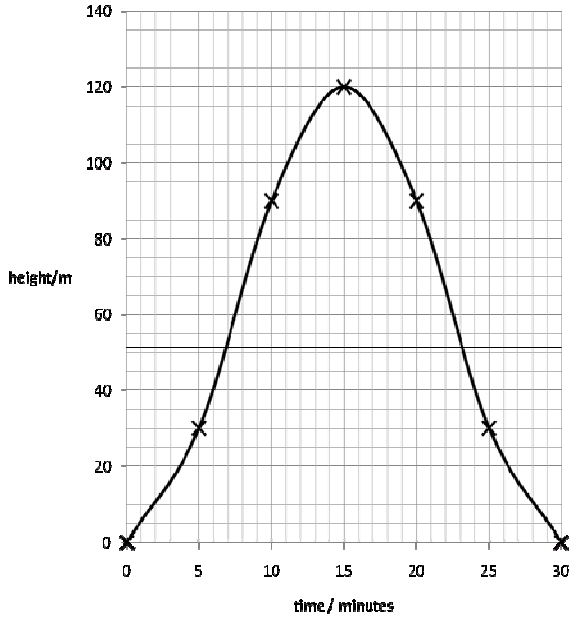
Question number	Answer	Notes	Marks
1 (a) (i)	5.4 ± 0.1 (cm);; if out of range allow 1 mark for 5.4 ± 0.2 (cm) if answer quoted to 3 or more SF, then deduct 1 mark	In the range 5.3 to 5.5 = 2 marks 5.2 OR 5.6 = 1 mark	2
(ii)	5.12 (cm)	Accept 5.1	1
(iii)	Substitution; Calculation; e.g. circumference = 1.510 × 3.142 = 4.744 cm	 Accept 4.7, 4.74 condone 5 with working credit alternative values of π e.g. 1.510 x 3.14 = 4.741 2 marks for correct answer without working POT error max 1 mark	2
(b)	Any four of :- General - MP1. Different precision / use of significant figures; MP2. Calculation error / value for π / unit error; MP3. Unskilled use of equipment; MP4. width of pen mark; String - MP5. Stretches / bends / has inconsistent tension; MP6. Thickness of string makes the circumference larger; MP7. Parallax error (when using ruler); Calliper - MP8. Zero error / calibration error; MP9. Pipe damaged / pipe not quite circular / equation assumes pipe is circular;	Allow a reverse argument where appropriate ignore ‘accurate’ Can’t do a true circle (only a helix) e.g. may not draw dots in a straight enough line, may not get the calliper at 90 degrees to the pipe, may crush the pipe with calliper Ignore unqualified ‘human error’ Total 9 Marks	4

Question number	Answer	Notes	Marks
2 (a)	Any two of 1. ruler has a **mm** scale ; 2. idea of inappropriate precision; 3. paper is (very) thin;	**ignore** vague statements e.g. the ruler is too big **allow** scale is too big paper is thinner than 1 **mm**	2
(b) (i)	C 0.1 mm		1
(ii)	Any two of 1. parallax error; 2. gap left between ruler and paper; 3. ruler not perpendicular; 4. zero error;	**allow** • misreading or inaccurate reading of the ruler • damaged ruler • top sheet not flat **ignore** air gaps between sheets folded paper miscounting sheets different sizes of paper incorrect recording of measurements need for more precise instrument human error	2

Question number	Answer	Notes	Marks
(c) (i)	An explanation including any 2 of	ignore idea that the forces are acting at different points on the plane	2
	1. cceleration needs an unbalanced force;	**allow** Newton I or Newton II unbalanced forces cause acceleration /deceleration / change of *velocity*	
	2. (constant velocity means) the aeroplane is not accelerating;	flying straight or not changing speed /direction	
	3. idea of absence of unbalanced/overall force;	'no resultant force' statement that there is a suitable pair of named balanced forces	
(ii)	weight arrow vertically down; lift arrow upwards; drag arrow to the left;	allow labelled arrows anywhere on the diagram vertical to 45deg to the right inside the angle of the plane wings	3
(iii)	lost as (/dissipated to) heat, sound etc	**allow** lost to the surroundings/air absorbed by surroundings/air i**gnore** kinetic energy 'other types of energy'	1
		Total	**11**

Question number	Answer	Notes	Marks
3 (a) (i)	170 x 0.74; 126 (m);	Correct final value = 2 irrespective of working If final value is incorrect, award one mark for correct working OR ACCEPT 125.8 (m) for one mark	2
(ii)	Any two of Miscounted number of paces; Guessed / estimated pace length; Uneven pace length; Measuring the shadow, not the wheel; Given to the nearest metre; ground may not be flat; shadow is different at different times of the day; shadow may have changed during measuring; may not have walked in a straight line; may not have walked across the centre of the shadow;	ACCEPT any other reasonable point IGNORE 'used no measuring equipment' IGNORE 'human error' alone	2
(iii)	Any one of Repeat and remove anomalies; check measurement of pace; use of tape measure / metre rule / trundle wheel / click wheel / step counter / GPS receiver;	ACCEPT other reasonable points 'Repeat' alone is insufficient IGNORE 'measure the actual London Eye' (doesn't improve the accuracy of *this* method)	1

Question number	Answer	Notes	Marks
3 (b) (i) cont	Suitable scale chosen (>50% of grid used); Axes labelled with scales <u>and units</u>; Plotting to nearest half square (minus one for each plotting / scale error);; Line (curve) of best fit acceptable; Sample graph:  	Units required on each axis On the time axis, accept 'min(s)' but not 'm' Two marks for plotting – lose one mark for each mistake to a maximum of losing two marks Judged by eye Not 'dot-to-dot', line should pass within one small square of each plotted point ACCEPT graph plotted with axes either way round	5

Question number	Answer	Notes	Marks
3 (b) (ii)	120 (m)	ACCEPT 120±5 (m);	1
(b) (iii)	Yes (no mark) Because 122 m is within tolerance / error zone / uncertainty of altimeter reading / (altimeter is) correct to nearest 5m / reading may not have been at the very top;	Accept NO if back up by incorrect value for (b) (ii) REJECT inconsistent answers (e.g. 'no' followed by reasoning that supports 'yes') IGNORE 'only 2m away', 'very close to', 'nearly the same', 'rough estimate' – key marking point is uncertainty, not closeness	1

Total 12 Marks

Question number	Answer	Notes	Marks
4 (a) (i)	only 2.65 (mm) circled;		1
(ii)	discards anomaly; performs averaging; quotes answer to 3sf / 2 d.p.; e.g. 3.60 + 3.62 + 3.63 + 3.61 ~~+ 2.65~~ + 3.62 + 3.60 + 3.61 (= 25.29) 25.29 ÷ 7 = 3.612857... = 3.61 (to 3 sf	÷ 7 or ÷ 8 sufficient even if sum is incorrect e.g. 3.61→3 marks 3.6128 →2 marks (wrong sf) 3.49→ 2 marks (includes anomaly) 3.4925→ 1 mark (includes anomaly and wrong sf)	3
(b) (i)	Bar chart/graph;	condone histogram	1
(ii)	Idea that (size) data is discontinuous; and either of - Idea that there are no values between sizes; Idea that a line graph would indicate continuity;	discrete, categoric, non continuous allow “no half sizes”	2
(iii)	Idea of inverse relationship; Idea of non-linearity;	allow a pattern sentence, condone negative correlation allow “almost” linear Ignore idea of proportionality	2

Question number	Answer	Notes	Marks
4 (c)	Any four of - MP1. idea of a displacement method; MP2. instrument to measure volume (of liquid displaced); MP3. a relevant experimental detail; MP4. second relevant experimental detail; MP5. use of **known liquid density** to find volume from mass (if appropriate);	 Allow overspill or rise in level Allow balance if mass method used (see MP5) Including • idea of repetition or averaging at any stage • **full** immersion of object • check liquid level in displacement can, • subtracting before and after volume measurements , • care with meniscus (e.g. in the measuring cylinder), • check zero or tare of balance • avoid parallax when reading scale as above	4

Total 13 marks

Question number	Answer	Notes	Marks
5 (a) (i)	B - 1 joule per second (1 J/s)		1
(ii)	C - 1 newton per square metre (1 N/m^2)		1
(b) (i)	A - the direction of a magnetic field		1
(ii)	A - has uniform strength		1
		Total	**4**