# A Level Core Practicals

# A-Level Physics Practicals

This document covers the core practical procedures across the A-Level Physics course, organized by module

---

# Module 3: Mechanics

## 1. Investigating Motion and Collisions

Focuses on verifying momentum conservation or investigating the relationship between force and acceleration.

**Equipment**

- Trolleys or air track gliders
- Air track or friction-compensated ramp
- Light gates and a digital data logger
- Interrupter cards (of known length)
- Masses and string (if investigating $F=ma$)

**Method & Data Analysis**

1. Set up the air track or ramp. If using a ramp, tilt it slightly to compensate for friction.
2. Attach an interrupter card to the trolley and set up two light gates.
3. For a collision, place one trolley at rest and launch the second toward it.
4. Record initial velocity ($u$) and final velocities ($v$) using light gates.
5. Measure the mass of each trolley.
6. **Data Analysis:** Compare initial momentum ($m_1u_1 + m_2u_2$) to final momentum ($m_1v_1 + m_2v_2$).
7. **Data Analysis:** Calculate kinetic energy ($1/2mv^2$) to determine if the collision was elastic.

**Improving Accuracy**

- Use an air track to eliminate friction.

- Ensure interrupter cards are vertical and measured precisely.
- Repeat measurements and calculate a mean.

### Safety

- Use a "catch box" to stop trolleys falling.
- Securely attach masses to the string.

---

## 2. Determining Acceleration of Free Fall ($g$)

Measuring $g$ using a falling object and electronic timing.

### Equipment

- Electromagnet and steel ball bearing
- Trapdoor and base unit
- Electronic timer or data logger
- Metre ruler and plumb line

### Method & Data Analysis

1. Position the electromagnet at height ($h$) above the trapdoor.
2. Release the ball; the timer starts on release and stops when the trapdoor is hit.
3. Repeat for at least five different heights.
4. **Data Analysis:** Use $h = 1/2gt^2$ (from $s = ut + 1/2at^2$ where $u=0$).
5. **Data Analysis:** Plot $h$ vs $t^2$. Gradient = $g/2$.

### Improving Accuracy

- Use a small, dense ball to minimize air resistance.
- Measure height from the bottom of the ball to the top of the trapdoor.

### Safety

- Switch off electromagnet when not in use.
- Keep floor clear of trip hazards.

---

## 3. Determining Terminal Velocity in Fluids

Investigating motion when drag force equals weight.

### Equipment

- Large transparent cylinder

- Viscous liquid (Glycerol or heavy oil)
- Steel ball bearings (varying sizes)
- Stopwatch and rubber bands (for markers)

**Method & Data Analysis**

1. Mark equal intervals on the cylinder using rubber bands.
2. Drop the ball bearing into the center.
3. Record time at each marker; constant time between markers indicates terminal velocity.
4. **Data Analysis:** Calculate $v = \Delta s / \Delta t$.
5. **Data Analysis:** Plot velocity vs time; the plateau is terminal velocity.

**Improving Accuracy**

- Drop in the center to avoid "wall effects."
- Use a tall enough cylinder to ensure terminal velocity is reached.
- Use video analysis for more precise timing.

**Safety**

- Clean spills immediately (slippery).
- Wear goggles to prevent splashes.

---

# 4. Experimental Determination of Centre of Gravity

Using the principle of moments to locate the balancing point.

**Equipment**

- Irregularly shaped flat object (lamina)
- Plumb line (string and weight)
- Clamp stand, pin, and pencil

**Method & Data Analysis**

1. Make three holes near the edges of the lamina.
2. Suspend the lamina and plumb line from a pin through one hole.
3. Mark the path of the plumb line on the lamina.
4. Repeat for other holes.
5. **Data Analysis:** The intersection of the lines is the centre of gravity.

**Improving Accuracy**

- Ensure the lamina swings freely.
- Use a thin, sharp pencil for lines.
- Space holes widely around the perimeter.

### Safety

- Take care with pins to avoid finger pricks.
- Secure the clamp stand to the desk.

---

## 5. Investigating Force-Extension Characteristics

Applying Hooke’s Law to determine material stiffness.

### Equipment

- Helical spring, rubber band, or polythene strip
- Clamp stand and slotted masses
- Millimetre ruler and set square

### Method & Data Analysis

1. Measure original length ($l_0$).
2. Add masses in increments, recording the new length ($l$).
3. Calculate extension $x = l - l_0$.
4. Unload masses to check for plastic deformation.
5. **Data Analysis:** Plot Force vs Extension.
6. **Data Analysis:** Gradient of linear section is the spring constant ($k$) where $F = kx$.

### Improving Accuracy

- Use a set square to avoid parallax error.
- Wait for oscillations to stop before reading.

### Safety

- Wear goggles in case the spring snaps.
- Use a padded box under masses to protect feet.

---

# Module 4: Electrons, Waves, and Photons

# 6. Determining the Young Modulus

Determining stiffness by measuring the ratio of tensile stress to tensile strain.

**Equipment**

- Long, thin metal wire
- G-clamp, pulley, and slotted masses
- Micrometer and travelling microscope

**Method & Data Analysis**

1. Measure wire diameter in several places to find average area ($A$).
2. Measure original length ($L$) from clamp to marker.
3. Add masses and measure extension ($\Delta L$) using a travelling microscope.
4. **Data Analysis:** Calculate stress ($\sigma = F/A$) and strain ($\varepsilon = \Delta L/L$).
5. **Data Analysis:** Plot Stress vs Strain. Gradient = Young Modulus ($E$).

**Improving Accuracy**

- Use a long wire (3m+) for larger extensions.
- Ensure the wire is straight and free of kinks.

**Safety**

- Wear goggles; wire can whip if it snaps.
- Use a padded box for falling weights.

---

# 7. Investigating Electrical Characteristics (I-V)

Examining how current varies with potential difference across components.

**Equipment**

- Variable DC power supply or rheostat
- Ammeter and Voltmeter
- Components: Resistor, filament lamp, diode, thermistor

**Method & Data Analysis**

1. Connect component in series with ammeter and variable resistor.
2. Connect voltmeter in parallel across the component.
3. Vary potential difference and record $I$ and $V$.
4. Reverse connections for negative readings.
5. **Data Analysis:** Plot $I$ vs $V$.

**Improving Accuracy**

- Use a potential divider for better control at low voltages.
- Switch off between readings to prevent heating.

**Safety**

- Components can become hot; avoid touching during operation.

---

# 8. Determining the Resistivity of a Metal

Calculating material-specific property independent of dimensions.

**Equipment**

- Resistance wire and micrometer
- Ammeter, Voltmeter, and metre ruler
- Jockey or crocodile clips

**Method & Data Analysis**

1. Measure wire diameter to find area ($A$).
2. Vary the length ($L$) of wire in the circuit.
3. Record Resistance ($R = V/I$) for each length.
4. **Data Analysis:** Plot $R$ vs $L$. Gradient = $\rho/A$.
5. **Data Analysis:** $\rho = \text{gradient} \times A$.

**Improving Accuracy**

- Pull wire taut against the ruler.
- Use low current to minimize heating.

**Safety**

- Wire can become very hot; do not touch while power is on.

---

# 9. Determining Internal Resistance

Investigating terminal voltage drop under load.

**Equipment**

- Cell, variable resistor, and switch
- Ammeter and Voltmeter

**Method & Data Analysis**

1. Record e.m.f. ($\varepsilon$) with switch open ($I=0$).
2. Close switch and vary current ($I$) using the variable resistor.
3. Record terminal voltage ($V$) and $I$.
4. **Data Analysis:** Use $V = \varepsilon - Ir$.
5. **Data Analysis:** Plot $V$ vs $I$. y-intercept = $\varepsilon$, magnitude of gradient = $r$.

**Improving Accuracy**

- Use a new battery for stable readings.
- Close switch only briefly for each reading.

**Safety**

- Avoid short circuits to prevent cell damage or leaks.

---

# 10. Investigating Potential Divider Circuits

Creating specific output voltages using resistor combinations.

**Equipment**

- Power supply, fixed resistors
- Thermistor or LDR
- Voltmeter, water bath/lamp

**Method & Data Analysis**

1. Set up two components in series.
2. Measure $V_{out}$ across one component.
3. Vary temperature (thermistor) or light (LDR).
4. **Data Analysis:** Compare to $V_{out} = V_{in} \times (R_2 / (R_1 + R_2))$.

**Improving Accuracy**

- Keep thermometer and thermistor close together.
- Measure distance to light source for LDR.

**Safety**

- Keep water away from power supplies.

---

# 11. Using an Oscilloscope to Determine Frequency

Measuring time periods to calculate wave frequency.

**Equipment**

- Oscilloscope (CRO)
- Signal generator

**Method & Data Analysis**

1. Connect signal generator to CRO.
2. Adjust Time-base to see at least one full cycle.
3. Measure horizontal divisions for one cycle.
4. Calculate Period ($T$) = divisions $\times$ Time-base.
5. **Data Analysis:** Frequency $f = 1/T$.

**Improving Accuracy**

- Measure across multiple cycles and divide.
- Align cycle start with a major grid line.

**Safety**

- Ensure equipment is PAT tested.

---

# 12. Demonstrating Wave Effects in a Ripple Tank

Visualizing reflection, refraction, and diffraction.

**Equipment**

- Ripple tank, motor-driven dipper
- Strobe light
- Barriers and glass blocks

**Method & Data Analysis**

1. Set up shallow water and constant dipper frequency.
2. Use strobe to "freeze" waves.
3. Use barriers for reflection/diffraction and glass blocks for refraction.

4. **Data Analysis:** Measure $\lambda$; calculate $v = f\lambda$.

**Improving Accuracy**

- Use a strobe for stable measurements.
- Ensure tank is level and on a damped surface.

**Safety**

- Keep water away from electricity.
- Be aware of strobe sensitivity (epilepsy).

---

# 13. Observing Polarising Effects

Demonstrating transverse wave planes.

**Equipment**

- Microwave transmitter/receiver and metal grille
- Light source and polarising filters

**Method & Data Analysis**

1. **Light:** Rotate one filter relative to another; observe intensity changes.
2. **Microwaves:** Rotate metal grille between transmitter and receiver.
3. **Data Analysis:** Note absorption when wires are parallel to electric field oscillation.

**Improving Accuracy**

- Use a digital light sensor.
- Keep metal objects away from microwave path.

**Safety**

- Do not look directly at high-intensity light.

---

# 14. Investigating Refraction and Total Internal Reflection

Mapping light paths across media boundaries.

**Equipment**

- Ray box, glass blocks (rectangular and semi-circular)
- Protractor and paper

### Method & Data Analysis

1. Trace block outline and entry/exit rays.
2. Measure angles of incidence ($i$) and refraction ($r$).
3. For TIR, use semi-circular block and increase $i$ until refraction disappears.
4. **Data Analysis:** Plot $\sin i$ vs $\sin r$. Gradient = $n$.
5. **Data Analysis:** Verify $n = 1 / \sin C$.

### Improving Accuracy

- Use a thin ray and sharp pencil.
- Use a large protractor.

### Safety

- Ray boxes get hot; turn off when not in use.

---

# 15. Superposition Experiments

Investigating interference patterns from coherent sources.

### Equipment

- Two speakers/Laser/Microwaves
- Double-slit slide and screen

### Method & Data Analysis

1. Shine laser through double-slit.
2. Measure slit separation ($d$), distance to screen ($D$), and fringe width ($w$).
3. **Data Analysis:** $\lambda = \frac{dw}{D}$.

### Improving Accuracy

- Ensure $D$ is large ($2\text{m}+$).
- Measure across several fringes and divide.

### Safety

- **Laser Safety:** Never look directly into the beam.

---

# 16. Determining the Wavelength of Light

Using diffraction to measure nanometer-scale wavelengths.

**Equipment**

- Laser, diffraction grating
- Metre ruler and tape measure

**Method & Data Analysis**

1. Shine laser through grating onto screen.
2. Measure distance to screen ($D$) and distance to maxima ($x$).
3. Calculate slit separation $d$ from lines per mm.
4. **Data Analysis:** Use $d \sin \theta = n\lambda$ where $\tan \theta = x/D$.

**Improving Accuracy**

- Large $D$ reduces percentage uncertainty.
- Measure between orders (e.g., $+1$ to $-1$) and divide.

**Safety**

- Standard laser safety protocols.

---

# 17. Observing Stationary Waves

Demonstrating interference forming nodes and antinodes.

**Equipment**

- Vibration generator, signal generator
- String, pulley, and weights

**Method & Data Analysis**

1. Vary frequency until a standing wave forms.
2. Find harmonics.
3. **Data Analysis:** Node-to-node distance = $\lambda/2$.
4. **Data Analysis:** Calculate $v = f\lambda$.

**Improving Accuracy**

- Use a sharp bridge for the fixed end.
- Repeat for multiple harmonics.

**Safety**

- Wear goggles in case the string snaps.

---

# 18. Determining the Speed of Sound in Air

Using resonance in a closed pipe.

**Equipment**

- Resonance tube, cylinder of water
- Tuning forks, metre ruler

**Method & Data Analysis**

1. Hold vibrating fork over tube and raise from water until resonance.
2. Measure air column length ($L$).
3. **Data Analysis:** First resonance $L + c = v/4f$ ($c$ is end correction).
4. **Data Analysis:** Plot $L$ vs $1/f$. Gradient = $v/4$.

**Improving Accuracy**

- Average length from raising and lowering.
- Perform end correction.

**Safety**

- Mop up water spills.

---

# 19. Determining the Planck Constant ($h$)

Using LED "turn-on" voltage.

**Equipment**

- LEDs of different wavelengths
- Power supply, voltmeter, resistor

**Method & Data Analysis**

1. Increase voltage until LED just glows; record threshold $V_0$.
2. Repeat for different colors.
3. **Data Analysis:** $eV_0 = hc/\lambda$.
4. **Data Analysis:** Plot $V_0$ vs $1/\lambda$. Gradient = $hc/e$.

#### Improving Accuracy

- Use a dark room to see initial glow.
- Extrapolate $I-V$ graph to $I=0$.

#### Safety

- Do not exceed LED current rating.

---

## 20. Demonstration of the Photoelectric Effect

Evidence for light as a particle.

#### Equipment

- Gold-leaf electroscope, zinc plate
- UV lamp, emery paper

#### Method & Data Analysis

1. Clean zinc plate and place on negatively charged electroscope.
2. Shine UV; leaf falls as electrons emit.
3. Repeat with glass (absorbs UV) or positive charge (no emission).
4. **Data Analysis:** $hf = \Phi + KE_{max}$.

#### Improving Accuracy

- Ensure zinc is freshly sanded.
- Use a dry room.

#### Safety

- **UV Safety:** Wear UV-filtering goggles; do not look at lamp.

---

# Module 5: Newtonian World and Astrophysics

## 21. Experimental Evidence of Electron Diffraction

Demonstrating wave-like nature of electrons.

### Equipment

- Electron diffraction tube
- EHT power supply

### Method & Data Analysis

1. Accelerate electrons through graphite target.
2. Measure diffraction ring diameters ($D$) on screen.
3. **Data Analysis:** Calculate $\lambda = \frac{h}{\sqrt{2meV}}$.
4. **Data Analysis:** Verify with $n\lambda = d \sin \theta$.

### Improving Accuracy

- Darkened room for visibility.
- Measure at multiple voltages.

### Safety

- **High Voltage:** Do not touch terminals.
- **Fragile Vacuum:** Handle tube with care.

---

## 22. Observing Brownian Motion

Evidence for kinetic theory of gases.

### Equipment

- Smoke cell, microscope, lamp

### Method & Data Analysis

1. Seal smoke in cell and illuminate from side.
2. Observe random, jerky motion under microscope.
3. **Data Analysis:** Conclude bombardment by invisible air molecules.

### Improving Accuracy

- Ensure cell is airtight.
- Let lamp warm up to avoid convection.

### Safety

- Use matches/smoke in ventilated area.

# 23. Determining Specific Heat Capacity

Measuring energy to raise material temperature.

**Equipment**

- Metal block, immersion heater, thermometer
- Ammeter, Voltmeter, Stopwatch, Insulation

**Method & Data Analysis**

1. Measure mass ($m$) and insulate block.
2. Record Temperature vs Time while heating.
3. **Data Analysis:** $E = VIt$.
4. **Data Analysis:** $P = mc \times (\Delta \theta / \Delta t)$.

**Improving Accuracy**

- Use oil in holes for thermal contact.
- Measure max temperature after heater is off.

**Safety**

- Heater gets very hot; use only when submerged.

# 24. Determining Specific Latent Heat

Energy for change of state at constant temperature.

**Equipment**

- Ice/Water, immersion heaters, balances

**Method & Data Analysis**

1. Use a "test" and "control" setup for melting ice.
2. Measure mass melted by heater ($m = m_{test} - m_{control}$).
3. **Data Analysis:** $L_f = VIt / m$.

**Improving Accuracy**

- Ensure ice is at $0\text{°C}$.
- Steady boil for vaporisation.

### Safety

- Avoid steam burns and keep water from electronics.

---

# 25. Investigating Gas Laws

Exploring P, V, and T relationships.

### Equipment

- Boyle’s Law apparatus, constant volume bulb
- Pressure gauge, water bath

### Method & Data Analysis

1. **Boyle:** Plot $P$ vs $1/V$.
2. **Pressure:** Plot $P$ vs $T$ (Celsius); extrapolate to $P=0$ for absolute zero.

### Improving Accuracy

- Change volume slowly (isothermal).
- Submerge entire gas volume in water bath.

### Safety

- Do not exceed pressure limits.

---

# 26. Investigating Circular Motion

Relationship between force, mass, velocity, and radius.

### Equipment

- Rubber bung, tube, string, masses
- Stopwatch, balance, ruler

### Method & Data Analysis

1. Whirl bung in horizontal circle with hanging mass providing centripetal force ($F=Mg$).
2. Maintain constant radius ($r$) and record time for 20 rotations.
3. **Data Analysis:** Calculate $v = 2\pi r / T$.
4. **Data Analysis:** Plot $F$ vs $v^2$. Gradient = $m/r$.

### Improving Accuracy

- Use slow-motion camera for rotations.
- Whirl as horizontally as possible.

**Safety**

- Clear "no-go" zone for swinging bung.
- Wear goggles.

---

## 27. Determining Period/Frequency of SHM

Factors affecting oscillating systems.

**Equipment**

- Masses, spring or pendulum
- Stopwatch, fiducial marker

**Method & Data Analysis**

1. Displace mass and record time for 20 oscillations.
2. Vary mass (spring) or length (pendulum).
3. **Data Analysis (Spring):** Plot $T^2$ vs $m$. Gradient = $4\pi^2/k$.
4. **Data Analysis (Pendulum):** Plot $T^2$ vs $L$. Gradient = $4\pi^2/g$.

**Improving Accuracy**

- Use fiducial marker at equilibrium.
- Small angles ($<10^\circ$) for pendulum.

**Safety**

- Padded catch box for falling masses.

---

# Module 6: Particles and Medical Physics

## 28. Investigating Capacitors in Combination

Verifying series and parallel rules.

**Equipment**

- Capacitors, multimeters

**Method & Data Analysis**

1. Measure $C_{total}$ for series and parallel arrangements.
2. **Data Analysis:** Parallel $C_{total} = \sum C$; Series $1/C_{total} = \sum 1/C$.

**Improving Accuracy**

- Account for zero error of meter.

**Safety**

- Check polarity of electrolytic capacitors.

---

# 29. Investigating Capacitor Charge and Discharge

Exponential decay of voltage/current.

**Equipment**

- Capacitor, resistor, DC source, stopwatch

**Method & Data Analysis**

1. Charge capacitor then discharge through resistor.
2. Record $V$ vs time.
3. **Data Analysis:** Plot $\ln V$ vs $t$. Gradient = $-1/RC$.
4. **Data Analysis:** Time constant $\tau$ is time to fall to $37%$.

**Improving Accuracy**

- Use high-resistance voltmeter.

**Safety**

- Capacitors store energy; discharge safely.

---

# 30. Determining Magnetic Flux Density ($B$)

Using a current balance to measure force.

**Equipment**

- Magnets, top-pan balance, stiff wire
- Power supply, ammeter

**Method & Data Analysis**

1. Place magnets on balance and tare.
2. Run current through wire between magnets.
3. Record mass change ($\Delta m$) for different currents ($I$).
4. **Data Analysis:** $F = \Delta mg$. Plot $F$ vs $I$. Gradient = $BL$.

**Improving Accuracy**

- Wire must be perfectly perpendicular to field.
- Use high-precision balance.

**Safety**

- Strong magnets (keep away from cards/pacemakers).

---

# 31. Investigating Magnetic Flux with Search Coils

Mapping field strength and orientation.

**Equipment**

- Search coil, solenoid, signal generator, CRO

**Method & Data Analysis**

1. Place search coil in solenoid with AC field.
2. Record induced e.m.f. ($V_0$).
3. Vary angle ($\theta$) or position.
4. **Data Analysis:** $V_0 \propto BAN\omega$.

**Improving Accuracy**

- High frequency for larger e.m.f.
- Keep away from other metal objects.

**Safety**

- Do not let solenoid overheat.

---

# 32. Investigating Transformers

Turn ratios and voltage relationships.

**Equipment**

- C-cores, copper wire, AC supply, voltmeters

**Method & Data Analysis**

1. Wrap primary and secondary coils on C-cores.
2. Measure $V_p$ and $V_s$ for different $N_s$.
3. **Data Analysis:** $\frac{V_s}{V_p} = \frac{N_s}{N_p}$.

**Improving Accuracy**

- Clamp cores tightly.
- Laminated cores reduce losses.

**Safety**

- **Low Voltage AC Only.**

---

# 33. Absorption of Alpha, Beta, and Gamma Radiation

Testing penetrating power.

**Equipment**

- Sources, G-M tube and counter
- Absorbers: Paper, Aluminum, Lead

**Method & Data Analysis**

1. Measure background count.
2. Measure count rate with source and different absorbers.
3. **Data Analysis:** Use corrected count rate (Total - Background).

**Improving Accuracy**

- Long counting times.
- Constant source-tube distance.

**Safety**

- **Time, Distance, Shielding.** Use forceps.

---

# 34. Determining the Half-Life of an Isotope

Measuring decay rate over time.

**Equipment**

- Protactinium generator, G-M tube, data logger

**Method & Data Analysis**

1. Shake generator and record count rate every 10s.
2. **Data Analysis:** Plot corrected count rate vs time.
3. **Data Analysis:** Find time to halve ($t_{1/2}$). Or plot $\ln(\text{Count Rate})$ vs $t$; gradient = $-\lambda$.

**Improving Accuracy**

- Start readings immediately after shaking.

**Safety**

- Sealed source but handle with care.

---

# 35. Simulation of Radioactive Decay

Statistical model using dice.

**Equipment**

- Large number of dice

**Method & Data Analysis**

1. Roll dice and remove those showing a "6".
2. Record remaining dice ($N$) vs throw number ($t$).
3. **Data Analysis:** Plot $N$ vs $t$ for exponential curve.
4. **Data Analysis:** Verify $\lambda = 1/6$.

### Improving Accuracy

- Use large starting number (500+).

---

Revision #3
Created 2026-04-26 13:35:06 UTC by Asad
Updated 2026-04-26 14:01:50 UTC by Asad