Paper 3 Practice questions (A Level) Answers

Question	Answer	Marks
Section A		
1 a	$T^2 = 4\pi^2 \frac{l}{g}$ Graph of T^2 against l is of the form $y = mx$ Gradient = $\frac{4\pi^2}{g}$	1 1 1
1 b	By calculation, a difference of + 0.05 in the reading for T = 2.45 s gives a difference of about 0.25 s^2 in T^2. For T = 1.10 s the difference is 0.1 s. The most pessimistic uncertainty = ± 0.25 s^2 should be used. Alternatively, the percentage uncertainty can be doubled to give a value for the percentage uncertainty in T^2: For T = 2.45 s, percentage uncertainty = 2%. Percentage uncertainty in T^2 = 4% which gives an absolute uncertainty of ± 0.24 s^2. Note that this gives a more pessimistic value of percentage uncertainty for the shorter time period (9%) but the absolute uncertainty is about 0.1 s so using ± 0.24 s^2 as the most pessimistic absolute uncertainty is reasonable.	1 1 1 1 1 1
1 c	Correctly labelled axes, accurate plotting, best fit straight-line, error bars consistent with answer to part **b**.	1 1 1 1
1 d	gradient of around 4 $m^{-1}\,s^2$ gives a value of 9.9 m s^{-2}	1 1
1 e	The absolute uncertainty in the gradient can be found by the (positive) difference in value between the best fit straight line and the worst fit straight line. The percentage uncertainty in the gradient = $\frac{\text{absolute uncertainty in gradient}}{\text{gradient of best line}} \times 100\%$ The percentage uncertainty in the gradient will give the percentage uncertainty in g.	1 1
2 a	The detector and counter are placed well away from the source. The counts are recorded over a length of time (for example, 100 s). The background count in Bq is found by dividing the number of counts recorded by the time period of the recording. If background count is considered all the readings will suffer from a systematic error as the counts are not due to the source.	1 1 1 1
2 b	Divided the number of counts recorded in 10 s by 10 to find number of counts per second. Correct for background radiation by subtracting the background count from each reading.	1 1
2 c i	Activity is the number of nuclei in a sample that decay in a second. Count-rate is the number of particles released by decaying nuclei per second that are recorded by the detector.	1
2 c ii	Count rate is proportional to activity.	1
2 c iii	gradient of graph = $-\lambda$ gradient = (e.g.) $\frac{4.0-5.4}{150}$	1 1

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	$= -0.0093\ s^{-1}$ half-life = $\frac{\ln 2}{\lambda}$ = 74 s	1 1
3 a	Low-resistance ammeter means that there is negligible p.d. across the meter. High resistance voltmeter means that the current registered on the ammeter represents the current through the load resistor (negligible current through voltmeter).	1 1
3 b i	Marking points: axes labelled with quantities and units, accurate plotting, best fit straight line	1 1 1
3 b ii	E.m.f. is p.d. at zero current (*y*-axis intercept). Value 6.0 V	1 1
3 b iii	Internal resistance is the negative of the gradient of the line. Gradient chosen, value 2.5 Ω	1 1 1
4 a	If the field between the magnets is uniform, a wire carrying constant current, at constant orientation to the field will interact with the field and produce a constant force registered by the balance, wherever the wire is positioned between the magnets.	1 1 1
4 b	gradient of line $= 1.35 \times 10^{-3}$ T m. Field strength = $\frac{1.35\times10^{-3}}{0.028}$ = 0.048 T	1 1 1
4 c	The results for smaller current will be less reliable as the percentage uncertainty is greater. However, small changes are difficult to detect across the range as the sensitivity of the balance is constant. The second student is incorrect. Although the wire will get hot the current reading on the ammeter will be correct. The resistance of the wire does not affect the experiment.	1 1 1 1
5 a i	Any two points from: • Correct reference to spread/range of data excluding potential outlier. • Visible gap between outlier and the rest of the data. • Attempt to quantify separation of the outlier from mean/minimum of remaining data in terms of spread.	2
5 a ii	Suggestion should make it clear that the wire has been damaged in some way.	1
5 b	uncertainty = 1 N Rounding force to ±1 N = 9 N	1 1
5 c i	percentage uncertainty = $\frac{0.005\times100}{0.38}$ = 1%	1 1
5 c ii	percentage uncertainty in *d* is less than percentage uncertainty in *F*.	1
5 d	mean stress = $\frac{9}{1.1\times10^{-7}}$ $= 8.2 \times 10^{7}$ Pa	1 1
6 a	The smallest difference in a reading that can be detected.	1
6 b i	digital: 0.01 A (This is the smallest current difference that can be read) analogue 2 A	1 1 1

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	(This is the value of a division.)	1
6 b ii	$\frac{0.01\times100}{3}$ = 0.3%	1 1
6 c i	All readings will be smaller than the correct value (by the same amount).	1
6 c ii	Adjusting the needle position (to zero)/noting the zero error and adding it to each reading.	1
6 d	13 A (calculated value 12.8 A)	1
6 e	Easier to see sudden movement of the needle than changes in digits.	1
6 f	one of: • Idea of not affecting the measurement. • Meter will overheat and could be damaged. • Smaller p.d. drop across resistor.	1
Section B		
1 a	A measurement between two divisions could be rounded to the nearest 10 kPa, so the maximum a value can change is 5 kPa so the true uncertainty is ±5KPa.	1 1
1 b	Stirring ensures uniform temperature throughout the water for measurement of temperature. Waiting a minute ensures the air is the same temperature as the water.	1 1
1 c i	All of the measurements are well within the bounds of the error bars and there is little deviation of the data points from the straight line of best fit.	1 1
1 c ii	$m = 0.31$ $c = 96$	2 1
1 d	use $y = mx + c$ When $y = 0$, $x = -\frac{c}{m}$ $= -\frac{96}{0.31} = -310\ °C$	1 1 1
1 e	The value of absolute zero is found by dividing a value by the gradient. So a steeper gradient would give a smaller (more correct) value.	1 1
1 f	Fatimah: • If the air temperature in the tubing is cooler, the measured temperature will be higher than the true value. • All the values are therefore ‘stretched’ horizontally, making the gradient too shallow. • To investigate, could e.g. reduce the length of the tubing/leave the system to stand for more time before taking measurements after a temperature is reached. Yuri: • If air leaked out, the pressure would be slowly reducing throughout the experiment compared to its value without leakage. • All the values are therefore ‘shrunk’ vertically, making the gradient too shallow. • To investigate, could e.g. replace the tubing with a different set/return the temperature to a value already measured and measure the pressure again/place the whole system underwater and check for bubbles.	6

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