the chain and finishes at the tip of the last vector in the chain.
To subtract a vector from another, reverse the direction of the one being taken away and then add.
To multiply a vector by a number, maintain the direction of the original vector and then extend or reduce the length of the vector by a factor equal to the number.
A vector can be split into two components that add up to equal the original vector.
Many problems can be made simple by splitting a vector into two components at right angles to each other. Vertical and horizontal for some situations. Parallel to the slope and across the slope for hills.
When an object is on a slope, the component of the weight force down the incline equals the weight times the sine of the angle of the slope to the horizontal.
When an object is on a slope, the component of the weight force across the incline equals the weight times the cosine of the angle of the slope to the horizontal.
When an object slides down a slope the normal reaction of the slope on the object is equal in size to the component of the weight force across the slope.
The velocity of an object relative to an observer equals the velocity of the object minus the velocity of the observer.

Dynamics

The tendency of an object to resist changes to its motion is called its inertia.
Inertia means stationary objects prefer to stay stationary and moving objects prefer to keep moving.
Forces are always created in pairs. The pairs have equal magnitude and opposite direction.
When an object rests or leans against a surface, the surface pushes back on the object with a force called a normal reaction. The normal reaction acts at 90 degrees to the surface.
For forces to be present, two objects must be interacting.
Each object receives one of the forces.
The resultant force on an object is the vector sum of all the forces acting on it.
The total of all the forces acting on an object equals its mass times acceleration.
When the aceleration of an object is zero, the total force on it is zero.
The change in velocity of an object equals its final velocity minus its initial velocity.
The acceleration of an object is in the same direction as the change in its velocity.
The acceleration of an object is in the same direction as the resultant force acting on it.
The change in velocity of an object is in the same direction as the resultant force on the object.

Gravity.

The force of gravity on an object is called its weight.
The weight of an object equals its mass in kg times the strength of gravity. On Earth, 9.8 N/kg.
The gravitational field at a point equals the force gravity applies to a 1 kg object.
When air resistance has no significant effect, an object's acceleration during free fall is vertically down and equal to the gravitational field strength g.
When air resistance is significant, a falling object increases speed but at a slower rate as it falls.

When air resistance equals the weight of the object, the object's speed stops increasing and remains constant.

Momentum.

The momentum of an object is a vector quantity and equals its mass times velocity.
The change in momentum is equal to the final momentum minus the initial momentum.
The total momentum of a system is the same, before and after any interaction.
The impulse an object receives equals the force acting on the object times the time it lasts.
The impulse an object receives equals its change in momentum.
The unit of impulse is the Newton times the second. This is equal to the momentum unit kilogram times metres per second.
The average force on an object times the time it acts equals the mass times the final velocity minus the mass times the initial velocity.
When a moving objects stops with out hitting another object, its momentum is transferred to the Earth.
Momentum can only be transferred between objects. Momentum is never stored and released.
When one object loses momentum, another object gains the momentum.
The area under a force versus time graph is equal to the impulse received by the object.

Energy.

Energy is a scalar quantity. No direction is involved.
The work done on an object is equal to the amount of force in the direction of motion times the distance moved.
The area under a force versus distance graph equals the work done on the object.
The kinetic energy of an object equals half its mass times the square of its speed.
To find the speed of an object isolate its kinetic energy from the other energy forms and use a half mass times speed squared.
The gravitational potential energy equals the mass times gravity times the vertical height above the ground.
When an object falls, its grav PE decreases and its kinetic energy increases.
When an object is moving upwards, its grav PE increases and its kinetic energy decreases.
When an object moves closer to the ground, its final KE equals its initial KE plus the loss in grav PE.
When an object moves upwards, its final KE equals its initial KE minus the gain in grav PE.
When friction is present, the work done by the friction equals the amount of heat energy transferred.
When friction is present, the work done by the force equals the change in KE plus the change in PE plus the heat energy released.
When an object is dropped, its KE just before reaching the ground equals its grav PE at the drop point.

Power.

Power measures how quickly energy is transferred.
Average power equals the work done or energy transferred divided by time.
The unit of power is the Watt. One Watt of power means one Joule of energy is transferred each second.