2.1: MOTION AND FORCES

Scalar and Vector Quantities

- **Vector: Magnitude and direction**
  - Velocity
    - Acceleration = Change in Velocity / Time
    - Velocity = Displacement / Time
  - Displacement
  - Momentum
  - Force
  - Acceleration
- **Scalar: Magnitude only**
  - Speed
    - Average Speed = Distance / Time
    - Typical speeds
      - Walking ~ 1.5 m/s
      - Running ~ 3 m/s
      - Cycling ~ 6 m/s
      - Sound ~ 330 m/s
    - Distance Travelled = Average Speed x Time
  - Distance
  - Energy

Experimental Methods

- Ruler drop
  - Experiment to measure human reaction time
    - ~ 0.2–0.9 seconds
- Light gates
  - Removes uncertainty when measuring time
  - No human reaction time

Graphs

- Velocity–Time graphs
  - Gradient = Acceleration
  - Area = Distance
- Distance–Time graphs
  - Gradient = Speed

Vehicles

- Stopping distance
  - = Thinking Distance + Braking Distance
  - Thinking Distance
    - Fatigue, drugs and alcohol
  - Braking Distance
    - Road, weather and vehicle conditions

Weight

- Weight = Mass x Gravitational Field Strength
- Gravitational Field Strength
  - Measured in N/kg
  - Depends on planet
    - Weight also changes with planet
- Measurement
  - Measured with Newton–meter
  - Measured in Newtons

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2.2: MOTION AND FORCES

Momentum

- Measured in kgm/s
- Momentum = mass x velocity
- Conservation
  - Total momentum before event = Total momentum after event
    Assuming no other external forces
  - $m_1v_1 = m_2v_2$
- Collisions
  - Force = rate of change of momentum
  - Seat belts
    - More time to change momentum
    - Smaller rate of change of momentum
    - Lower force

Circular Motion

- Centripetal Force
  - Acts towards centre of circle
    Causes acceleration that changes velocity
- Velocity
  - Speed
    - Stays constant
  - Constantly changing

Newton's Laws

- First Law
  - Velocity of an object only changes if there is a resultant force
  - Object is stationary
  - If resultant force = 0
  - Object moving at constant velocity
- Second Law
  - The acceleration of an object is directly proportional to the resultant force acting on it
- Third Law
  - The forces on interacting objects are equal and opposite
- F = m a
  - Inertial Mass
    - How difficult it is to change object's velocity
  - F = mΔv / t
    - Force = Change in Momentum / Time

KEY

'Higher tier only' written in green.

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