Physics Required Practicals

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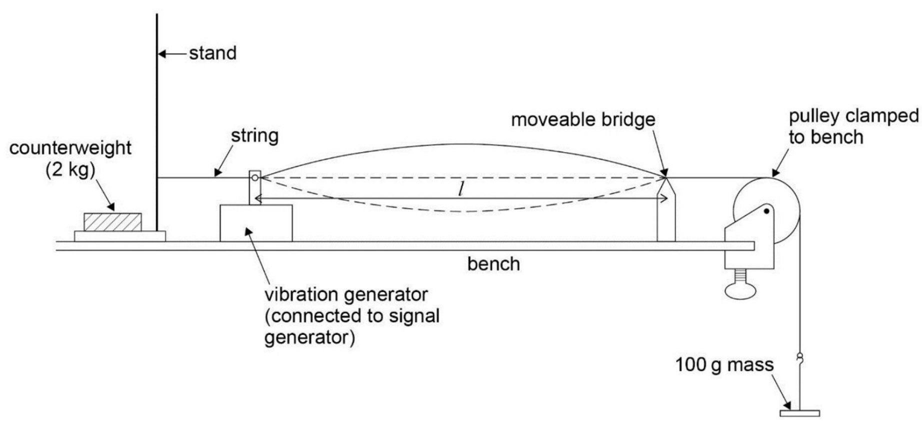
General writeup tricks: always use at least 10 different values, give specific figures e.g. measure every 5 seconds. Repeat twice more if needed.

1 Stationary waves

1.1 Methodology



1. Use signal generator connected to a vibration generator to produce the vibrations
2. Adjust the frequency until a first harmonic is produced on the string
3. Plot a graph of f against $\frac{1}{l}$ / $\frac{1}{\sqrt{\mu}}$ / $\sqrt{T}$ (to find the other variables using the gradient of the graph)

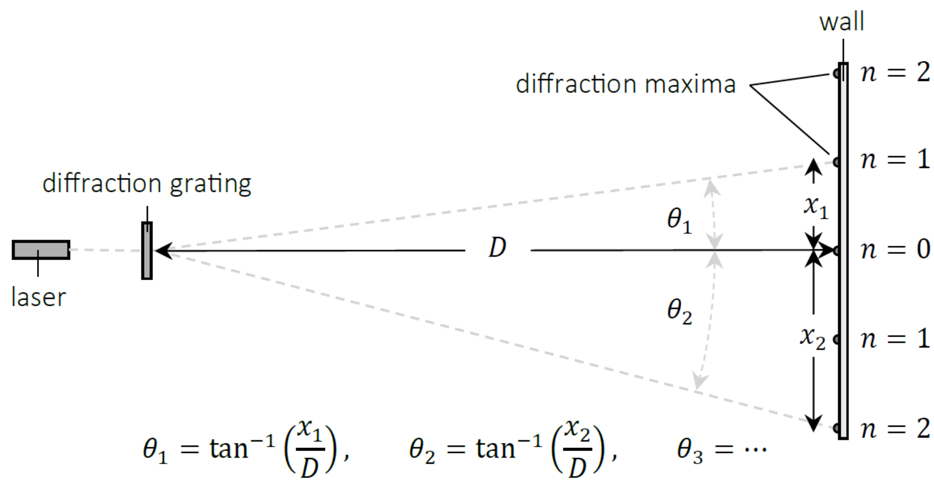
1.2 Sources of errors

1.2.1 Random errors

- Difficult to pinpoint where the amplitude is the greatest
- Difficult to ensure that the correct distance between nodes / antinodes is measured
- Metre rule might not be accurate enough

2 Young's double slit and diffraction gratings

2.1 Methodology



2.1.1 Determining slit separation in a double slit

1. Illuminate a double slit with a laser of known wavelength λ
2. Project the interference pattern onto a screen D meters away
3. Measure the average fringe spacing
4. $w = \frac{\lambda}{s} \times D$ so $s = \frac{\lambda}{\text{gradient}}$

2.1.2 Finding wavelength of light

Similar to the method above, but we use a double slit with a known spacing s and we still plot a graph of w against D, so $\lambda = s \times \text{gradient}$.

2.1.3 Determining average grating spacing d

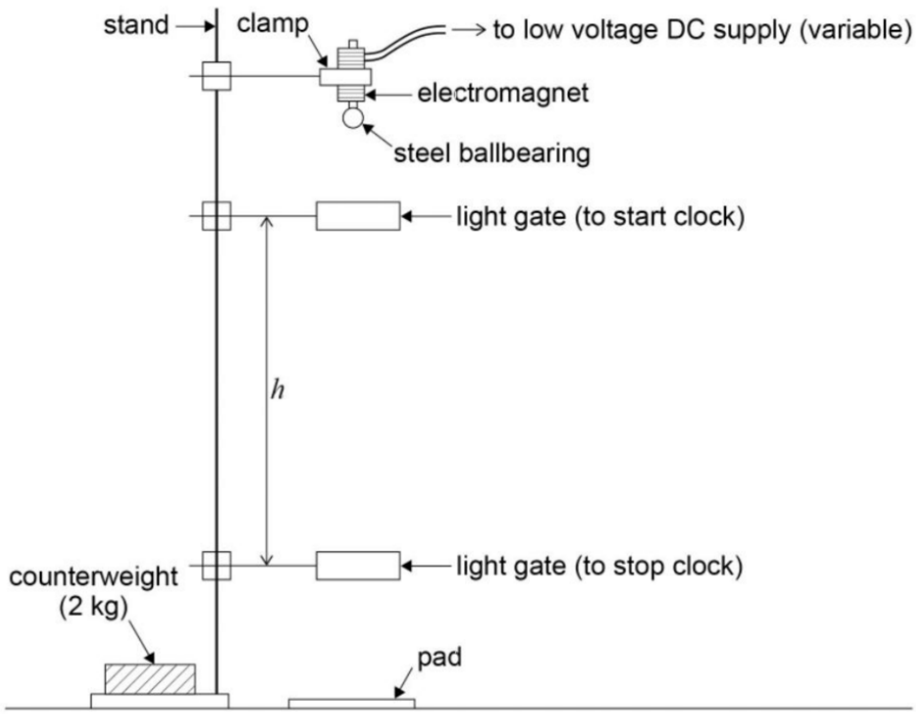
1. Illuminate a diffraction grating with a laser of known wavelength λ
2. Project the pattern onto a screen at a fixed distance D away
3. Measure the angles of diffraction θ_n for multiple maxima ($\theta_n = \tan^{-1}\left(\frac{x_n}{D}\right)$)
4. Plot a graph of $\sin\theta_n$ against n, so gradient $= \frac{\lambda}{d}$

2.2 Safety precautions

- Don't shine laser as people
- Don't look at laser (even reflected)
- Wear safety goggles
- Don't shine the laser at reflective surfaces
- Display warning signs

3 Determining g

3.1 Methodology



1. Keep the upper light gate at a constant distance from the electromagnet
2. Change the distance h between the two light gates by adjusting the position of the lower light gate
3. Measure the time t it takes to pass from the upper light gate to the lower light gate
4. Using $h = ut + \frac{1}{2}gt^2$: $\frac{2h}{t} = 2u + gt$ (assume that the initial speed u at the first light gate is constant
5. Plot a graph of $\frac{2h}{t}$ against t: gradient $= g$

3.2 Safety precautions

- The electromagnet requires current so keep dry

- Cushion / soft surface used to catch the ball so it doesn't damage the surface / roll off

3.3 Sources of errors

3.3.1 Random errors

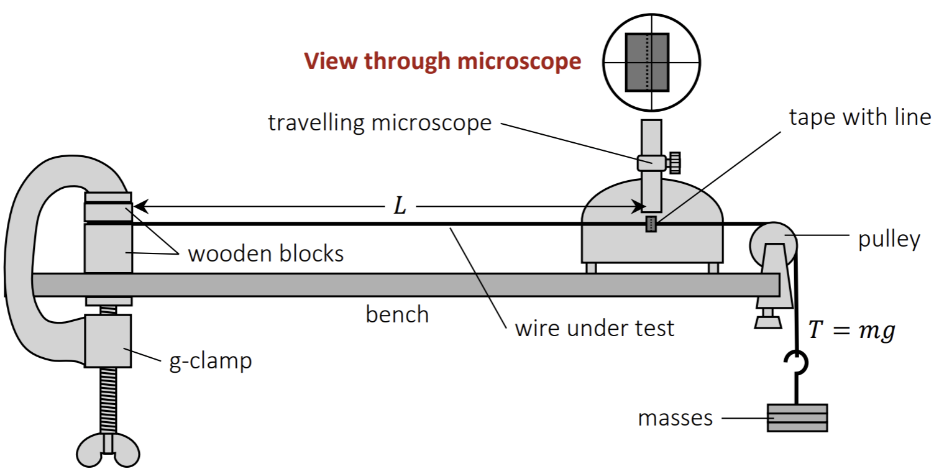
- The ball might not fall through the centre of the light gate so the time that it obscures the light at the gate is reduced
- Parallax error for reading h

3.3.2 Systematic errors

- Air resistance reducing the value of g measured
- The meter rule used to measure the distance between light gates might not be perfectly upright which increases the distance measured

4 Young Modulus

4.1 Methodology



1. Measure the diameter of a wire with a micrometer (measure in several places + several directions and calculate the mean diameter after removing the anomalies)
2. Measure the original length of the wire with meter rule

3. Mark a cross onto the wire with the tape
4. Align the travelling microscope with the cross
5. Add load and align the travelling microscope with the cross again
6. Measure the amount of extension
7. Repeat this for a range of loads (up to the limit of proportionality)
8. Calculate the tensile stress and strain of the wire at various points
9. Plot a graph of stress against strain and $E =$ gradient

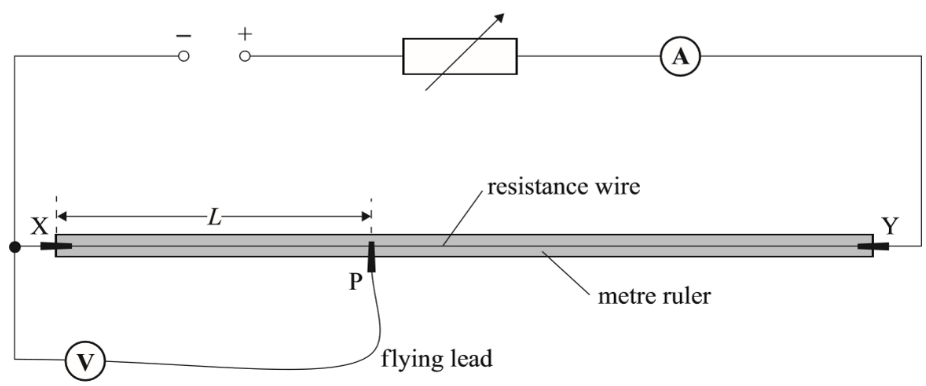
4.2 Sources of errors

4.2.1 Random errors

- Extension might be too small to be measured accurately (even to nearest mm)

5 Resistivity of a wire

5.1 Methodology



1. Adjust the voltage of the power supply / variable resistor to keep current at a constant value
2. Adjust the flying lead for various lengths of the wire
3. Read off V and I value from voltmeter and ammeter and calculate $R = \frac{V}{I}$

4. Plot a graph of resistance against length

5. Measure the diameter of wire with micrometer (measure from multiple points and take mean) so cross sectional area $A = \frac{\pi d^2}{4}$

6. $\rho = \text{gradient} \times A$

5.2 Sources of errors

5.2.1 Random errors

- Diameter of wire may vary along the line
- Current of the wire will heat up the wire and increase its resistivity

5.2.2 Systematic errors

- Non-ideal voltmeter and ammeter
- Voltmeter and ammeter not zeroed correctly

6 EMF and internal resistance

6.1 Methodology

1. Measure the load voltage V for various current I by adjusting the total resistance of the circuit

2. Plot a graph of V against I

3. $r = -\text{gradient}$, $\varepsilon = \text{y-intercept}$

6.2 Sources of errors

6.2.1 Random errors

- Current in the circuit can cause the circuit and the cell to increase and cause the internal resistance to increase so the switch should be turned off when not in use

6.2.2 Systematic errors

- Non-ideal voltmeter and ammeter
- Voltmeter and ammeter not zeroed correctly

7 Simple harmonic motion

7.1 Methodology

7.1.1 Mass-spring system

1. Measure the time T^2 period with different masses m
2. Plot a graph of T^2 against m and a straight line relationship should be seen (gradient = $\frac{4\pi^2}{k}$)
3. This can be used to find the spring constant

7.1.2 Pendulum

1. Measure the time T^2 period with different lengths of pendulum l
2. Plot a graph of T^2 against m and a straight line relationship should be seen (gradient = $\frac{4\pi^2}{g}$)
3. This can be used to determine g

7.2 Sources of errors

7.2.1 Random errors

- Difficult to determine when the spring / pendulum has completed a cycle - use fiducial marker to help, place at equilibrium position where the system has the highest speed

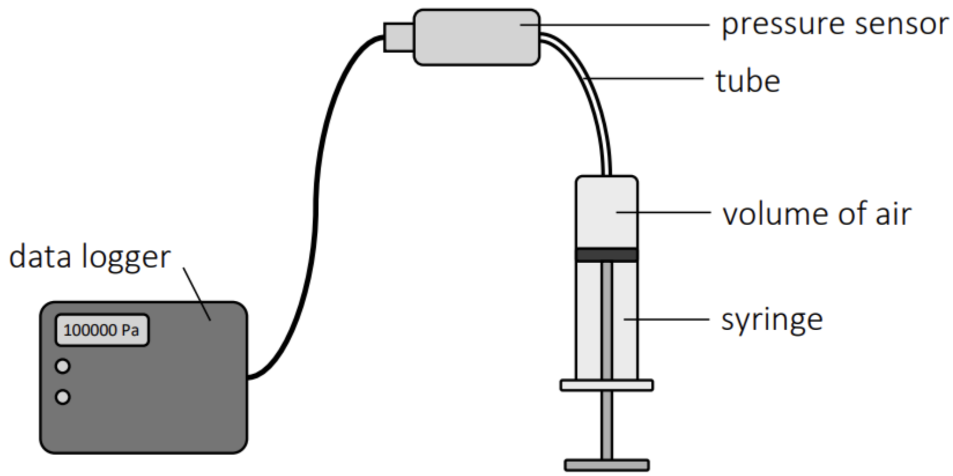
7.2.2 Systematic errors

- Human reaction time for measuring time periods

8 The gas laws

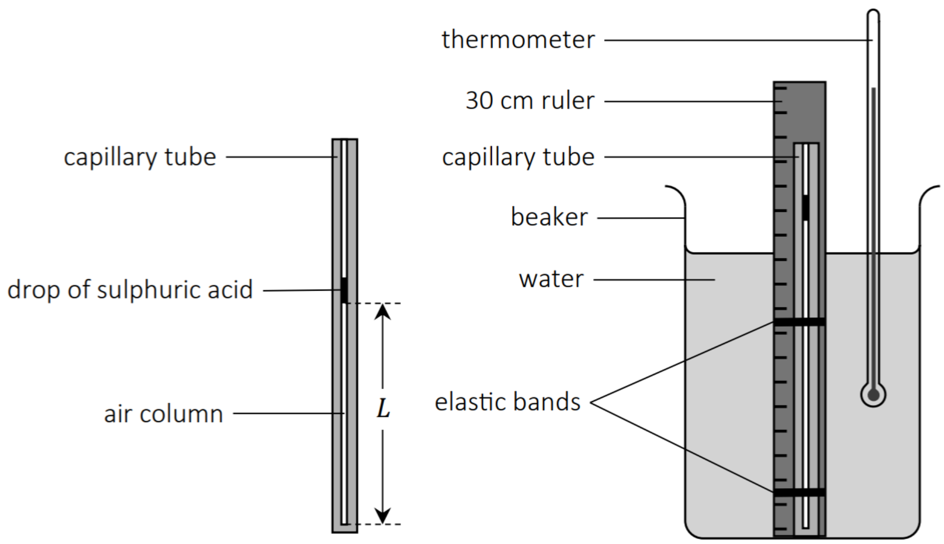
8.1 Methodology

8.1.1 Boyle's Law



1. Set the syringe to a fixed volume and attach it to the tubing
2. Take a series of pressure-volume readings
3. Plot a graph of $\log V$ against $\log P$ - gradient should be -1

8.1.2 Charle's Law



1. Make sure the open end of the capillary tube is at the top when placed in the beaker
2. By varying the temperature of the water obtain values of the length (and hence volume) of the air sample for a range of different temperatures
3. Plot a graph of V against T
4. Extrapolate to $V = 0$ to find an value of absolute zero

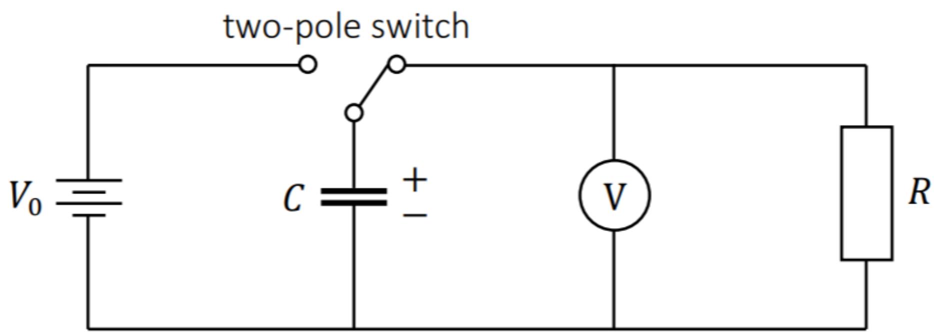
8.2 Sources of errors

- The temperature of gas in syringe might change as we compress / expand it - minimise change by changing the volume slowly
- Parallax error when measuring the length of air column
- The temperature of the water vary continuously so the length might change whilst reading

9 Charging and discharging capacitors

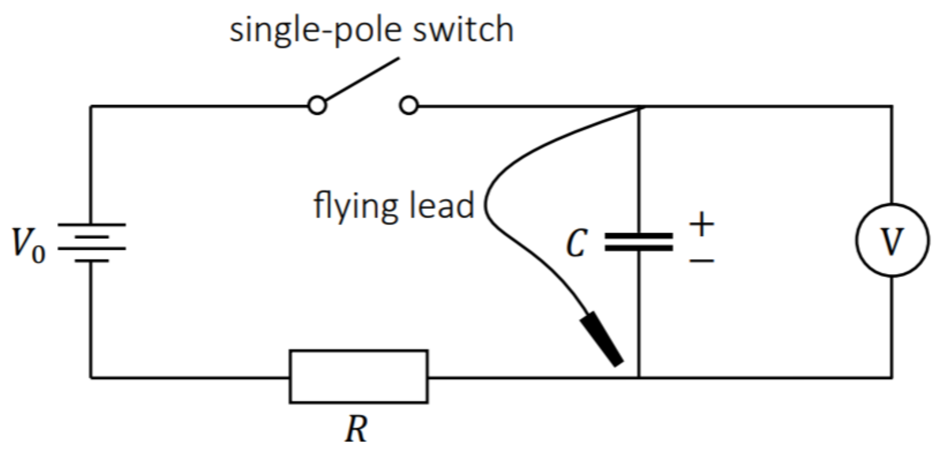
9.1 Methodology

9.1.1 Discharging a capacitor



1. Charge the capacitor fully
2. Record the charged voltage V_0
3. Turn the switch to the right so the capacitor discharges
4. Measure the value of V at fixed intervals
5. Plot a graph of $\ln \frac{V}{V_0}$ against t so gradient $= -\frac{1}{RC}$

9.1.2 Charging a capacitor



1. Discharge the capacitor fully by short-circuiting the capacitor with a flying lead

2. Close the switch to start charging
3. Measure the value of V at fixed intervals
4. Record the final voltage V_{max}
5. Plot a graph of $\ln\left(1 - \frac{V}{V_{\text{max}}}\right)$ against t so gradient $= -\frac{1}{RC}$

9.2 Sources of errors

9.2.1 Random errors

- Human reaction time with timings

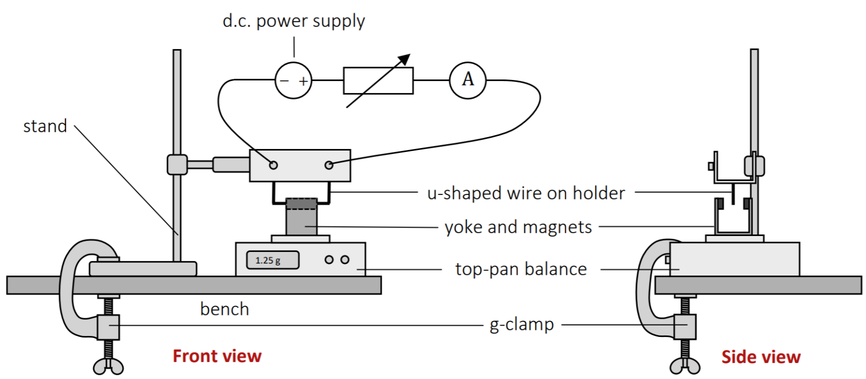
9.2.2 Systematic errors

- Circuit heats up after use which increases the resistance and hence increases the time constant
- The charging slows with time so we might have recorded a value of V_{max} that is less than the actual value

10 Magnetic force on a wire

10.1 Methodology

10.1.1 Force against current



1. Adjust current by adjusting the resistance of the variable resistor
2. Measure the mass reading on the balance and convert to weight

3. Plot a graph of weight against current

10.1.2 Force against length

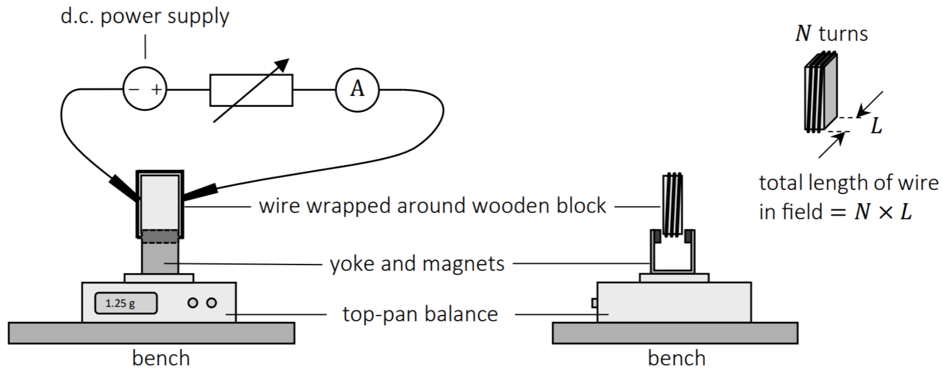


Figure 10-2: Experimental setup to investigate the effect of length on force.

1. Use a constant current but change the number of turns of wire on the block
2. Plot a graph of weight against length in the magnetic field

10.2 Sources of errors

10.2.1 Random errors

- Currently changing due to heating in the wire
- Reading on the mass balance can fluctuate

10.2.2 Systematic errors

- Wire not perfectly perpendicular to the field so actual length in the field is less than measured
- Wire wrapped at an angle so actual length longer
- Mass balance not zeroed correctly

11 Magnetic flux linkage

11.1 Methodology

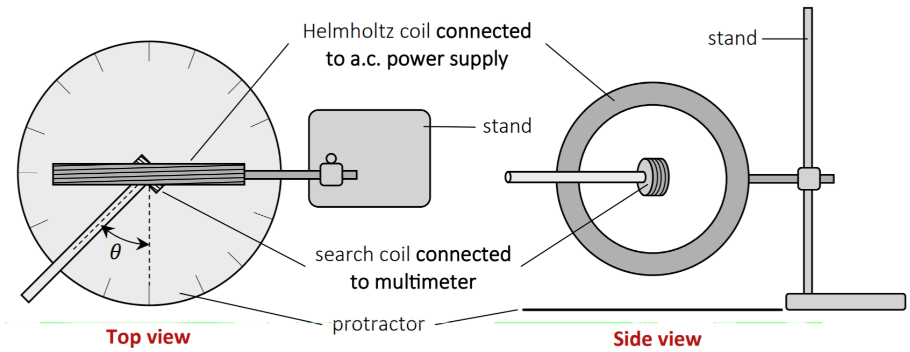


Figure 11-1: Experimental setup to investigate flux linkage.

1. Put the search coil at the centre of the Helmholtz coil
2. Vary the angle θ between the search coil and the normal of the Helmholtz coil
3. Record the ε reading for each value of θ
4. Plot a graph of ϵ against $\cos\theta$ and a straight line relationship should be seen

11.2 Sources of errors

11.2.1 Random errors

- Parallax error when measuring θ from above

11.2.2 Systematic errors

- Wire might not be put exactly at the centre of the coil so the magnitude of EMF drops
- Resistance of the wire in the search coil lowers ε as some voltage is dissipated in the wire

12 Inverse square law

12.1 Methodology

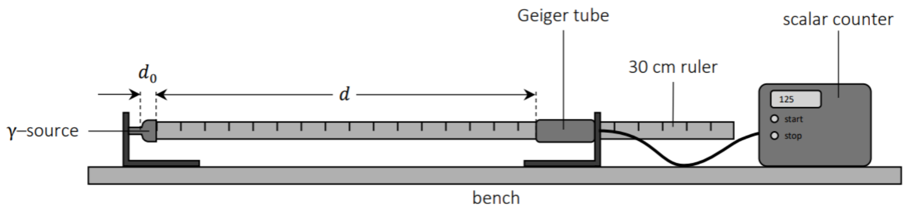


Figure 12-1: Experimental setup to investigate the inverse square law.

1. Measure the background count rate (over a long period)

2. Find the corrected count rate C at various distances d

3. To find d_0: plot a graph of d against $\sqrt{\frac{1}{C-C_0}}$ and $d_0 = -$y-intercept

12.2 Safety precautions

- Do not point the gamma radiation source at others / do not look into the source

- Remove the source from room and seal in lead container when unused

- Use tongs / tweezers to handle source

- Stand behind a lead absorber / screen

- Read local rules

12.3 Sources of errors

12.3.1 Random errors

- Background count rate might alter randomly during the measurement process

- The gamma radiation source might not be directly pointed to the counter which means that there are less count recorded than expected

- The gamma radiation's decay rate varies from time to time since it is a random process so we might not have measured the actual decay rate

12.3.2 Systematic errors

- The gamma radiation might slightly lose its strength when penetrating through the GM tube's wall so the actual count rate is higher than recorded
- The ionisation rate is calculated as the average of the ionisation rate of the area around the tube, however, since the radiation weakens with distance, the ionisation rate varies across the tube