

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

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.

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.

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.

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.

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.

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.