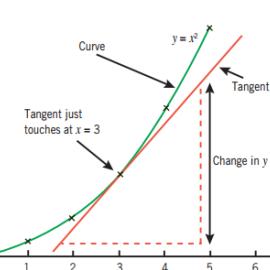
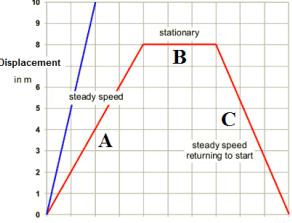
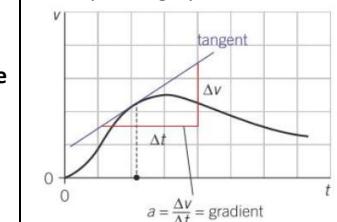
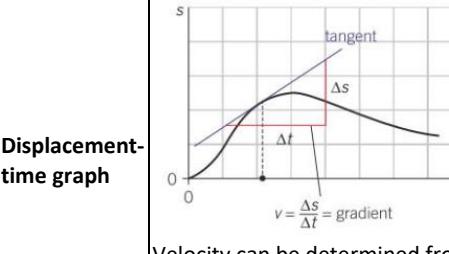
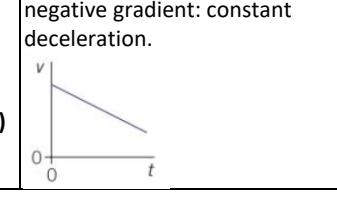
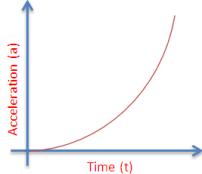
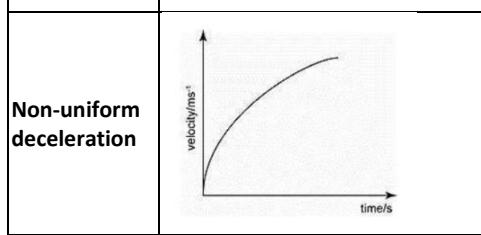


1. Distance and speed		2. Displacement and velocity		3. Acceleration	
Average speed	<p>The rate of change in distance calculated over a complete journey.</p> $\text{average speed} = \frac{\text{distance travelled}}{\text{time taken}}$ $v = \frac{\Delta x}{\Delta t}$ <p>v – average speed (<math>\text{m s}^{-1}</math>)  <math>\Delta x</math> – distance travelled (m)  <math>\Delta t</math> – time (s)</p>	<b>Gradient</b> <p>In a graph, the change in the vertical axis quantity divided by the corresponding change in the horizontal axis quantity.</p> <b>Instantaneous speed</b> <p>The speed at the moment it is measured – speed over an infinitesimal interval of time. The greater the gradient, the greater the instantaneous speed.</p> <b>Distance-time graph varying speed</b> <p>The gradient of the tangent to the graph represents the instantaneous speed.</p>  <p>When you calculate the gradient, make sure the triangle that you draw on the graph is large enough to provide an accurate answer.</p>	<b>Displacement</b> <p>The distance travelled in a particular direction – it is a vector with magnitude and a direction, measured in m.</p> <b>Displacement-time graph</b> 	<b>Acceleration</b> <p>The rate of change of velocity, a vector quantity.</p> $a = \frac{\Delta v}{\Delta t}$ <p>a – acceleration (<math>\text{m s}^{-2}</math>)  <math>\Delta v</math> – change in velocity (<math>\text{m s}^{-1}</math>)  <math>\Delta t</math> – time taken (s)</p> <b>Velocity-time graphs</b> 	
Distance	<p>Distance is a scalar quantity that refers to "how much ground an object has covered" during its motion, measured in m.</p>				<p>A straight line of constant, positive gradient: constant acceleration.</p> 
Time	Measured in seconds, s.				
Delta $\Delta$	<p>Is a shorthand for <i>change in</i>.</p> <ul style="list-style-type: none"> <li>• Stationary object is represented by a horizontal line</li> <li>• An object moving at a constant speed is represented by a straight, sloping line.</li> </ul>  <p>The gradient of the graph represents the speed.</p>		<b>Displacement-time graph</b>  <p>Velocity can be determined from the gradient of the displacement-time graph.</p>		<p>A straight line of zero gradient: constant velocity or zero acceleration.</p> 
Distance-time graph constant speed		<b>Average velocity</b> <p>The change in displacement for a journey divided by the time taken.</p> $\text{average velocity} = \frac{\text{change in displacement}}{\text{time taken}}$ $v = \frac{\Delta s}{\Delta t}$ <p>v – average velocity (<math>\text{m/s}</math>)  <math>\Delta s</math> – change in displacement (m)  <math>\Delta t</math> – time taken (s)</p>			<p>A straight line of constant negative gradient: constant deceleration.</p> 
Constant speed	Motion in which the distance travelled per unit time stays the same, measured in m/s.				

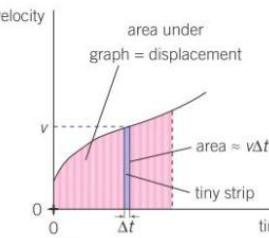
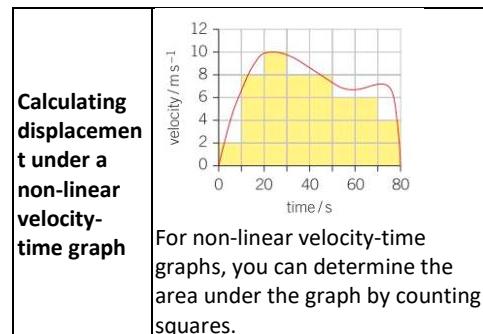
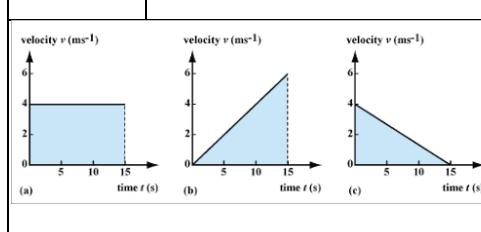
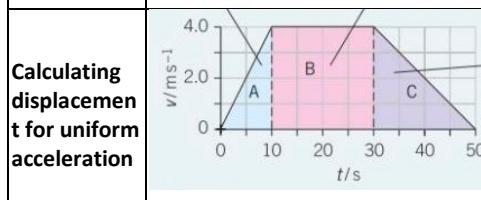
**Non-uniform acceleration**

A curve with changing gradient: acceleration is changing.

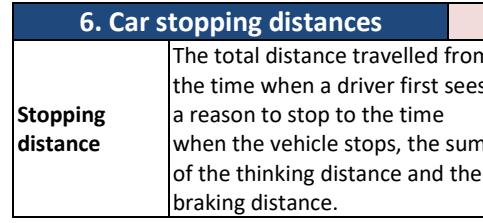



#### 4. More on velocity – time graphs

The area under velocity-time graph is equal to displacement.

5. Equations of motion	
<b>suvat</b>	s – displacement/distance travelled u – initial velocity v – final velocity a – acceleration t – time taken for the change in velocity
<b>Equation without s</b>	$v = u + at$
<b>Equation without v</b>	$s = ut + \frac{1}{2}at^2$
<b>Equation without a</b>	$s = \frac{1}{2}(u + v)t$
<b>Equation without t</b>	$v^2 = u^2 + 2as$



**Thinking distance**

The distance travelled by a vehicle from when the driver first perceives a need to stop to when the brakes are applied.

Thinking distance = speed x reaction time

Distance is directly proportional to time.

**Braking distance**

Distance travelled by a vehicle from the time the brakes are applied until the vehicle stops.

Distance is directly proportional to the initial speed squared.

If you double your initial velocity, it is going to take four times the distance to brake.

**Reaction time**

Reaction time is the amount of time it takes to respond to a stimulus.

**Factors affecting braking distance**

- The type of braking system,
- Brake pad material,
- Brake alignment,
- Tyre pressures,
- Tyre tread and grip,
- Vehicle weight,
- Suspension system,
- The co-efficient of friction of the road surface,
- Wind speed,
- Slope of road,
- Surface smoothness
- The braking technique applied by the driver.

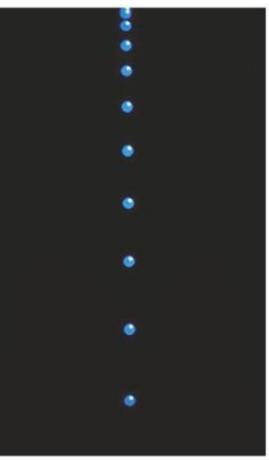
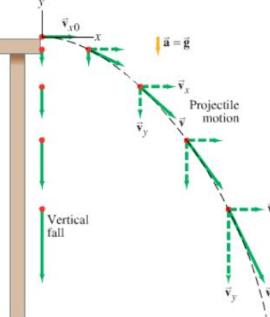
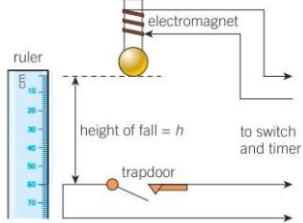
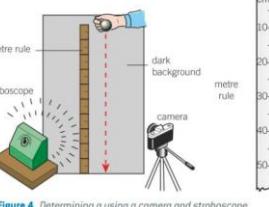
- Factors affecting thinking distance**
- Speed
  - Distractions, e.g. mobile phones
  - Alcohol
  - Drugs
  - Tiredness
  - Visibility

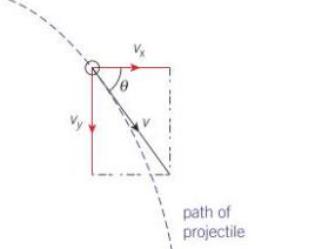
- Factors affecting thinking and braking distance**
- speed

Speed / mph	20	30	40	50	60	70
Speed / m s⁻¹	8.9	13.4	17.8	22.2	26.7	31.1
Thinking distance / m	6	9	12	15	18	21
Braking distance / m	6	14	24	38	55	75
Stopping distance / m	12	23	36	53	73	96

Thinking, braking, and overall stopping distances according to the Highway code.

7. Free fall and g	
<b>Free fall</b>	The motion of an object accelerating under gravity with no other force acting on it.
<b>Acceleration of free fall</b>	The rate of change of velocity of an object falling in a gravitational field, symbol $g$ , measured in $\text{m s}^{-2}$ .  The value for $g$ varies depending upon factors including altitude, latitude, and the geology of an area.

<b>Determining g</b> <p>The basic idea behind determining <math>g</math> in the laboratory is to drop a heavy ball over a known distance and time its descent.</p> <p>Methods for measuring <math>g</math> are:</p> <ul style="list-style-type: none"> <li>- electromagnet and trapdoor</li> <li>- light gates</li> <li>- taking pictures</li> </ul>	<b>Taking pictures</b> <p><b>Camera in rapid-fire repeating mode</b></p> 	<b>8. Projectile motion</b> <p><b>Free fall</b></p> <p>A free falling object is an object that is falling under the sole influence of gravity.</p> <ul style="list-style-type: none"> <li>- Free-falling objects do not encounter air resistance.</li> <li>- All free-falling objects (on Earth) accelerate downwards at a rate of <math>9.8 \text{ m s}^{-2}</math>.</li> </ul> <p><math>v(0)=0</math></p> <p><math>v(t)=gt</math></p> <p><math>h = \frac{1}{2}gt^2</math></p> <p><math>v^2 = 2gh</math></p> <p><math>v = gt</math></p> <p><math>h</math> – height (m)  <math>a = g</math> – gravitational field strength (<math>\text{m s}^{-2}</math>)  <math>t</math> – time (s)  <math>v</math> – vertical velocity (<math>\text{m s}^{-1}</math>)</p>	<b>Horizontal projectile motion</b> <p>The motion in two dimensions <math>x</math> and <math>y</math>.</p> <ul style="list-style-type: none"> <li>- The motion can be looked at as two components of the motion separately: horizontal (<math>x</math>-axis) and vertical (<math>y</math>-axis).</li> </ul> 
<b>Electromagnet and trapdoor</b>  <p>The value for <math>g</math> is calculated from the height from the fall and the time taken.          Negative side – tiny delays into the timing.</p>	<p><b>A stroboscope illuminates the scene with rapid flashes.</b></p>  <p><b>Figure 4 Determining <math>g</math> using a camera and stroboscope</b>          The camera shutter is held open, producing a photograph with multiple images of the falling ball.</p>	<p><b>Vertical motion – upward</b></p> <ul style="list-style-type: none"> <li>- An object that is thrown vertically upwards decelerates under the earth's gravity. Its speed decreases until it attains a maximum height, where the velocity is zero.</li> <li>- Then it is accelerated uniformly downwards under gravity. When it returns to the point of projection, it has the same speed as that at the instant of projection.</li> <li>- no air resistance</li> <li>- suvat equations</li> </ul>	<ul style="list-style-type: none"> <li>- Assuming no air resistance.</li> <li>- An object projected horizontally will reach the ground in the same time as an object dropped vertically, from the same height.</li> <li>- The vertical displacement and time of flight can be calculated using equations of motion.</li> </ul> <p><b>Horizontal projectile motion – horizontal component</b></p> <ul style="list-style-type: none"> <li>- Horizontal velocity remains constant.</li> <li>- Horizontal acceleration is equal to zero.</li> <li>- The horizontal velocity is unaffected by the fall.</li> </ul> <p><b>Horizontal projectile motion – vertical component</b></p> <ul style="list-style-type: none"> <li>- The vertical velocity changes due to acceleration of free fall.</li> </ul>
<b>Light gate</b> <p>A light gate usually consists of two light beams, one above the other, with detectors connected to a timer.</p>			

<b>Horizontal projectile motion – velocity <math>v</math></b>  Actual velocity $v = \sqrt{v_x^2 + v_y^2}$ $v_x$ – vertical component $v_y$ – horizontal component $\theta = \tan^{-1} \left( \frac{v_y}{v_x} \right)$	
<b>Projectile motion</b> <ul style="list-style-type: none"><li>- Projectile fired at an angle <math>\theta</math> to the horizontal.</li></ul>  <ul style="list-style-type: none"><li>- The motion can be analysed in terms of the independence of motion in the horizontal and vertical directions.</li><li>- The horizontal component of the velocity is <math display="block">v_x = v \cos \theta</math></li><li>- The vertical component of the velocity is <math display="block">v_y = v \sin \theta</math></li></ul>	