Y9 Forces Topic – what you need to know:

Forces and motion

Scalars are quantities that have magnitude only. Vectors are quantities that have magnitude and an associated direction.

You should be aware that distance, speed and time are examples of scalars and displacement, velocity, acceleration, force and momentum are examples of vectors.

If an object moves in a straight line, how far it is from a certain point can be represented by a displacement-time graph.

The speed of an object can be determined from the gradient of a distance-time graph. If an object is accelerating its speed at any particular time can be determined by finding the gradient of the tangent of the distance-time graph at that time.

The velocity of an object is its speed in a given direction.

The velocity **v** of an object is given by the equation:

v = s / t

where **s** is the displacement and **t** is the time taken.

The acceleration **a** of an object is given by the equation:

a = (v - u) / t

where **u** is the initial velocity, **v** is the final velocity and **t** is the time taken.

The acceleration of an object can be determined from the gradient of a velocity-time graph.

The distance travelled by an object can be determined from the area under a velocity-time graph.

Resultant forces

Whenever two objects interact, the forces they exert on each other are equal and opposite.

A number of forces acting at a point may be replaced by a single force that has the same effect on the motion as the original forces all acting together. This single force is called the resultant force.

A resultant force acting on an object may cause a change in its state of rest or motion.

If the resultant force acting on a stationary object is:

- zero, the object will remain stationary
- not zero, the object will accelerate in the direction of the resultant force.

If the resultant force acting on a moving object is:

- zero, the object will continue to move at the same speed and in the same direction
- not zero, the object will accelerate in the direction of the resultant force.

The relationship between force **F**, mass **m** and acceleration **a** is:

F = m × a

Forces and terminal velocity

The faster an object moves through a fluid the greater the frictional force which acts on it.

An object falling through a fluid will initially accelerate due to the force of gravity. Eventually the resultant force will be zero and the object will move at its terminal velocity (steady speed).

You should understand why the use of a parachute reduces the parachutist's terminal velocity.

You should be able to draw and interpret velocity-time graphs for objects that reach terminal velocity, including a consideration of the forces acting on the object.

The relationship between weight **W**, mass **m** and acceleration of free fall **g** is:

W = m × g

Forces and braking

When a vehicle travels at a steady speed the resistive forces balance the driving force.

You should realise that most of the resistive forces are caused by air resistance.

The greater the speed of a vehicle the greater the braking force needed to stop it in a certain distance.

You should understand that for a given braking force, the greater the speed, the greater the stopping distance.

The stopping distance of a vehicle is the sum of the distance the vehicle travels during the driver's reaction time (thinking distance) and the distance it travels under the braking force (braking distance).

A driver's reaction time can be affected by tiredness, drugs and alcohol.

You should appreciate that distractions may affect a driver's ability to react.

When the brakes of a vehicle are applied, work done by the friction force between the brakes and the wheel reduces the kinetic energy of the vehicle and the temperature of the brakes increases.

A vehicle's braking distance can be affected by adverse road and weather conditions and poor condition of the vehicle.

You should understand that "adverse road conditions" includes wet or icy conditions. Poor condition of the car is limited to the car's brakes or tyres.