AQA FORCES – part 1

Forces and their interactions

Gravity

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

Each Kg has a gravitational pull of 9.8N.

Weight = mass X gravitational field strength — W = m X g

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

Scalar and vector quantities

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

An arrow can be used to show vectors	*Length of arrow = magnitude of vector*
	Direction of arrow = direction of vector

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

Area	*Metres squares (m^2)*
Weight	*Newton (N)*
Mass	*Kilograms (kg)*
Gravitational field strength	*Newton per kilogram (N/Kg)*
Force	*Newton (N)*
Work done	*Joules (J)*
Distance	*Metres (m)*
Moment	*Newton-metres (Nm)*

Pressure = height X density X gfs

Moments, levers and gears

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M = F X d

Moment = force X distance

Moment	*Turning effect of a force about a pivot*
Lever	*A small force exerted with a long lever applies a large force*

Principle of moments

In a balanced system, the sum of the clockwise moments = the sum of the anti-clockwise moments

Gears	*Increase or decrease the rotational effect of a force*

Pressure

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Pressure = Force ÷ Area

P = F ÷ A

Pressure and depth

Pressure on divers depends on weight of water above

Upthrust

Resultant force exerted by a fluid

Fluid	*A liquid or gas*

Flows and changes shape to fill a container.

Hydraulic machine	*Use liquids to transmit pressure*

Atmospheric pressure

Caused by billions of air particles colliding with a surface.

Unit	*Newton (N)*	1N
Kilo	*Kilonewton (KN) = 1000*	1X 10^3
Mega	*Meganewton (MN) = 1000,000*	1 X 10^6

Centre of mass	*The weight of an object acts through a single point*

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.

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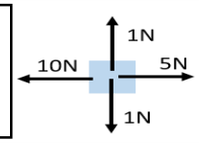
Work done against frictional forces, temperature of object rises.

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

Object moves left with a force of 5N



If force is at right angles to direction of movement, NO work is done.

Work done and energy transfer

Work done	*When work is done, energy is transferred*	Work done = force X distance moved W = F X s
		1J of work is done when 1N of force moves an object through a distance of 1m, in the direction of the force.

Forces and elasticity

One force	*The object changes speed or direction*
More than one force	*The object changes shape*

Two balanced forces can stretch a object.

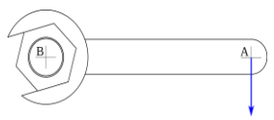
Two balanced forces can compress an object.

Three balanced forces can bend an object.

Elastic deformation	*The object has been stretched but returns to its original length*
Inelastic deformation	*The object has been stretched but does not return to its original length*
Extension	*The difference between stretched and unstretched lengths*

Limit of proportionality

Beyond this point the spring is permanently deformed



Stretching a spring	Force = spring constant X extension, F = k X e
	EPE = ½ X spring constant X (extension)^2, EPE = ½ ke^2

Elastic Potential energy (EPE) — *Energy stored in a stretched spring*

Force	*Newton (N)*
Spring constant	*Newton per metre (N/m)*
Extension	*Metres (m)*
EPE	*Joules (J)*

AQA FORCES – part 2

Describing motion

Aeroplane banks to change direction	Velocity changes.
Car travelling around a bend	Constant speed, direction changes.
Satellite orbiting the Earth	Constant speed, direction changes.

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

Velocity	*The speed of an object with direction*	Vector

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Speed of sound 330m/s.

Speed = distance ÷ time — v = s ÷ t

Speed	*How fast an object moves*	Scalar
Displacement	*Includes the distance and direction an object moves*	vector
Distance	*How far an object moves*	scalar

Car on motorway	*30m/s*	Walking	*1.5m/s*
Train	*60m/s*	Running	*3m/s*
Jet plane	*200m/s*	Cycling	*6m/s*

Speed is rarely constant.

Distance-time graph	*Shows how far an object moves along a straight line*
Speed of object	*Use the gradient of graph*

Gradient = vertical ÷ horizontal

Accelerating objects	*It takes time for objects to reach top speed*	Draw a tangent to the curve, work out gradient.

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Distance travelled	*Area under the graph shape*

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Velocity-time graph	*Shows speed of an object*

Accelerating	*Object getting faster*
Decelerating	*Object slowing down*

Acceleration = change in velocity ÷ time taken

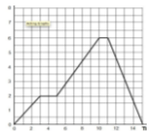
Acceleration	*Change in velocity*	Vector

Constant acceleration

(final velocity)^2 – (initial velocity)^2 = 2 X acceleration X distance

$V^2 - u^2 = 2 \times a \times s$

Forces, acceleration and Newton's Laws of motion



Falling objects

Falling objects accelerate due to gravity.	In no air resistance, objects accelerate at 9.8m/s^2	Air resistance slows falling objects down.

Terminal velocity	*Weight of an object is balanced by resistive forces*	Object moves at a constant velocity. Resultant force = 0.

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Parachuting	*Size of air resistance depends on area of object and speed*
Larger the area, the larger the air resistance.	
Larger the speed, the larger the air resistance.	

Inertia	*When objects continue in the same state of motion*

Speed or direction only changes if a resultant force acts on the object

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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.

Acceleration is proportional to resultant force.

Acceleration is inversely proportional to mass.

Force = mass X acceleration

F = m X a

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

Forces and braking

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

Speed affects both thinking and braking distances.

Typical reaction time = 0.7s

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*

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.

Momentum

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Is a vector

p = m X v

Momentum = mass X velocity

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.

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Changes in momentum

Force is applied to stop momentum

If momentum changes slowly, the force applied is small so less damage.

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Crumple zones

Speed / velocity	*Metres per second (m/s)*
Distance	*Metres (m)*
Time	*Seconds (s)*
Acceleration	*Metres per second squared (m/s^2)*
Force	*Newton (N)*
Mass	*Kilogram (Kg)*
Momentum	*Kilograms metres per second (Kgm/s)*