EDEXCEL TOPIC 2 - MOTION AND FORCES (part 1)

Measuring Motion

Car in town	*13m/s*
Car on motorway	*31m/s*
Train	*55m/s*
Sound in air	*340m/s*

Wind	*5 – 20 m/s*

Describing Motion

Scalar and vector quantities

Speed	*How fast an object moves*	The speed of a car is 30m/s. A car moves forward with a velocity of 30m/s.
Velocity	*Speed + direction*	
Distance	*How far*	The table is 1m long.
Displacement	*Distance + direction*	The beach is 1km due east of the town.

Scalar	*A quantity that only has magnitude (size)*	e.g. mass, time, speed, temperature, energy, distance.
Vector	*A quantity that only has magnitude and direction*	e.g. force, velocity, momentum, displacement, acceleration, weight.

Speed is rarely constant.

Walking	*1.4m/s*
Running	*3m/s*
Cycling	*5.5m/s*

Average speed = distance ÷ time

s = d ÷ t

Equations

Acceleration = (final velocity – initial velocity) ÷ time taken

a = (v – u) ÷ t

Acceleration	*How quickly an object speeds up*
	The change in velocity in a certain amount of time

Acceleration is positive, object is accelerating

Acceleration is negative, object is decelerating

(final velocity squared – initial velocity squared) = 2 X acceleration X distance ÷ time taken

$v^2 - u^2 = 2 \times a \times x$

Uniform acceleration	*Acceleration due to gravity is constant for objects in free fall*
	Constant acceleration

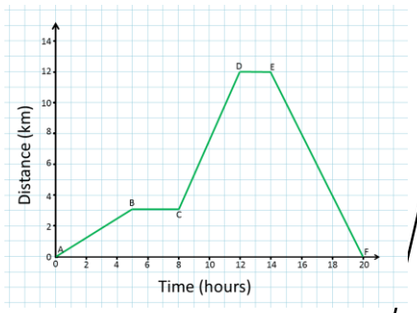
Estimating Acceleration	*Estimate how long it takes the object to stop and then use the acceleration equation*

Acceleration in free fall = 10m/s²

Core Practical
Determine the speed of objects
Using light gates

Speed	*Metre/second (m/s)*
Distance	*Metre (m)*
Time	*Second (s)*
Current	*Ampere (A)*
Temperature	*Kelvin (K)*
Acceleration	*Metres/second squared (m/s²)*
Velocity	*Metre/second (m/s)*

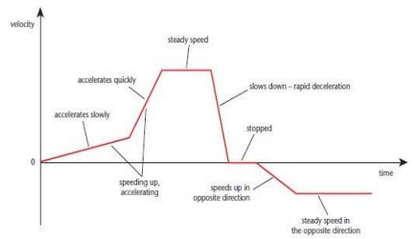
Motion Graphs



Distance-time graphs

Distance-time graph	*Shows how far an object moves along a straight line*
Speed of object	*Use the gradient of graph*
Object stopped	*Graph line flat*
Object going faster	*Graph line steeper*
Object accelerating	*Graph line curves*

Calculating speed from d-t graph	*If the graph is a straight line, the speed along the line is equal to the gradient of the line*	Gradient = vertical ÷ horizontal
	If the graph is a curve, the speed is found by drawing a tangent to the curve and then the gradient of the tangent	



Velocity-time graphs

Velocity-time graph	*Shows how fast an object moves*
Gradient of graph	*Object accelerating*
Graph line flat	*Object has constant / steady speed*
Graph line steeper	*Object has greater acceleration*
Positive diagonal line	*Object is accelerating at a constant rate*
Negative diagonal line	*Object is decelerating at a constant rate*
Graph line curves	*Object is changing acceleration*

Calculate acceleration	*Use the gradient gradient = vertical ÷ horizontal*	

Calculating distance travelled from v-t graph	*The area under a section of the graph is equal to the distance travelled in that time*	Distance = Speed X time
	If the acceleration is constant, the area can be split into a rectangle or a triangle	Area of rectangle = base X height Area of triangle = ½ base X height

EDEXCEL TOPIC 2 - MOTION AND FORCES (part 1)

Describing Motion

Scalar and vector quantities

A quantity that only has magnitude (size)	e.g. mass, time, speed, temperature, energy, distance.
A quantity that only has magnitude and direction	e.g. force, velocity, momentum, displacement, acceleration, weight.

Speed + direction	*How fast an object moves*	The speed of a car is 30m/s. A car moves forward with a velocity of 30m/s.
How far		The table is 1m long.
Distance + direction		The beach is 1km due east of the town.

Speed is rarely constant.

5 – 20 m/s	

13m/s	
31m/s	
55m/s	
340m/s	

1.4m/s	
3m/s	
5.5m/s	

Average speed = distance ÷ time

s = d ÷ t

Measuring Motion

Equations

Acceleration = (final velocity – initial velocity) ÷ time taken

a = (v – u) ÷ t

How quickly an object speeds up	
The change in velocity in a certain amount of time	

Acceleration is positive, object is accelerating

Acceleration is negative, object is decelerating

(final velocity squared – initial velocity squared) = 2 X acceleration X distance ÷ time taken

$v^2 - u^2 = 2 \times a \times x$

Acceleration due to gravity is constant for objects in free fall	
Constant acceleration	
Estimate how long it takes the object to stop and then use the acceleration equation	

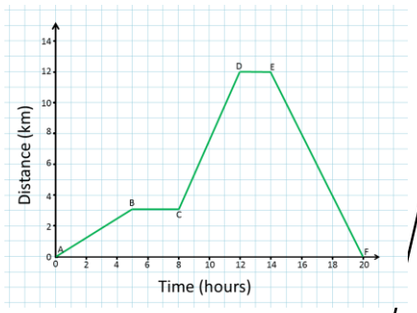
Acceleration in free fall = $10m/s^2$

Determine the speed of objects	
Using light gates	

	Metre/second (m/s)
	Metre (m)
	Second (s)
	Ampere (A)
	Kelvin (K)
	Metres/second squared (m/s^2)
	Metre/second (m/s)

Motion Graphs

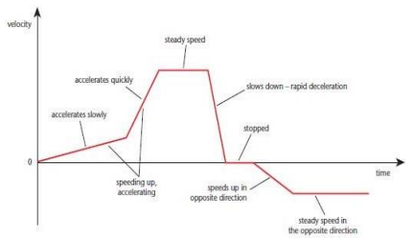
Distance-time graphs



Distance-time graph	*Shows how far an object moves along a straight line*
	Use the gradient of graph
	Graph line flat
	Graph line steeper
	Graph line curves

	If the graph is a straight line, the speed along the line is equal to the gradient of the line	Gradient = vertical ÷ horizontal
	If the graph is a curve, the speed is found by drawing a tangent to the curve and then the gradient of the tangent	

Velocity-time graphs



Velocity-time graph	*Shows how fast an object moves*
	Object accelerating
	Object has constant / steady speed
	Object has greater acceleration
	Object is accelerating at a constant rate
	Object is decelerating at a constant rate
	Object is changing acceleration

	The area under a section of the graph is equal to the distance travelled in that time	Distance = Speed X time
	If the acceleration is constant, the area can be split into a rectangle or a triangle	Area of rectangle = base X height Area of triangle = ½ base X height

	Use the gradient gradient = vertical ÷ horizontal

EDEXCEL TOPIC 2 - MOTION AND FORCES (part 1)

Measuring Motion

Car in town	
Car on motorway	
Train	
Sound in air	
Wind	

Acceleration is negative,

Acceleration is positive,

$a = (v - u) \div t$

Acceleration	

$v^2 - u^2 = 2 \times a \times x$

Uniform acceleration	

Walking	
Running	
Cycling	

Speed

$s = d \div t$

Average speed

Equations

Estimating Acceleration	

Acceleration in free fall = 10m/s²

Speed		
Velocity		
Distance		
Displacement		

Scalar and vector quantities

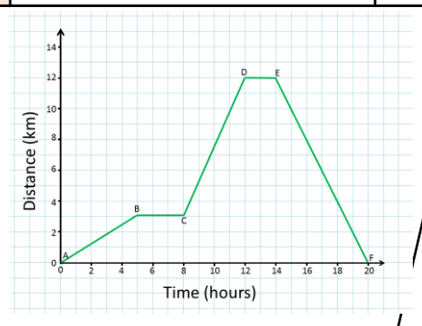
Scalar		
Vector		

Describing Motion

Core Practical

Speed	
Distance	
Time	
Current	
Temperature	
Acceleration	
Velocity	

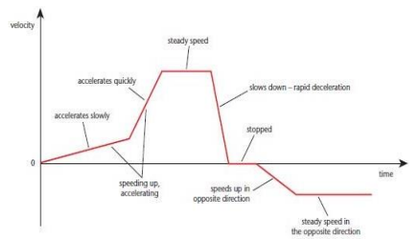
Motion Graphs



Distance-time graphs

Distance-time graph	*Shows how far an object moves along a straight line*
Speed of object	
Object stopped	
Object going faster	
Object accelerating	

Calculating speed from d-t graph		Gradient =



Velocity-time graphs

Velocity-time graph	*Shows how fast an object moves*
Gradient of graph	
Graph line flat	
Graph line steeper	
Positive diagonal line	
Negative diagonal line	
Graph line curves	

Calculate acceleration		

Calculating distance travelled from v-t graph		

EDEXCEL TOPIC 2 - MOTION AND FORCES (part 1)

Describing Motion

Scalar and vector quantities

Measuring Motion

Equations

Acceleration

Acceleration

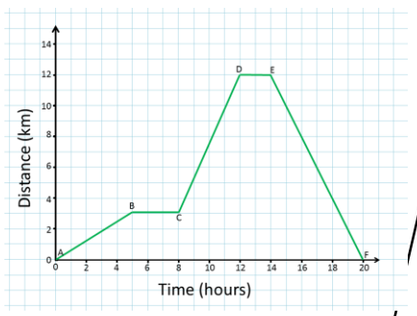
$a = (v - u) \div t$

$v^2 - u^2 = 2 \times a \times x$

Acceleration in free fall = $10 m/s^2$

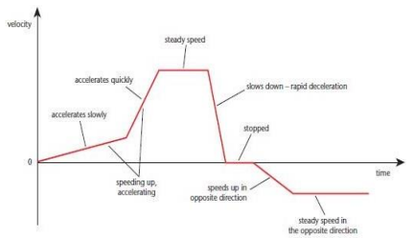
Core Practical

Motion Graphs



Distance-time graphs

Distance-time graph	*Shows how far an object moves along a straight line*



Velocity-time graphs

Velocity-time graph	*Shows how fast an object moves*

EDEXCEL TOPIC 2 - MOTION AND FORCES (part 2)

Forces

Contact and Resultant forces

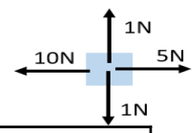
Force	***Push or pull***	Stretch, squash, turn.
Contact force	***Exerted between two objects when they touch***	Friction, air resistance, tension.
Non-contact force	***Exerted between two objects without touching***	Gravity, electrostatic forces, magnetic forces.

Resultant force	***The overall effect of all of the forces acting upon an object***	Two forces acting in the same direction are added.
		Two forces acting in the opposite direction are taken away.

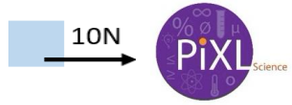
An arrow can be used to show vectors

- ***Length of arrow = magnitude of vector***
- ***Direction of arrow = direction of vector***

Object moves left with a force of 5N.



Free body diagram	***Show magnitude and direction of all forces upon an object***



Weight	***Newton (N)***
Mass	***Kilograms (kg)***
Gravitational field strength	***Newton per kilogram (N/kg)***
Force	***Newton (N)***
Acceleration	***Kilogram metre per second (Kg m/s)***
Momentum	***Joules (J)***
Velocity	***Metre per second (m/s)***
Time	***Second (s)***

Reactions and stopping

Measuring reaction times	***How fast someone reacts***

Dropping the ruler test or computer based test.

Typical reaction time = 0.2 – 0.6s.

Frictional forces decelerate a moving object and bring it to rest.

. An alert driver has a reaction time of 1s.

Thinking distance	***Distance travelled whilst the driver reacts***
Braking distance	***Distance travelled whilst the car is stopped by the brakes***
Stopping distance	***Total thinking and braking distances***

Speed affects both thinking and braking distances.

Car's mass ~1000Kg, single decker bus ~10,000Kg, loaded lorry ~30,000Kg

PHYSICS ONLY

Speed increases so does stopping distance.

Speed increases thinking distance also increases at the same rate.

If speed doubles, braking distance increases by a factor of four (2^2).

Factors affecting stopping distances	Drivers reaction times	Drinking alcohol, taking drugs, tired.
	Braking distances	Weather conditions, worn brakes or tyres, road surface, size of braking force.

Braking and kinetic energy	***Work done by braking force, reduces kinetic energy***	Kinetic energy decreases, temperature of brakes increases due to frictional forces.

Work done to bring a vehicle to rest = its initial kinetic energy

Newton's Laws and Momentum

Newton's first Law	***Balanced forces***	When the resultant force on an still object = 0, the object is stationary.
		When the resultant force on a moving object = 0, the object is at a constant speed.
Newton's second Law	***Unbalanced forces***	When the resultant force is greater than 0, the object accelerates. It could speed up, slow down or change direction.
Newton's third Law	***Equal and opposite forces***	When two objects interact the forces exerted are equal and in an opposite direction.

Conservation of momentum	***When two objects collide, the momentum they have before the collision = the momentum they have after the collision***	
	Closed system = no external forces acting on it.	

Crumple zones

Changes in momentum	***Force is applied to stop momentum***	**If momentum changes slowly, the force applied is small so less damage.**

F = (mv – mu) ÷ t

Force = change in momentum ÷ time.

Is a vector.

Momentum = mass X velocity

p = m X v

F = m X a

Force = mass X acceleration.

HIGHER ONLY

Inertial mass	***How difficult it is to change the velocity of an object***	If the mass is large, to change velocity a big force is needed.
Inertial mass = force ÷ acceleration.		

HIGHER ONLY

When objects continue in the same state of motion	Speed or direction only changes if a resultant force acts on the object
Inertia	

HIGHER ONLY

Gravitational field strength	Gravity exerted around an object.	Earth's gfs = 9.8N/kg.

Each Kg has a gravitational pull of 9.8N.

W = m X g

Weight = mass X gravitational field strength

Weight	***Force acting upon an object due to gravity***	Newton (N)
Mass	***How much matter***	Kilograms (Kg)

Core Practical

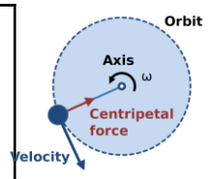
Investigate force, mass and acceleration

Vary mass added to trolley.

- Acceleration is proportional to resultant force.
- Acceleration is inversely proportional to mass.

Car travelling around a bend	Constant speed, direction changes.
Satellite orbiting the Earth	Constant speed, direction changes.

There must be a resultant force acting upon the object.



Centripetal force	***This force acts towards the centre of the circle***

Changing velocity	***Objects in a circular motion, change direction but keep a constant speed***

An object travelling in a circle at a constant speed, is constantly changing direction so it is constantly changing velocity which means it is accelerating.

EDEXCEL TOPIC 2 - MOTION AND FORCES (part 2)

Forces

Contact and Resistant forces

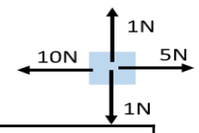
	Push or pull	Stretch, squash, turn.
	Exerted between two objects when they touch	Friction, air resistance, tension.
	Exerted between two objects without touching	Gravity, electrostatic forces, magnetic forces.

	The overall effect of all of the forces acting upon an object	Two forces acting in the same direction are added.
		Two forces acting in the opposite direction are taken away.

10N →

	Length of arrow = magnitude of vector
	Direction of arrow = direction of vector

Object moves left with a force of 5N.



	Show magnitude and direction of all forces upon an object

	Newton (N)
	Kilograms (kg)
	Newton per kilogram (N/kg)
	Newton (N)
	Kilogram metre per second (Kg m/s)
	Joules (J)
	Metre per second (m/s)
	Second (s)

Reactions and stopping

	How fast someone reacts
Dropping the ruler test or computer based test.	
Typical reaction time = 0.2 – 0.6s.	

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PHYSICS ONLY

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Work done to bring a vehicle to rest = its initial kinetic energy

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. An alert driver has a reaction time of 1s.

	Distance travelled whilst the driver reacts
	Distance travelled whilst the car is stopped by the brakes
	Total thinking and braking distances

Speed affects both thinking and braking distances.

	Drivers reaction times	Drinking alcohol, taking drugs, tired.
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Crumple zones

	Force is applied to stop momentum	**If momentum changes slowly, the force applied is small so less damage.**

HIGHER ONLY

F = (mv – mu) ÷ t

Force = change in momentum ÷ time.

Is a vector.

Momentum = mass X velocity

p = m X v

Momentum

	How difficult it is to change the velocity of an object	If the mass is large, to change velocity a big force is needed.
Inertial mass = force ÷ acceleration.		

HIGHER ONLY

Newton's Laws and Momentum

	Balanced forces	When the resultant force on an still object = 0, the object is stationary.
		When the resultant force on a moving object = 0, the object is at a constant speed.
	Unbalanced forces	When the resultant force is greater than 0, the object accelerates. It could speed up, slow down or change direction.
	Equal and opposite forces	When two objects interact the forces exerted are equal and in an opposite direction.

	When objects continue in the same state of motion	Speed or direction only changes if a resultant force acts on the object

HIGHER ONLY

	Investigate force, mass and acceleration
Vary mass added to trolley.	

Acceleration is proportional to resultant force.
Acceleration is inversely proportional to mass.

Force = mass X acceleration.

F = m X a

Frictional forces decelerate a moving object and bring it to rest.

	When two objects collide, the momentum they have before the collision = the momentum they have after the collision
Closed system = no external forces acting on it.	

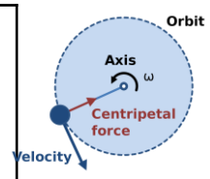
	Force acting upon an object due to gravity	Newton (N)
	How much matter	Kilograms (Kg)

W = m X g

Weight = mass X gravitational field strength

	Gravity exerted around an object.	Earth's gfs = 9.8N/kg.

Each Kg has a gravitational pull of 9.8N.



	Constant speed, direction changes.
	Constant speed, direction changes.

There must be a resultant force acting upon the object.

An object travelling in a circle at a constant speed, is constantly changing direction so it is constantly changing velocity which means it is accelerating.

	This force acts towards the centre of the circle
	Objects in a circular motion, change direction but keep a constant speed

HIGHER ONLY

EDEXCEL TOPIC 2 - MOTION AND FORCES (part 2)

Partners in excellence

Forces

Force		
Contact force		
Non-contact force		

An arrow can be used to show vectors

10N

Object moves

1N, 10N, 5N, 1N

Free body diagram

Resultant force

Each Kg

Gravitational field strength

W = m X g

Weight =

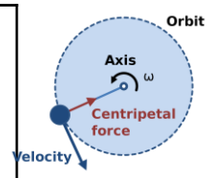
Weight		
Mass		

Car travelling around a bend

Satellite orbiting the Earth

acting upon the object.

An object travelling in a circle at a constant speed,



Centripetal force

Changing velocity

HIGHER ONLY

Contact and Resultant forces

Reactions and stopping

Weight		
Mass		
Gravitational field strength		
Force		
Acceleration		
Momentum		
Velocity		
Time		

Measuring reaction times

Frictional forces decelerate

. An alert driver

Thinking distance

Braking distance

Stopping distance

Speed affects

PHYSICS ONLY

Speed increases

Speed increases

If speed doubles,

Work done to bring a vehicle to rest =

Factors affecting stopping distances

Braking and kinetic energy

Car's mass
single decker bus
loaded lorry

Core Practical

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Inertia

HIGHER ONLY

Newton's Laws and Momentum

Force =

F = m X a

Newton's first Law		
Newton's second Law		
Newton's third Law		

Conservation of momentum

F = (mv – mu) ÷ t

Is a vector.

Momentum =

p = m X v

Force = =

Momentum

Crumple zones

Changes in momentum

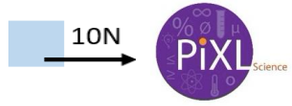
HIGHER ONLY

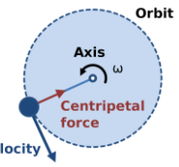
Inertial mass

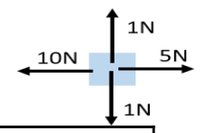
EDEXCEL TOPIC 2 - MOTION AND FORCES (part 2)

Forces

- Contact and Resultant forces
- Reactions and stopping







HIGHER ONLY

HIGHER ONLY

Newton's Laws and Momentum

PHYSICS ONLY

Momentum

HIGHER ONLY

Crumple zones

Frictional forces
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