Section 1: Key terms

Scalar quantity	Have magnitude only.
Vector quantity	Have magnitude and direction.
Force	A push or a pull that acts on an object due to the interaction with another object (interaction pair).
Resultant force	A single force that has the same effect as all the original forces acting together.
Contact forces	forces between objects that are physically touching (friction, air resistance, tension, normal contact force).
Non-contact forces	Forces between objects that are physically separated (gravitational, electrostatic, magnetic force).
Mass	The quantity of matter in an object. Measured in kg.
Weight	The force acting on an object due to gravity. Measured in N.
Elastic object	An object is elastic when it returns to its original shape when the forces deforming it are removed. The increase of length from the original shape of this object is called extension.
Non-elastic object	An object that either cannot be deformed or cannot go back to its original shape when deformed.
Distance	How far an object moves. Scalar quantity. Doesn't involve direction.
Displacement	Includes both the distance an object moves and its direction. Vector quantity.
Centre of a mass	The point at which its mass can be thought of as being concentrated.

Physics 3 - Forces in Action

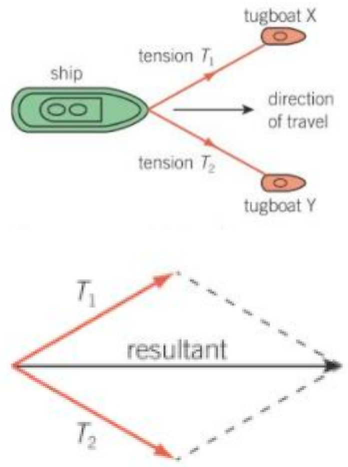
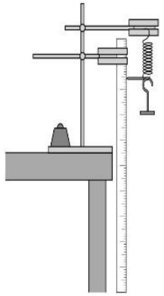


Figure 1. Combining forces.

Section 2: Forces and elasticity

Variable	Definition	Word equation	Symbol equation	Extra information
Weight	Force acting on an object due to gravity	Weight, N = mass, kg x gravitational field strength, N/kg	w=m x g	Measured using a Newtonmeter
Work done	When a force causes an object to move through a distance work is done on the object.	Work done, J= Force,N x distance, m	W=F x s	Work done against frictional forces acting on an object causes a rise in the temperature of the object
Hooke's Law	The extension of a spring is directly proportional to the force applied, as long as its limit of proportionality is not exceeded	Force applied, N = spring constant, N/m x extension, m	F= k x e	This is valid provided that the limit of proportionality is not exceeded
Elastic potential energy	Work done in stretching or compressing a spring (up to the limit of proportionality)	Elastic potential energy, J = 0.5 x spring constant, N/m x (extension)^2, m^2	E_P= 0.5 x k x e ^{2}	

Required Practical: Force and Extension



1. Attach the two clamps to the clamp stand using the bosses. The top clamp should be further out than the lower one.
2. Place the clamp stand near the edge of a bench. The ends of the clamps need to stick out beyond the bench.
3. Place a heavy weight on the base of the clamp stand to stop the clamp stand tipping over.
4. Hang the spring from the top clamp.
5. Attach the ruler to the bottom clamp with the zero on the scale at the top of the ruler. If there are two scales going in opposite directions you will have to remember to read the one that increases going down.
6. Adjust the ruler so that it is vertical. The zero on the scale needs to be at the same height as the top of the spring.
7. Attach the splint securely to the bottom of the spring. Make sure that the splint is horizontal and that it rests against the scale of the ruler.
8. Take a reading on the ruler – this is the length of the unstretched spring.
9. Carefully hook the base of the weight stack onto the bottom of the spring. This weighs 1.0 newton (1.0 N).
10. Take a reading on the ruler – this is the length of the spring when a force of 1.0 N is applied to it.
11. Add further weights. Measure the length of the spring each time.
12. Record your results in a table. You will need a third column for the extension. This is the amount the string has stretched. To calculate this you subtract the length of the unstretched spring from each of your length readings.
13. Do not put the apparatus away yet.
14. Plot a graph with: 'Extension of spring in cm' on the y-axis , 'Weight in N' on the x-axis.
15. Hang the unknown object on the spring. Measure the extension and use your graph to determine the object's weight. Check it with a newtonmeter.

Section 3: Forces and motion

Variable	Definition	Word equation	Symbol equation
Speed	Scalar quantity. How far an object is moving at a certain amount of time. (Typical values: walking ~1.5m/s, running ~3m/s, cycling ~6m/s, speed of sound ~330m/s)	Speed, m/s = $\frac{\text{Distance travelled, m}}{\text{time, s}}$	V=s/t
Velocity	Vector quantity. Speed at a given direction.		
Acceleration	The acceleration of an object is its change of velocity per second	Acceleration, m/s²= $\frac{Change\ in\ velocity, m/s}{Time\ taken, s}$	$\alpha = \frac{\Delta v}{t}$
Uniform acceleration	Occurs when the speed of an object changes at a constant rate.	(final velocity)^2 -(initial velocity)^2 = 2 x acceleration x distance	$V^2 - u^2 = 2as$

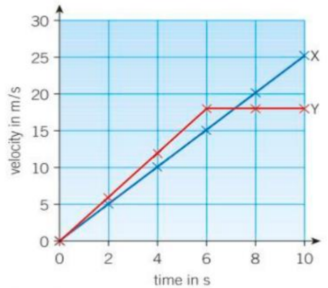


Figure 2. A velocity-time graph. The gradient of a line on a velocity-time graph represents acceleration.

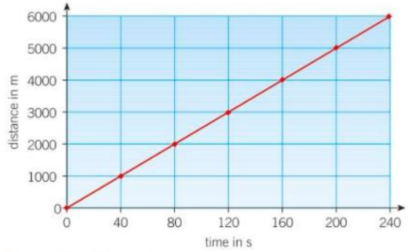


Figure 3. A distance-time graph. The gradient of a line on a distance-time graph represents speed.

Section 5: Forces and braking

Stopping distance	• 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). • The greater the speed of the vehicle, the greater the stopping distance.	**Stopping distance=thinking distance + braking distance**
Reaction time	It varies from person to person (typical values: 0.2-0.9s)	Can be affected by tiredness, drugs and alcohol.
Braking distance	The distance a vehicle travels under the braking force	Can be affected by wet or icy road conditions.

Section 4: Newton's Laws

Newton's First Law of motion	If the resultant force acting on an object is zero and: • The object is stationary, the object remains stationary. • The object is moving, the object continues to move at the same speed and in the same direction. So the object continues to move at the same velocity.	Apply to: explain motion of objects moving with a uniform velocity and objects where the speed and/or direction changes.
Newton's Second Law	The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object	Equation: resultant force, N= mass, kg, x acceleration, m/s^2
Newton's Third Law	Whenever two objects interact, the forces they exert on each other are equal and opposite.	Apply to: Explain equilibrium.

Required Practical: Acceleration

- The first experiment will investigate how the acceleration depends upon the force. The force is provided by the weight stack.
- Attach the full weight stack (1 N) to the end of the string.
- Switch on the software. Make sure the glider is in position and switch on the vacuum cleaner.
- The glider should accelerate through the light gates towards the bench pulley.
- Record the acceleration. Repeat.
- If the two values are not similar, repeat again.
- Record your readings in a table such as the one below. Calculate the mean.
- Remove one weight (0.2 N) and attach that to the glider. This will keep the total mass constant. (The weight stack is being accelerated too.)
- Repeat the experiment for a force of: 0.8 N, 0.6 N, 0.4 N, 0.2 N. Remember to
- attach each weight to the glider as it is removed from the weight stack.
- Plot a graph with: 'Acceleration in m/s^2' on the y-axis , 'Force in N' on the x-axis.