LESSON 6.1.2
Choosing Methods
Fields, Thermodynamics and Oscillations

Choose the measurement that answers the question, then check that its range, response and uncertainty suit the physical effect.

QUESTION → SIGNAL → METHOD → RESULT

1. FIELDS

Map magnetic field at different positions?

Read a suitably ranged magnetic probe and record position. To test magnetic force instead, measure force on a current-carrying wire.

2. THERMODYNAMICS

Measure heating or a change of state?

For specific heat capacity, measure energy and temperature rise. During a phase change, measure energy and mass changed instead.

3. OSCILLATIONS

Find just the period, or the motion shape?

Time many cycles for a mean period. Use a motion trace if you also need displacement, amplitude, phase or damping.

A STRONG JUSTIFICATION NAMES A LIMIT

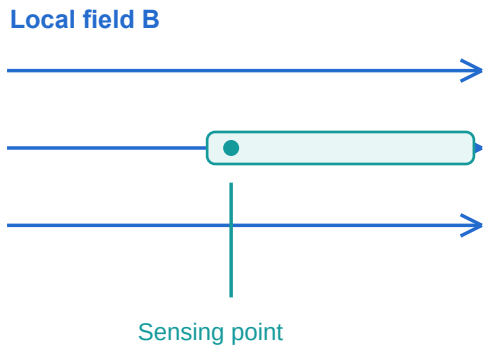
State the expected reading, the instrument range and resolution, the dominant error, and the check that reveals it. A digital display does not guarantee accuracy.

Curriculum: Pearson IAL Physics, Unit 6 planning, pp. 39-40.

1 Fields: direct or indirect?

Choose a magnetic probe to map B at a point. Choose a force measurement to investigate how a current-carrying wire interacts with B.

A. MAGNETIC PROBE: POSITION AND ORIENTATION MATTER



Align the sensitive axis with the field using the probe instructions. A single-axis sensor reads a component, not automatically the full magnitude.

Keep orientation fixed; measure position from the sensing element. Zero in a defined reference field and check calibration.

Select a range that will not saturate. Earth's field and nearby magnetic objects may affect weak-field readings. A zero taken with the source off measures changes relative to that background.

B. FORCE METHOD: TEST THE INTERACTION

$$F = BIL \sin\theta \qquad \text{at } 90°: B = \frac{F}{IL}$$

Use a fixed straight length L in an approximately uniform field, perpendicular to B. Vary current I and measure force with a force sensor or the reaction on the magnets using a balance. Keep the wire mechanically separate from the balance.

ILLUSTRATIVE BALANCE READING

Change in balance reading: 0.50 g; I = 1.00 A; L = 0.050 m.

$$B = \frac{0.00050 \times 9.81}{1.00 \times 0.050} = 0.098\ \text{T}$$

Use F = |Δm|g, with mass in kg. A graph of F against I has gradient BL at 90°. Only the wire length within the uniform field counts. Check force zero and background before each series.

Limit current to avoid hot wires; switch off before moving contacts. Secure magnets and keep fingers clear of pinch points.

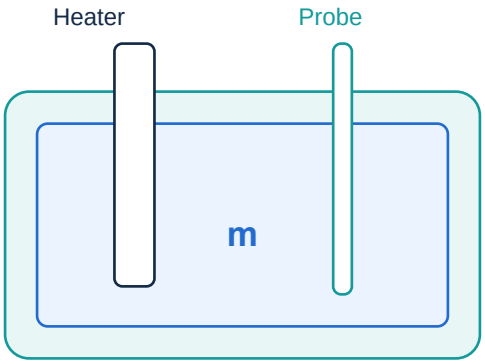
Probe technique: Vernier Magnetic Field Sensor manual (check your actual model).

Physics reference: OpenStax University Physics 2, §11.4.

2 Thermal methods: track the energy

Specific heat capacity c links energy input to temperature change. Specific latent heat L links energy input to mass changing phase.

A. ELECTRICAL HEATING OF A SOLID BLOCK



Block mass m; insulating jacket

Weigh the block. Fit the heater and temperature probe closely, using suitable thermal contact material. Measure V across the heater and I through it.

Record temperature against time at measured, nearly constant electrical power. Include a baseline before heating.

$$E = VIt \qquad c \approx \frac{VIt}{m\Delta\theta}$$

This estimate assumes negligible energy loss and negligible heating of the apparatus. A plot of temperature against time gives slope s; ideally c = VI/(ms). Inspect curvature and probe lag before selecting a fit interval.

EXAMPLE: 12.0 V, 2.00 A, 300 s; m = 1.00 kg, Δθ = 8.0 K

$$c \approx \frac{12.0 \times 2.00 \times 300}{1.00 \times 8.0} = 900 \text{ J kg}^{-1} \text{ K}^{-1}$$

Use insulation and a modest temperature rise above room temperature. Heat escaping or heating the apparatus reduces the block's rise, making the uncorrected value of c too high. Allow for sensor response and uneven block temperature.

B. PHASE CHANGE: MEASURE MASS, NOT A TEMPERATURE RISE

For steady melting or boiling, measure the mass changed during a timed interval and account for background energy transfer. The ideal relation is E = LΔm; temperature alone cannot tell you how much material changed phase.

Choose a probe with a suitable temperature range and response time; compare it against a reference. For gas-law work, use absolute pressure and Kelvin temperature, and let the gas return to the intended temperature before reading.

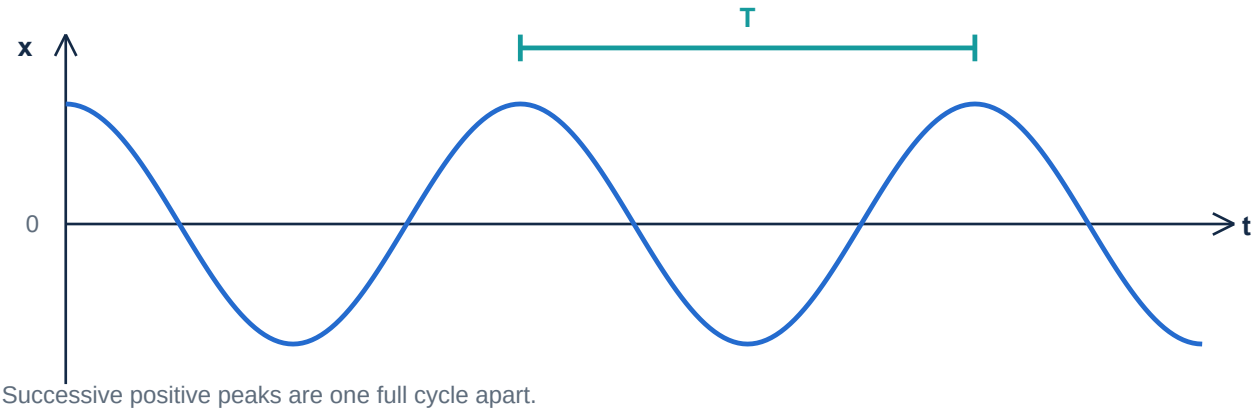
Safety: use a low-voltage heater, protect from burns, and never seal a boiling vessel.

Physics reference: OpenStax University Physics 2, §1.4; Pearson specification p. 33.

3 Oscillations: choose the time record

A timer gives event times. A displacement sensor gives the shape of the motion. Choose according to the quantity you need, not just the available equipment.

DISPLACEMENT-TIME TRACE: ONE PERIOD RETURNS TO THE SAME PHASE



Successive positive peaks are one full cycle apart.

A. STOPWATCH + FIXED MARKER

For a slow, clearly visible oscillator, time N complete cycles at the same point in the same direction. Repeat the run and average periods. Count cycles, not every crossing.

B. LIGHT GATE + ELECTRONIC TIMER

For repeatable crossings, remove manual start/stop delay. Verify the gate mode: adjacent equilibrium crossings are half a period apart; same-direction crossings are a full period apart.

C. MOTION SENSOR + DATA LOGGER

For displacement, amplitude and damping, record x against time. Keep the target in range and sample many times per cycle. Check the trace for missed peaks, noise or reflections.

ILLUSTRATIVE TIMING CHECK

$$T = \frac{12.00\ \text{s}}{20} = 0.600\ \text{s} \qquad f = \frac{1}{T} = 1.67\ \text{Hz}$$

A ±0.20 s uncertainty in the total time gives ±0.010 s in T (1.7%). At 100 samples/s, a 0.600 s cycle has 60 samples: a useful starting choice, not a guarantee of accuracy.

Keep the chosen mass, spring and release conditions fixed unless they are the variable. Secure the support and loads; ensure motion stays inside the sensor's working range.

References: OpenStax University Physics 1, §15.1; Pearson Student Practical Guide.

Next: 6.1.3 Controlling variables in complex experiments.