Physics Exam Scope

November 15, 2025

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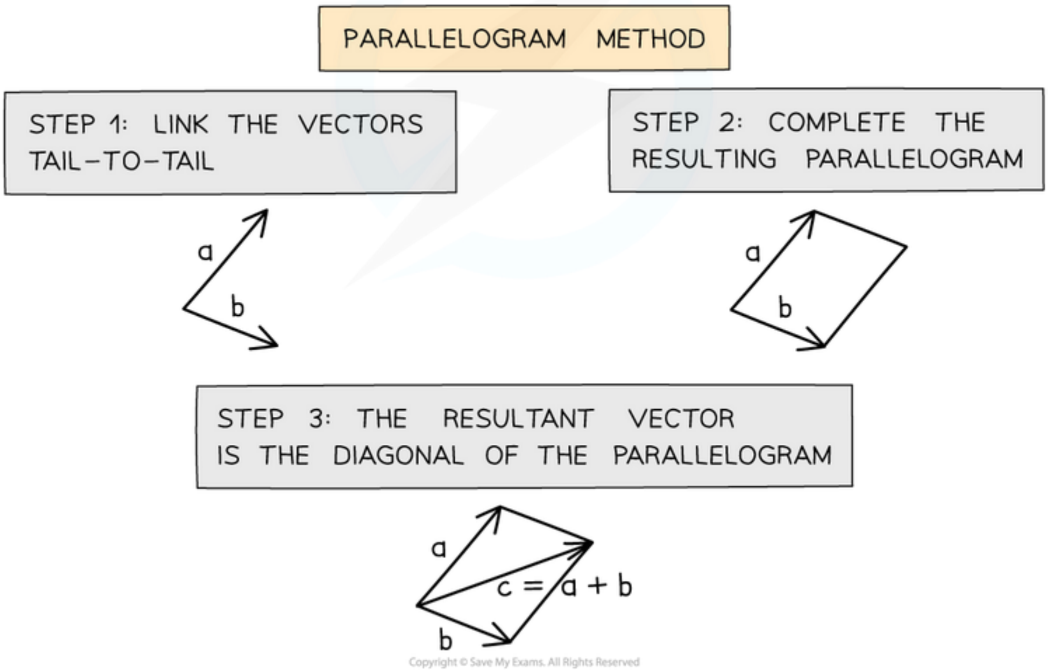
3.1 Forces

- Parallelogram method for resultant forces



- Magnitude scale
  Scale drawings
- Kinetic and gravitational potential energy
  - $KineticEnergy = \frac{1}{2} \times m \times v^2$
  - $GPE = mgh = KineticEnergyLost$
- Energy resources
  - List
    1. Fossil fuels
    2. Biofuels
    3. Water
       * Ocean waves
       * Hydroelectric dams
    4. Geothermal
    5. Nuclear fuel
    6. Light from the Sun
       * Solar cells
    7. Infrared and other EM waves
       * Heat water

        * Solar panels
        * Wind energy
    - Radiation is the main source of energy for all resources except
        1. Geothermal
        2. Nuclear
        3. Tidal
    - Advantages of different energy sources
        * Is it renewable?
        * What fuel does it need?
        * What pollutants does it produce?

- Energy-power relationship(calculation)
    - Equations:
      $WorkDone = Force \times Distance$
      $Power(Watt) = \frac{WorkDone}{Time}$
      $Energy = Power \times Time$

- Moment
  $Moment(Nm^{-1}) = Force(N) \times DistanceFromPivot(m)$ $F_1d_1 = F_2d_2$
    - Use force to find cross-sectional area
      $Pressure(Pa) = \frac{Force(N)}{Area(m^2)}$

3.2 Thermal Physics

- Radiation
  How surfaces affect radiation

	Matt black	Shiny white
Emmision	Good	Bad
Absorbtion	Good	Bad

- Convection
    - How a radiator works
      It uses convection and radiation. Explain radiation specifically
        * Convection
          The main method used by the radiator
            · Steps
            1. The air is heated by the radiator
            2. The hot air rises
            3. It cools down
            4. The cool air falls
            5. It flows to back to the radiator
            6. This repeats

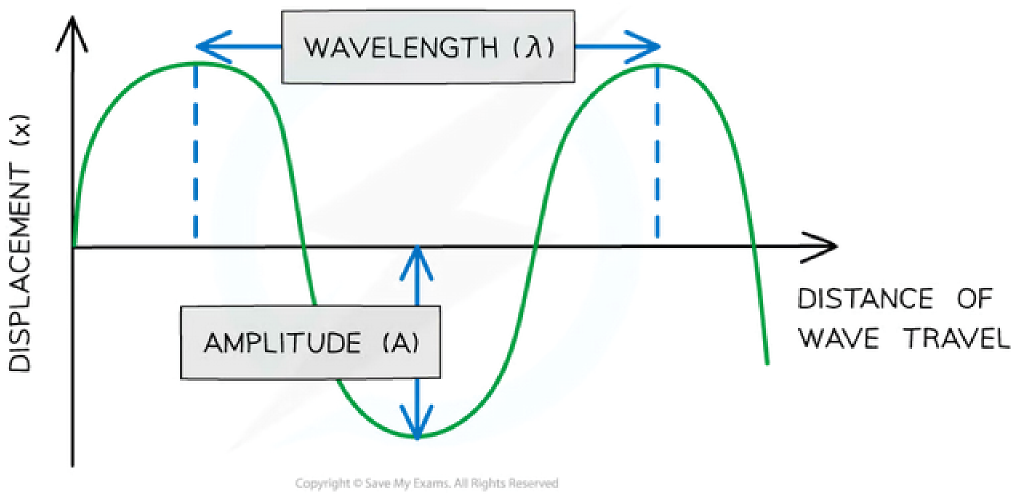
        * Radiation
          Secondary method used by the radiator
            · The infrared radiation given off by the radiator is absorbed by Walls and people near the radiator

- Kinetic theory
  How temperature affects particles
  - Temp ↑, Kinetic energy of particles ↑
  - Arrangement and motion of particles

	Solid	Liquid	Gas
Density	High	Medium	Low
Arrangement	Regular	Random	Random
Movement	Vibrate in place	Move past each other	Move quickly in all directions
Energy	Low	Greater	Greatest

  - Intermolecular forces
    1. Solids
       * They have strong intermolecular forces
       * The particles are held in place
    2. Liquids
       * They have enough energy to overcome their intermolecular forces
       * Their particles are held close together
    3. Gases
       * They have even more energy
       * Their particles move randomly, quickly
       * There are large spaces inbetween gas particles

3.3 Waves



- Diagrams
  Make sure to draw the
  - The normal line
  - The displacement line
- Terminology
  - Parts of a wave diagram
    1. Normal line(time)
    2. Displacement(vertical line)
       It is the distance the wave particles move
    3. Transverse wave
       Oscillates perpendicular to the normal(direction of energy transfer)
       (a) Crest/peak
           The highest point of the wave
       (b) Trough
           The lowest point of the wave
    4. Longitudinal wave
       Oscillates parallel to normal
       (a) Rarefraction
           A point of low pressure
       (b) Compression
           Point of high pressure
       (c) Wavefront
           A line used to represent a single wave
  - Parts of a wave
    1. Frequency(f)
       The number of complete waves per second $Frequency = \frac{1}{Period} = \frac{N.O.Cycles}{Time}$
    2. Period(t)
       The time taken to complete a wave $Period = \frac{1}{Frequency} = \frac{Time}{N.O.Cycles}$
    3. Amplitude(A)
       The maximum distance of a wave from the normal
    4. Wavelength: Lambda Λ
       The length of a wave(distance between 2 points on a wave)
    5. Wave speed
       Speed of wave $Speed = f\Lambda$
- Definition
  When energy is transferred without transferring matter

3.4 Light

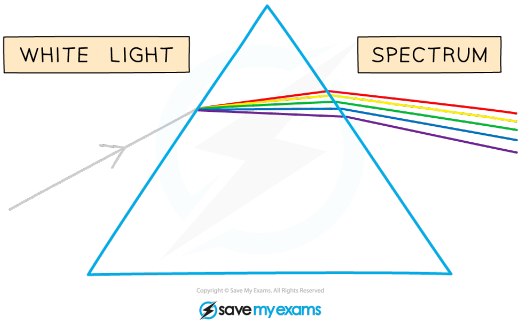
- Refraction calculation
  - Snell's law
    $n_1 sin\theta_1 = n_2 sin\theta_2$

- Refractive index
  $n = \frac{sin\theta_i}{sin\theta_r} = \frac{SpeedOfLightInAir}{SpeedOfLightInMaterial} = \frac{1}{sin\theta_c}$

  $\theta_c = CriticalAngle$

- Misc
  - Optical density ↑, refractive index ↑

- White light dispersion

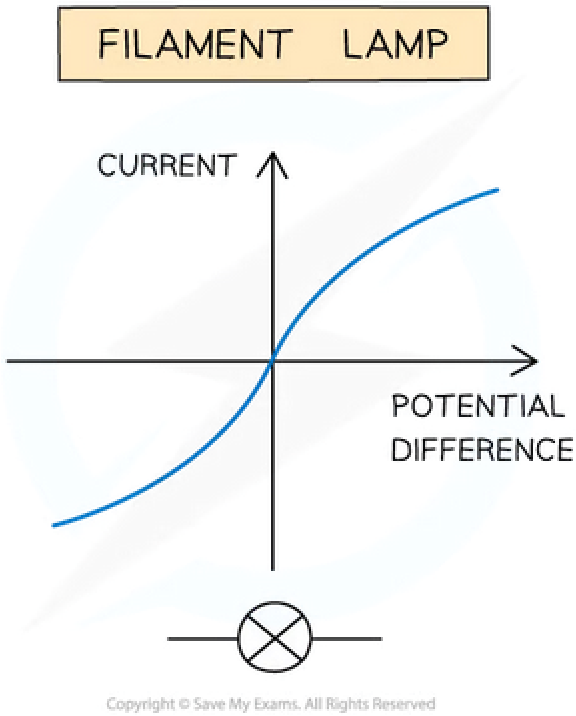


  - Dispersion
    - Definition
      Separation of white light into a spectrum through refraction
    - Explanation
      - Red: Longest wavelength
        So it is refracted the least
      - Violet: Shortest wavelength
        So it is refracted the most

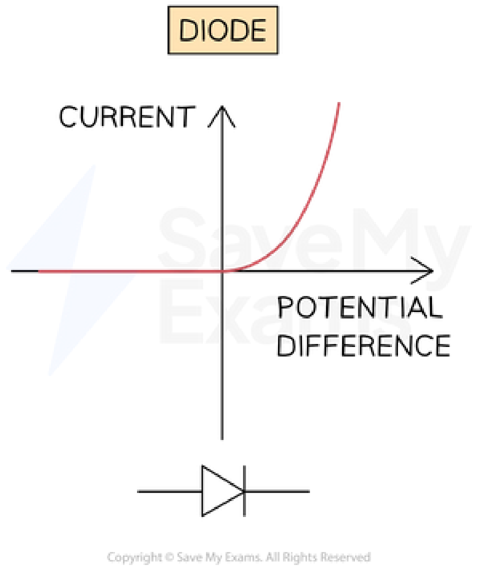
- Misc
  - More optically dense to less
    Light refracted away from normal
  - Less optically dense to more
    Light refracted towards normal

3.5 Electricity

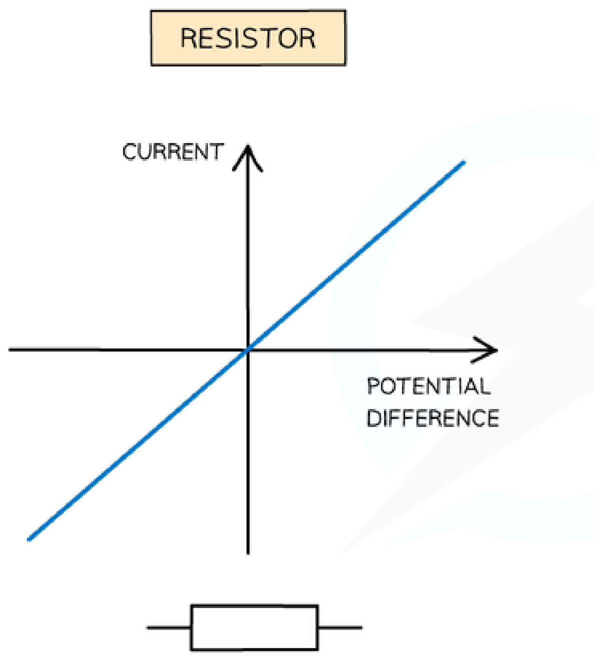
- Filament lamps
  - As heat ↑, resistance ↑
- Resistance, voltage and current calculation $I = \frac{V}{R} = \frac{Q}{t}$ $E.M.F. = \frac{W}{Q}$ $P = IV$ $E(transferred) = ItV$
  - Ohm's Law $R = \frac{V}{I}$
- Current-voltage graphs
  - Filament lamp
    * Kind of looks like a sine wave
    * As voltage gets further from 0
      The current rises less and less



- Diode
  * Like an exponential graph with an asymptote at y = 0
  * The y can only change at one side of the y-axis

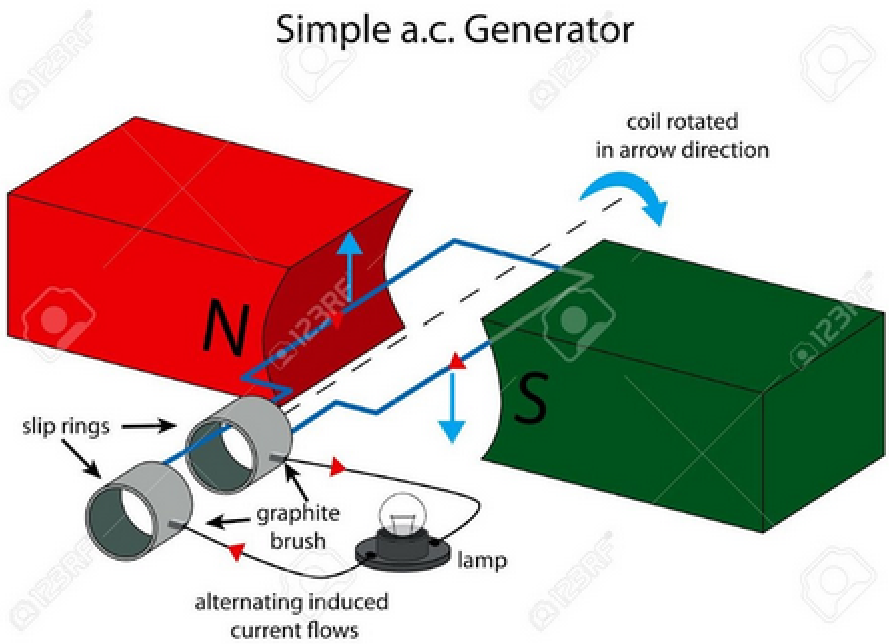


- Constant resistor
  * Looks like y = mx



3.6 Electro-magnetism

- Simple A. C. generator



  - Fleming's right hand rule
  - Components
    1. Coil
       Spun so it cuts the magnetic field lines
    2. 2 slip rings & brushes
       So the contacts are always connected
    3. Magnets
       Generates the magnetic field lines

- Investigating electro-magnetic induction
  How does a magnet induce an electric current?
  - When a conductor cuts the magnetic fields

3.7 Radioactivity

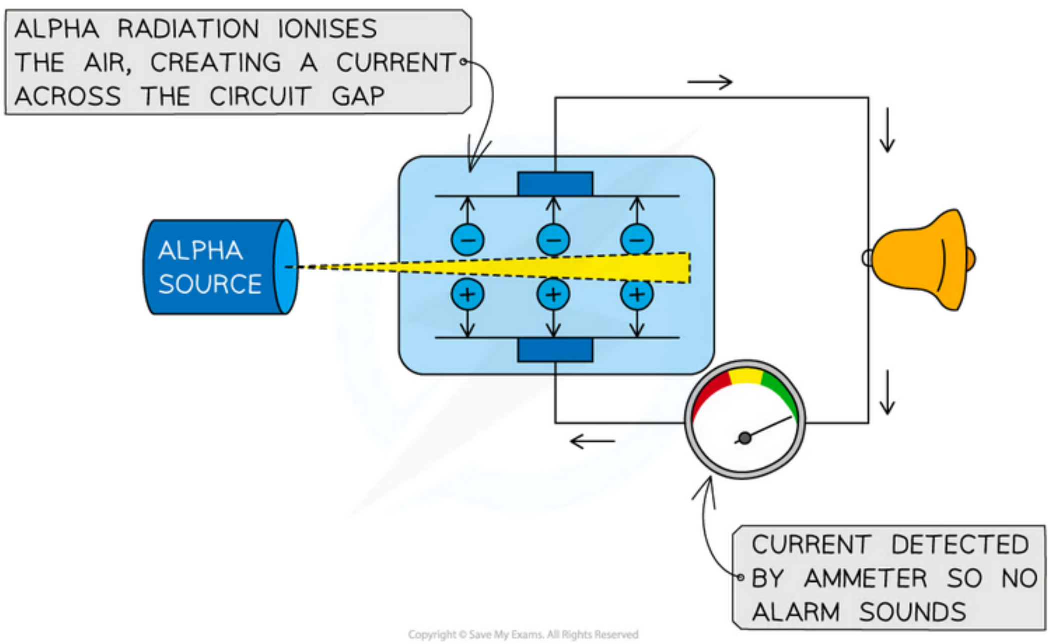
- Applications of alpha, beta and gamma radiation
  1. Household smoke detectors
  2. Irradiating food to kill bacteria
  3. Sterilisation of equipment using gamma rays
  4. Measuring and controlling thicknesses of materials
     e.g. In paper making
  5. Diagnosis and treatment of cancer using gamma rays

- Define ionisation and how does each particle(alpha, beta, gamma) ionise?

	Alpha	Beta	Gamma
Penetration(stopped by)	Low(paper)	Medium(aluminium)	High(lead)
Ionising power	High	Medium	Low

  - Ionising power
    The higher the ionising power the more likely the emission is to remove electrons from the atoms it collides with.
    How strong the ionising power is based on the energy and charge of the emission
    1. Alpha has the highest mass(2) and charge(+2), so it has the highest ionising power
    2. Beta has no mass but a -1 charge, so it has moderate ionising power
    3. Gamma has both no mass and no charge, so it has very weak ionising power
  - Penetration power is the ability of an emission to go through a substance
    It depends on the size and mass of the emission
    * Lead can absorb all emissions

- Smoke detectors
  How they work?



1. There is an alpha emitter in the smoke detector
2. The emitted alpha particles ionise the air and generate a current
   If the current is detected, the alarm doesn't sound
3. When smoke enters the detector, it attaches to the air ions and makes them uncharged
4. The current drop prompts the alarm to start ringing

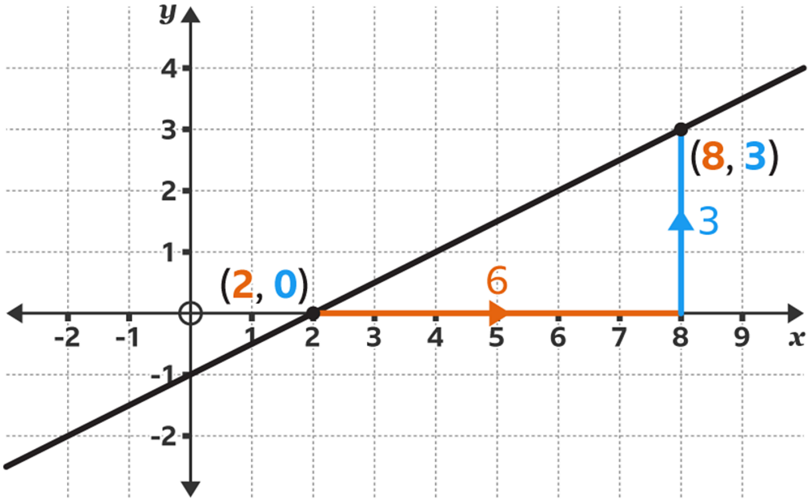
3.8 Space Physics

- Orbital speed calculation $Speed = \frac{2\pi \times AverageRadiusOfOrbit}{OrbitalPeriod}$
- Life cycle of a star
  1. Nebula
     Clouds of gas and dust with hydrogen
  2. Protostar
     When the gravity pulls the gas and dust together
     The GPE is turned into thermal E
  3. Main sequence star
     When forces of attraction and expansion(from nuclear fusion) equal out and the star becomes stable
     The fusion creates heavier elements from hydrogen and helium
  4. Red Giant
     When the helium and hydrogen runs out it becomes cold and red and starts to swell
     If it is large enough it becomes a red supergiant
  5. Death
     - For red giants
       Red giant $\rightarrow$ White dwarf $\rightarrow$ Black dwarf
     - For red supergiants
       * Shrinks then explodes(supernova)
       * Outside dust and gas leave
       * The rest collapses into a neutron star
         If it is large enough it becomes a black hole
  6. Second generation stars
     Stars made from the dust and gas from the supernova of dead stars
- Misc
  - Constants
    * 1 light year = $9.5 \times 10^{15} m$
    * Diameter of milky way = 100, 000 light years
    * Hubble constant $H_0 = 2.2 \times 10^{-18}$
      · Its equation $H_0 = \frac{v}{d}$
        v is velocity the galaxy is moving away from Earth
        d is the distance from Earth
  - Age of the universe $\frac{d}{v} = \frac{1}{H_0}$

4 Paper 6

4.1 Misc

- Calculating gradient
  - Use the triangle method



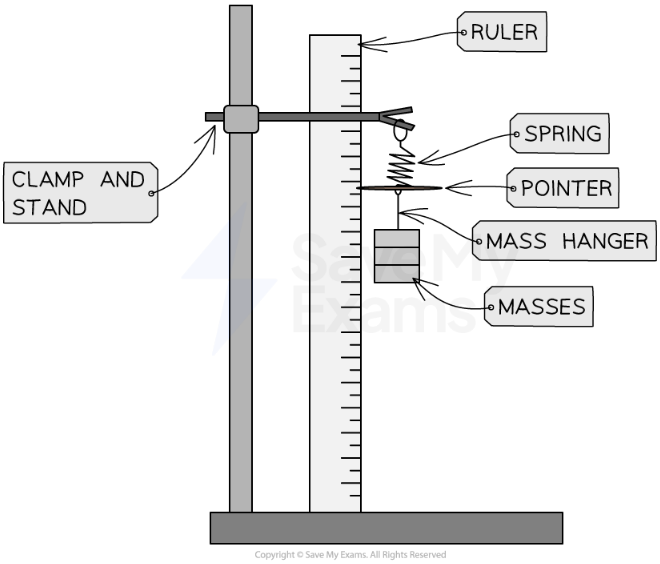
1. Form a triangle with the 2 furthest points on the graph
2. Measure the change in x and y
3. Calculate the gradient

- Read measuring cylinders from the bottom of the meniscus

4.2 Forces

- Hooke's Law
  - Definition
    The extension of an elastic object is directly proportional to the force applied, up to the limit of proportionality
  - Calculation $F(N) = k(\frac{N}{cm})x(cm)$
    k = Spring's constant($\frac{N}{cm}$), x = extension
  - Limit of proportionality
    As you increase the force on a spring, there is a point at which the extension is no longer proportional(doesn't follow Hooke's Law)

- Experiment



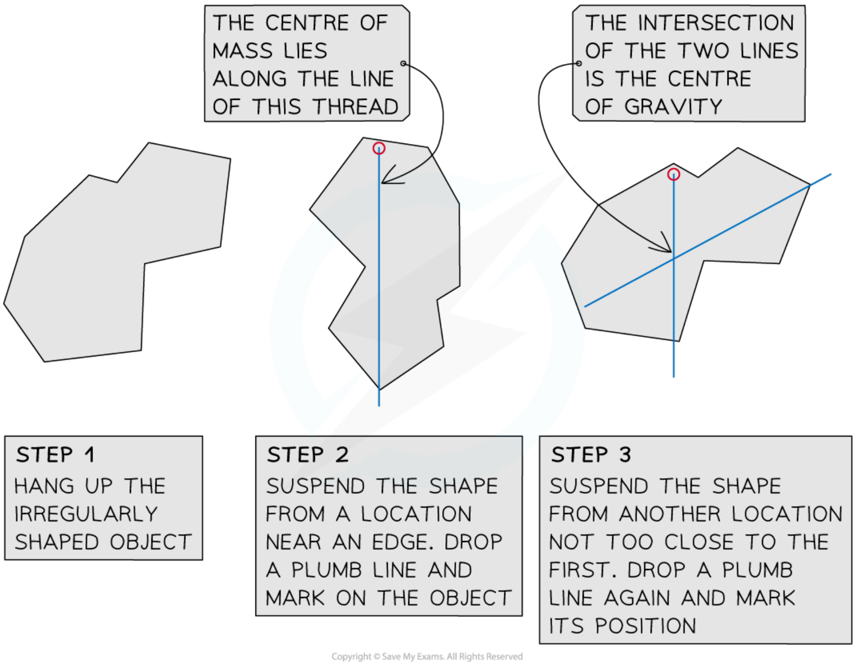
  - Materials
    1. Clamp and stand
    2. Ruler
    3. Spring
    4. Masses
    5. Pointer
  - Process
    1. Set up the apparatus according to the diagram
    2. Measure the natural length(no load) of the spring with the ruler
    3. Add mass to the spring and measure the new length
       Get the extension length by subtracting the natural length with the new length
    4. Repeat with all masses
  - Possible errors
    1. Parallax error
       If your eye is not perpendicular to the spring and ruler, it will give a false reading

4.3 Electricity

- Resistance of a diode
  How is it different to a filament lamp?
  - A diode has very high resistance in only one direction
  - A filament's resistance increases as the temperature increases
    - High current causes the lamp to heat up
- Draw circuit
  Remember the symbols

4.4 Planned experiment

- Moment & centre of gravity
  - Inventigating the centre of gravity of objects



    * Materials
        1. Plane lamina
           To be investigated
        2. Plumb line
        3. Pencil
    * Process
        1. Suspend the plane lamina and the plumb line from the same pivot
        2. Draw a line along the line on the lamina
        3. Suspend again from another point
        4. Draw a second line along the line
        5. The intersection between the lines as the centre of gravity