Science: Forces

Year 9 Term 5

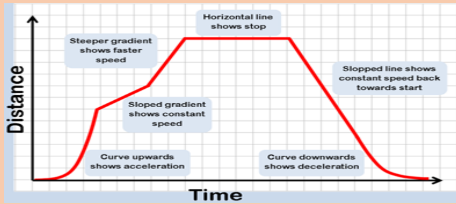
Trinity MAT

Key Term	Definition
Scalar	A physical quantity that only has magnitude (size) e.g. speed or distance.
Vector	A physical quantity that has magnitude and direction e.g. velocity or displacement.
Acceleration	The rate of change of velocity. a = (v-u) ÷ t Where: a is acceleration v is final velocity u is starting velocity t is time
Speed	Distance travelled per unit time. speed = distance ÷ time
Displacement	Distance travelled in a certain direction.
Terminal velocity	When an object has reached optimum velocity due to the weight of an object being equal to the air resistance acting on it.
Resultant force	The overall force acting on an object due to the effect of the other forces acting on that object.
Work done	Work Done is a measure of the energy transferred. The unit of measure is a Joule (J) or a newton-metre (Nm). Work done = force x distance
Power	A measure of the rate of energy transfer. The unit of measure is Watts (W). Power = Energy Transferred / Time taken
Newton's first law	An object will remain at rest or moving at a constant velocity unless acted on by an external force.
Newton's second law	The acceleration of an object is proportional to the force applied. Force = mass x acceleration
Newton's third law	When two objects interact, they exert equal and opposite forces on one another.
Inertia	A measure of how difficult it is to change the velocity of an object. The greater the mass, the greater the inertia.
Momentum	A quantity that depends on mass and velocity. Momentum = mass x velocity
Weight	The force that an object exerts due to its mass and the gravitational field. Weight = mass x gravity
Hooke's law	The strain on an object is proportional to the stress applied within the elastic limit. Force = spring constant x extension
Work done (by an elastic material)	A measure of the energy stored in an elastic object when it is stretched. Energy = 0.5 x spring constant x extension^2
Gravitational potential energy	The energy stored by an object depends on its position above the earth's surface. GPE = mass x height x gravitational field strength

Distance - Time Graphs

The gradient of the line is the speed of the object. The steeper the line, the higher the speed.
To determine the speed at a particular point during acceleration a tangent to the curve must be drawn and the gradient determined.

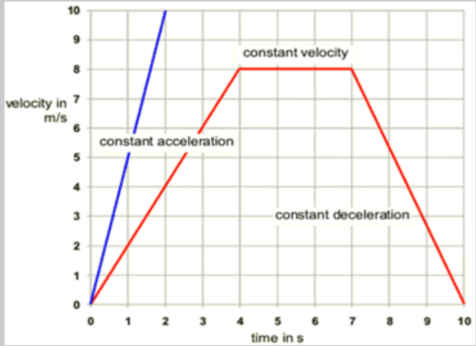
gradient = (change in y) / (change in x)



Velocity-time graphs (uniform motion)

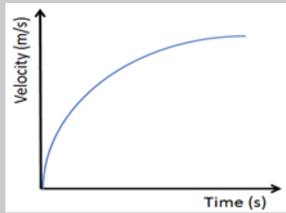
The gradient of the graph is used to determine acceleration. The steeper the gradient the greater the acceleration.

The distance travelled can be determined by calculating the area under the graph.

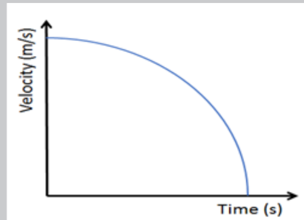


Velocity-time graphs (non-uniform motion)

To determine the acceleration at a particular point a tangent must be drawn and the gradient of the tangent determined.

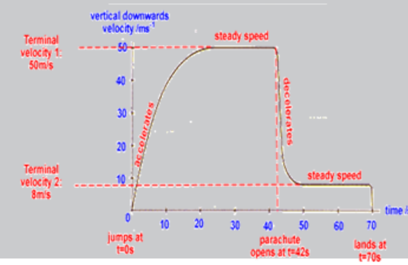


Non-uniform acceleration



Non-uniform deceleration

Terminal Velocity
The bigger the surface area, the less time the object will accelerate so the lower the terminal velocity reached.



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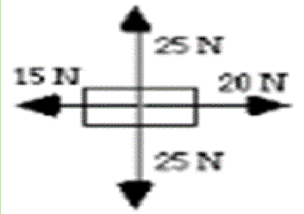
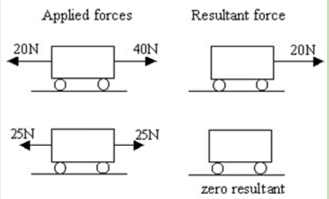
Force Diagrams

Forces are vectors because they have magnitude and direction. They are therefore represented with an arrow. The longer the arrow the larger the force.



Resultant Forces

The resultant force is the overall force acting on an object.



Contact Forces	When two objects have to touch in order to exert a force on one another.	• Friction • Drag • Normal contact • Tension
Non-contact Forces	When objects can exert a force on one another without touching.	• Electrostatic • Magnetism • Gravity

Higher-Tier Momentum

Momentum is a quantity that depends on mass and velocity. The units of measure are kgm/s.

Momentum = mass x velocity

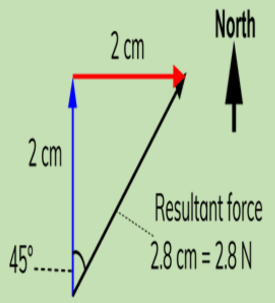
During collisions momentum is conserved. The total momentum before the collision is equal to the total momentum after.

In an **elastic collision** the total kinetic energy (KE) before is the same as the total KE after the collision. In an **inelastic collision** some of the initial KE is transferred to other forms such as thermal energy.

Higher Tier - Resultant Force

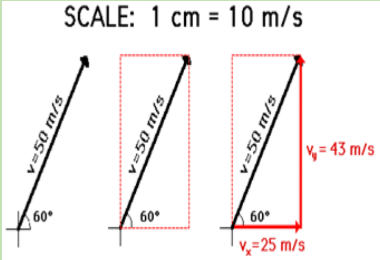
To calculate the resultant force of two perpendicular vectors:

- Draw the two vector tip-to-tail
- Add the resultant from the tail of the first arrow to the tip of the last
- Measure the length of the resultant
- Use the scale factor to find magnitude



Resolving Vectors

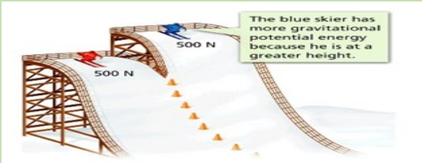
One vector can also be broken into the perpendicular components that combine to form it. This is also achieved with a scale diagram.



Gravitational Potential Energy

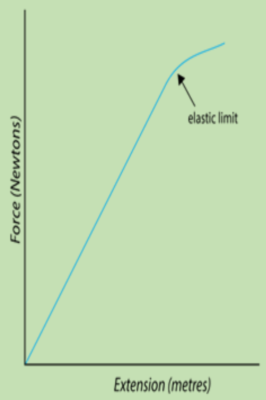
The gravitational field strength is the measure of the force on a 1kg mass when it is a gravitational field of a planet. The lager the mass of the planet the greater the gravitational field strength.

Gravitational field strength on earth is 10N/kg.



Hooke's Law

The extension of a spring is **proportional** to the force applied. If the force is doubled then the extension of the spring will also double.
The spring constant it tells you how stiff a spring is, the greater the spring constant the more difficult it is to stretch.
Hooke's law is only obeyed for the linear region of the graph, this is where elastic deformation occurs. When the graph begins to curve it is when the elastic limit has been exceeded. Beyond this point the material undergoes plastic deformation.



When plotting a force extension graph the Force is on the y-axis and the extension is on the x axis. The **gradient** of the graph is equal to the spring constant. The steeper the gradient, the stiffer the spring: this mean more force is required to cause the spring to extend.
To stretch, bend or compress an object two forces need to be applied. If when the forces are removed the object returns to its original shape the object has undergone **elastic deformation**. **Plastic deformation** has occurred if when the forces are removed the object no longer returns to its original shape. The object has been permanently changed.

Practical

The equipment required is shown in the diagram. The extension should be measured 3 times and an average should be taken to ensure the any anomalous results can be identified.

To improve the precision of the results a set square can be used to ensure the ruler is at 90°. You should also make sure the zero on the ruler is at the end of the spring.