***1 June 02 P1 Q26** frequency f = N/t. N = 3.5 cycles, t = 2.0 ms x 10 cm = 20 ms
**** 2 Nov 02 P1 Q7** B *f = N/t* = 8.5 / 60x10^{-3}
***3 June 03 P1 Q6** B
****4 June 03 P1 Q26** B *f = N/t. N* = 2 cycles, t = 8 x 2.5 ms
****5 Nov 03 P1 Q5** time interval = 6 ms x 4.5 cm
***6 Nov 03 P1 Q6** B zero error = + 0.14 mm; diameter = 2.59 – 0.14
***7 June 04 P1 Q4** C
*****8 June 04 P1 Q5** C Period = 4 x 10 ms = 40 ms. For new time base, number of cm = 40/20 = 2 cm
***9 Nov 04 P1 Q4** A
****10 Nov 04 P1 Q5** B Period = 0.02 x 10^3 s. Time base = 0.02 x^3 / 8
***11 June 05 P1 Q5** D
****12 June 06 P1 Q4** D $y \propto \frac{1}{d^2}$
***13 June 06 P1 Q5** C
*****14 Nov 06 P1 Q4** DPeriod = 0.02 x 10^3 ms. No of division = = 0.02 x 10^3 / 10 = 2 div
****15 June 07 P1 Q4** C Period = 4 x 2.5 ms. Positive peak = 3.4 x 5 mV
****16 June 07 P1 Q5** A *R = V/I* = 1200 x 10^{-3} / 0.48
****17 Nov 07 P1 Q6** A
***18 Nov 08 P1 Q5** B
***19 June 09 P1 Q3** B
***20 June 09 P1 Q4** B

Section B
June 07 P2 Q1

1	**(a)**	**(i)**	all positions (accept 20, 40, 60, 80) marked to within ±5° positions are 40°, 70°, 90° and 102° *(-1 for each error or omission)*	B2	
		(ii)	allow 107° → 113°	B1	[3]
	(b)		e.g. more sensitive at <u>low</u> volumes *(do not allow reference to 'accuracy')*	B1	[1]

2.2 Errors and uncertainties
Section A
****1 June 02 P1 Q4** B
***2 June 02 P1 Q5** C
***3 Nov 02 P1 Q5** D
***4 Nov 02 P1 Q6** C
***5 June 03 P1Q4** A
****6 June 03 P1 Q5** C Calculate the absolute uncertainty of v
****7 Nov 03 P1 Q4**. D temperature rise $\delta\theta$ = 100 – 40 = 60 °C, uncertainty in $\delta\theta$ = (0.5 + 0.5) °C. % uncertainty = (1.0 / 60) x 100
****8 June 04 P1 Q6** C power P = I^2 R. Find % uncertainty in I = ; % uncertainty in I^2 = 2 x % uncertainty in I = . % uncertainty in P = % uncertainty in I^2 + % uncertainty in R
***9 Nov 04 P1 Q6** D
****10 June 05 P1 Q4** C v = s/t. Find % uncertainty in s and % uncertainty in t. Then % uncertainty in v = % uncertainty in s + % uncertainty in t. Round up to 1 sf, since values given are in 3 sf.

***11 Nov 05 P1Q4** B
****12 Nov 05 P1 Q5** C Density ρ = M / V = M / (l x b x h). % uncertainty in ρ = % uncertainty in M + % uncertainty in *l* + % uncertainty in b + % uncertainty in *h*
****13 June 06 P1 Q6** C
***14 Nov 06 P1 Q5** A
****15 Nov 06 P1 Q6** D apply R = V/I and $\frac{\delta R}{R} = \frac{\delta V}{V} + \frac{\delta I}{I}$
***16 Nov 07 P1 Q4** D
****17 Nov 07 P1 Q5** C Add all % uncertainties
***18 June 08 P1 Q4** C (0.05/1.00 + 0.01/0.50) x 100
***19 June 08 P1 Q5** D
*****20 Nov 08 P1 Q4** D Uncertainty due to fluctuation = 0.02. Uncertainty due to systematic error = 1/100 x 2.0 = 0.02. Total uncertainty = 0.04

Section B

1 June 02 P2 Q2 (a) systematic error. There is a zero error.
(b) micrometer screw gauge has an uncertainty of 0.01 mm. The uncertainty is small. Hence readings are precise. The zero error introduce will cause the readings to consistently larger or consistently smaller than the true reading.

2 Nov 02 P2 Q2

2 (a) 1.6 ± 0.2 cm .... B1 [1]

(b) 1.6 / 50 = 0.032 ...(ignore any uncertainties)...................... B1 [1]

(c) idea of adding fractional uncertainties C1
(0.2 / 1.6) + (0.1 / 50)
= 0.127 OR 12.7% ...(-2 marks if uncertainties not added) A1
actual uncertainty = (±) 0.004 .... A1 [3]
(do not allow more than 2 sig. fig)

3 Nov 04 P2 Q1
(a) (i) take into account of zero error
(ii) take reading at 5 positions along the length of the wire
(iii) take reading in different directions spiral along the wire
(b)(i) % uncertainty in diameter = (0.02 / 0.50) x 100 =
(ii) Area A = πr^2 = πd^2 / 4 ; Hence % uncertainty in A = 2 x % uncertainty in diameter =

4 Nov 06 P2 Q1 (c) (i) points scattered about the line of best fit.
(ii) the graph does not start from the origin.

5 Nov 07 P2 Q1

1	(a)	systematic: e.g.	constant error (in all readings) cannot be eliminated by averaging error in measuring instrument	B1	
		random: e.g.	readings scattered (equally) about true value error due to observer can be eliminated by averaging (*only if averaging not included for systematic*)	B1	[2]

(b) $15 = \pi \times R^2 \times 20$

R = 0.4886 cm (accept any number of s.f.)	C1	
% uncertainty in V = 3.3 % (or 0.5/15)	C1	
% uncertainty in L = 0.5 % (or 0.1/20)	C1	
% uncertainty in R = 1.9 % (i.e. one half of the sum)	C1	
$R = 0.489 \pm 0.009$ cm	A1	[5]

6 June 09 P2

Q1

1	(a)	(i)	micrometer (screw gauge) / travelling microscope	B1	[1]
		(ii)	*either* ohm-meter *or* voltmeter and ammeter *or* multimeter/avo on ohm setting	B1	[1]
		(iii)	*either* (calibrated) c.r.o. *or* a.c. voltmeter and × √2	B1	[1]

(b)	density = mass / volume	C1	
	$= 580 / 6^3 = 2.685$ g cm^{-3} ...(*allow 2.68, 2.69, 2.7*)	A1	
	% uncertainty in mass = (10 / 580) × 100 = 1.7%	C1	
	% uncertainty in volume = 3 × (0.1 / 6) × 100 = 5.0%	C1	
	uncertainty in density = 0.18 g cm^{-3}		
	density = 2.7 ± 0.2 g cm^{-3}	A1	[5]
	(*answer* 2.69 ± 0.09 *g cm*$^{-3}$ *scores 4 marks*)		