Combined Science - Physics

CP2 Knowledge organiser

P2: Forces and motion

Lesson sequence

1. Resultant forces
2. Newton's first law
3. Mass and weight
4. Newton's second law
5. Core practical – investigating acceleration (CP12)
6. Newton's third law
7. Momentum (HT)
8. Stopping distances
9. Car safety

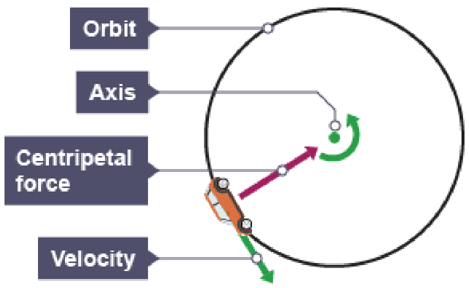
1. Resultant forces

***Scalar quantity**	A quantity with magnitude (but no direction).
***Vector quantity**	A quantity with magnitude and direction.
***Force arrows**	Arrows can be used to represent forces: - Direction = direction of force - Length = size of force
****Resultant force**	The force left over when forces acting in opposite directions are cancelled out.
****Calculating resultant force**	Subtract the total force in one direction from the total force in the other direction.
***Balanced forces**	When the resultant force is zero (because forces acting in opposite directions are the same size).
***Unbalanced forces**	When the resultant force is non-zero (because there is more force in one direction than another).

2. Newton's first law

***Newton's first law of motion**	An object will move at the same speed and direction unless it experiences a resultant force.

****The effect of resultant forces**	Resultant forces cause acceleration: speeding up, slowing down or changing direction
****Effect of forces on motion**	Forces make you start moving, stop moving or change direction, they are not needed to keep you moving!
*****Circular motion**	Moving in a circle is a type of acceleration because you are changing velocity (your direction changes even if your speed does not).
*****Centripetal force**	A force acting towards the centre of a circle that enables objects to move in a circle.
*****Sources of centripetal force**	Gravity – keeps the Earth orbiting the sun Tension – lets a bucket swing in circles on a rope Friction – keeps cars turn round a roundabout



3. Mass and weight

***Mass**	The quantity of matter in an object is made of. Units = kilograms, kg.
***Weight**	A force caused by gravity pulling downward on an object. Units = newtons, N.

***Force meter**	An instrument for measuring forces. They usually involve a spring that stretched more the more the force.
****Gravitational field strength**	The strength of gravity, which is different on different planets. Units = newtons per g=kilogram, N/kg.
****Gravitational field strength on Earth**	10 N/kg
****Calculating weight**	Weight = mass x gravitational field strength W = m x g Weight = N Mass = kg Gravitational field strength = N/kg
****Air resistance**	A force greater by the air pushing against you as you move. Faster movement → greater air resistance.
*****Motion whilst falling**	Accelerate until the air resistance is equal to the weight; now there is no resultant force so speed stays constant.

4. Newton's second law

***Newton's second law of motion**	Force = mass x acceleration
****Acceleration is greater when…**	- The force is greater - The mass is smaller
***Calculating forces**	Force = mass x acceleration F = m x a Force = N Mass = kg Acceleration = m/s^2

***Calculating acceleration**	Acceleration = mass / force a = F / m Force = N Mass = kg Acceleration = m/s^2
*****Inertial mass**	The mass calculated by measuring the acceleration produced by force, using the equation 'm = F / a'
*****The point of inertial mass**	Inertial mass is the same as mass measured with a mass balance, but it gives us a way to measure mass where there is no gravity, such as in space.

5. Core practical – investigating acceleration (CP12)

***CP12 - Aim**	To investigate how changing force changes acceleration.
***CP12 - Setup**	A trolley on a ramp with 90 g masses. 10 g mass hanger attached to trolley via a string over a pulley.
***CP12 – Data collection**	Release the trolley, use light gates to measure the acceleration.
***CP12 – Variations**	Move 10 g of mass from the trolley to the mass hanger each time.
***CP12 – Independent variable**	The force: each 10 g mass = 0.1 N force
***CP12 - Results**	Ore mass → more force → greater acceleration.

6. Newton's third law

***Newton's third law**	For every action force there is an equal but opposite reaction force.
***Action force**	The force you push or pull with.
***Reaction force**	A force of the same size but opposite direction to an action force.
***Action-reaction forces**	If, A applies an action force to B, B applies a reaction force of same size and opposite direction to A.

****Action-reaction vs balanced forces**	Similarities: same sizes, opposite directions Differences: balanced forces act on same object, action-reaction act on different objects
*****Action-reaction forces - collisions**	E.g. kicking a ball: the foot pushes the ball, the ball pushes back on the foot.

7. Momentum (HT)	
***Momentum**	The tendency of an object to keep moving.
***Calculating momentum**	Momentum = mass x velocity field strength p = m x v Momentum = kg m/s Mass = kg velocity = N/kg
Momentum and force calculations	Force = change in momentum / time F = (mv – mu)/t Force = N Mass = kg Velocity = m/s Time = s
*****Conservation of momentum**	Total momentum before and after a collision is the same.

8. Stopping distances	
***Stopping distance**	The distance travelled from when a hazard is seen to when you fully stop.
***Thinking distance**	The distance travelled from when a hazard is seen to when you brake.
***Braking distance**	The distance travelled from when you brake to when you fully stop.
****Calculating stopping distance**	Stopping distance = thinking distance + braking distance

****Thinking distance and reaction time**	Slower reactions = greater thinking distance
****Thinking distance increased by…**	Higher speed, tiredness, illness, drugs, distractions, old age
****Braking distance increased by**	Higher speed, poor brakes, poor tyres, wet/icy/gravelly road, downhill, heavier load

9. Crash hazards	
****Crash danger**	Crashes involve large decelerations, creating large forces which can injure you.
****Car safety features**	Increase the time a collision takes, reducing deceleration and forces.
****Three car safety features**	Crumple zones, (stretchy) seat belts, air bags
*****Collision forces**	Greater momentum change → greater force
****Calculating collision forces**	Force = change in momentum / time F = (mv – mu)/t Force = N Mass = kg Velocity = m/s Time = s