

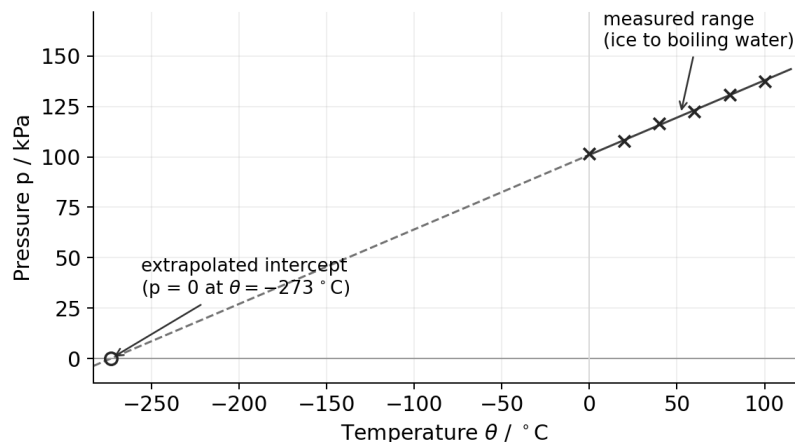
Exercise walk-through

6.2

Implementation and measurement critique

Pearson Edexcel · International A-Level · Physics

Plan an extrapolation to absolute zero



- 1 **Range** ice to boiling water bounds the measured temperatures
- 2 **Readings** at least five paired pressure and temperature values, stirred and perpendicular
- 3 **Graph** best-fit line extended to zero pressure; the intercept estimates -273°C

Time many oscillations, mark the centre

Displace the mass a small distance and release.



Start timing only after several oscillations, at the centre marker.

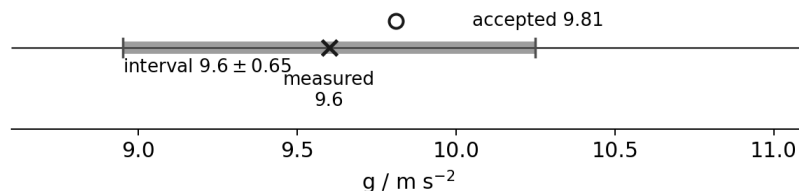


Time ten oscillations; repeat and record the totals.



Divide the mean total by ten for the period.

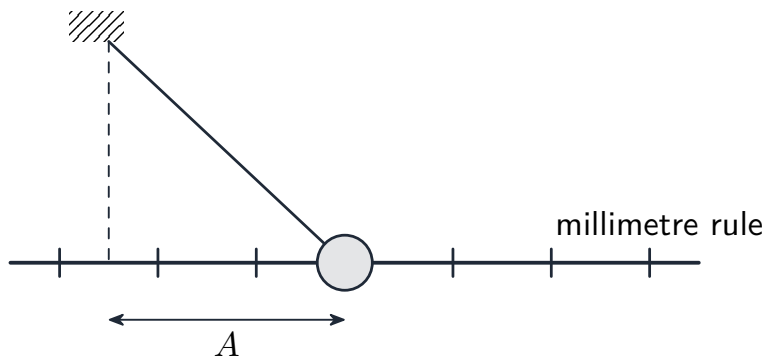
Turn the result into a conclusion



- 1 **Interval** $9.6 \times (1 \pm 0.068) = 8.9$ to 10.3 m s^{-2}
- 2 **Compare** accepted 9.81 lies inside, so the measurement is accurate
- 3 **Honest** consistency does not prove identity; other values also fall inside

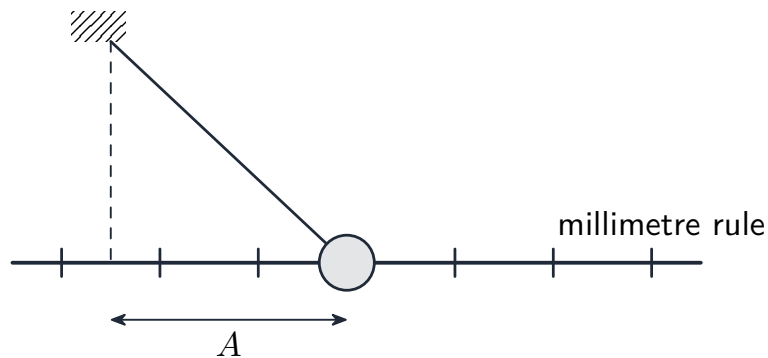
Exercise 2.1

2.1 A student records the amplitude of a damped pendulum every five oscillations, using a rule marked in millimetres placed behind the bob. Give two reasons why recording the amplitude to the nearest 1 mm would not be appropriate. [2]



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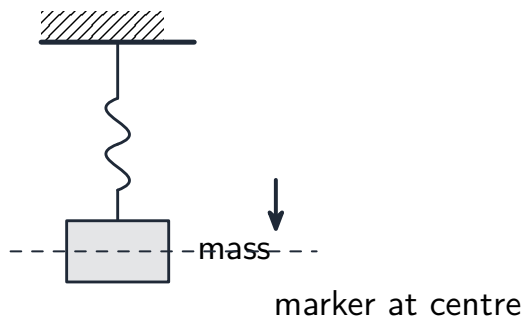
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2.1 Any two of: the bob passes its turning point quickly, so the exact moment of maximum displacement is hard to judge; the line of sight to the rule is unlikely to stay perpendicular, and parallax blurs the reading; the bob swings a measurable distance in front of the rule, so the scale is not in the plane of the motion.

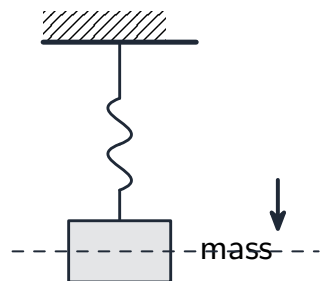
Exercise 2.2

2.2 The period of a mass–spring system is found by timing 10 oscillations four times: 6.88, 6.93, 6.84, 6.96 s. Calculate the mean period T and state why timing 10 oscillations beats timing one, in terms of percentage uncertainty. [3]



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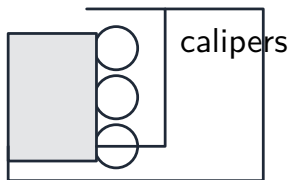


marker at centre

2.2 Mean of the totals: $\bar{t}_{10} = (6.88 + 6.93 + 6.84 + 6.96)/4 = 6.9025$ s, so $T = 0.69025 \approx 0.69$ s. The reaction-time uncertainty is a nearly fixed absolute amount; spreading it over ten oscillations divides it by ten in the period, so the percentage uncertainty in T is far smaller than timing one swing.

Exercise 2.3

2.3 The internal diameter of a spring's coil is measured with vernier calipers. Describe one technique that improves the accuracy of this measurement and name the type of error it attacks. [2]

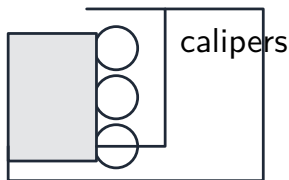


spring coil (internal diameter)

3 Exam-style questions

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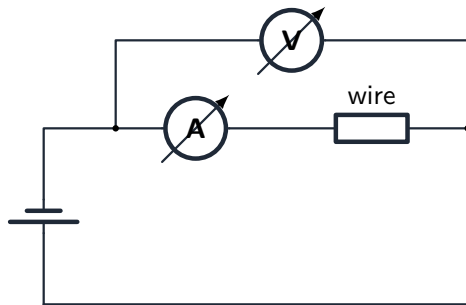
3 Exam-style questions

2.3 Close the jaws first and check the zero reading, subtracting any offset from every measurement – this attacks a systematic error. Or: measure at several orientations around the coil and average, because the coil is not perfectly circular – this attacks random variation. Either with its named error type earns both marks.

Exercise 3.1

3.1 A student measures the resistance of a thin wire with the circuit shown. The voltmeter is connected across the ammeter **and** the wire together.

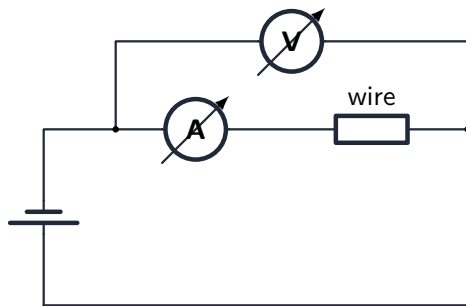
Explain why the calculated resistance will not equal the wire's resistance, and describe how the voltmeter should be connected. State one further practical reason the measured value could still be too large. [4]



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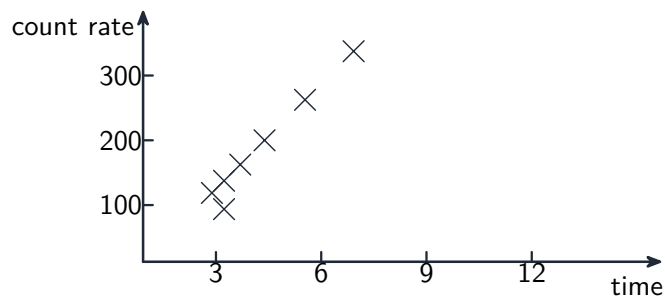


3.1 The voltmeter reading includes the ammeter's potential difference as well as the wire's, so V/I gives the combined resistance, larger than the wire alone. The voltmeter must be connected in parallel with the wire only. The measured value could still be too large because the wire warms as current flows, increasing its resistance; switching off between readings or using a low current reduces this.

Exercise 3.2

3.2 A student plots a graph of count rate against time for a decaying source, using the graph below.

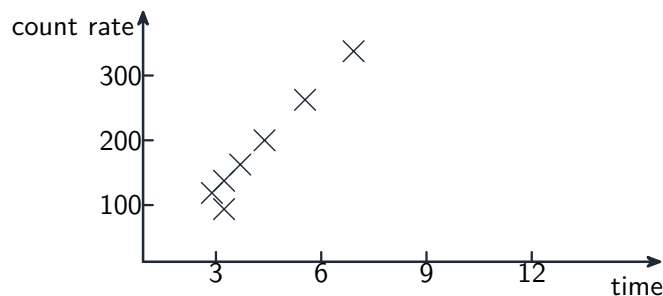
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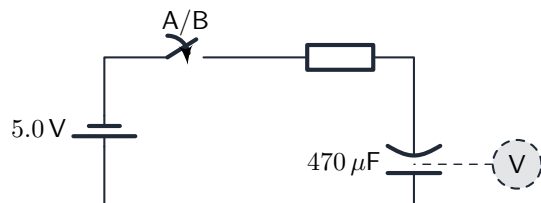


3.2 Any three of: only four data points, too few to establish a trend or a reliable line; the points occupy well under half of the grid, so scatter and curvature are hard to judge; the horizontal scale is marked in threes, an awkward scale that is hard to subdivide; no best-fit line has been drawn. Consequence: with the points crowded into one corner, a gentle curve cannot be distinguished from a straight line, so the decay constant read from the graph would be unreliable.

Exercise 3.3

3.3 A student charges a $470\ \mu\text{F}$ electrolytic capacitor from a $5.0\ \text{V}$ supply through a resistor, using a two-position switch. Position A connects the supply; position B disconnects the supply and leaves the capacitor isolated with a voltmeter across it.

- (a) State two safety precautions specific to electrolytic capacitors. [2]
- (b) The student records the voltmeter reading immediately after charging and again every $10\ \text{s}$, tabulating 2.51 , 2.5 , 2.42 and $2.6\ \text{V}$. Identify the faults in this recording. [3]
- (c) Describe how the circuit should be completed so the voltmeter reads the capacitor alone, and explain one way the timing of the readings could be improved. [3]

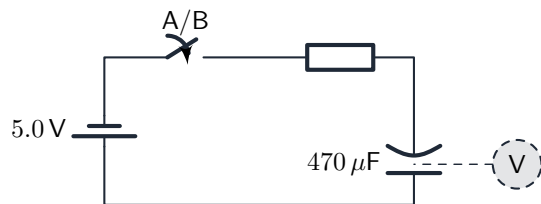


position B not yet wired

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3.3 (a) Observe the correct polarity when connecting the electrolytic capacitor; keep the supply below its working voltage and discharge it before handling. (b) The column mixes decimal places: 2.5 needs recording to $0.01\ \text{V}$ like the others; $2.6\ \text{V}$ departs from the

Full solution 3.3

3.3 (a) Observe the correct polarity when connecting the electrolytic capacitor; keep the supply below its working voltage and discharge it before handling. (b) The column mixes decimal places: 2.5 needs recording to 0.01 V like the others; 2.6 V departs from the decreasing pattern of the others and should be flagged and repeated, not kept silently; the times of the readings are not recorded beside them, so the data cannot be plotted or checked for consistency. (c) The voltmeter goes in parallel with the capacitor alone, and position B must leave the capacitor connected only to that voltmeter so the stored charge is not shared. Timing: use a data logger or record paired time and voltage readings simultaneously, or use a stopwatch started at the switch-over with a helper reading the meter – the point is simultaneity of the pair.