Measurement Techniques

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Measurement Techniques
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **86 minutes**

Score: **/71**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** **(i)** car uses 210 / 14 = 15 litres of fuel C1
volume reading = 45 litres . ..... A1 [2]

(ii) from 'full' to '3/4' mark ..... B1 [1]

(b) **(** line/graph does not pass through ('empty, 0) / there is an intercept ..... B1 [1]
(*do not allow 'non-linear'*)

(ii) (meter shows zero fuel when there is some left in the tank so)
acts as a 'reserve' ..... B1 [1]

[Total: 5]

CHEMISTRY ONLINE
— TUITION —

2 **(a** **(i)** *either* 1.55% *or* 1.6% …(not 1.5 or 2) ..... A1 [1]

(ii) *either* 1.09% *or* 1.1% …(not 1.0 or 1) ..... A1 [1]

(b) answer of {**(ii)** + 2 × **(i)**} to any number of sig. fig.
either 4.2% *or* 4.3% ..... A1 [1]

(c) **(i)** *either* the value has more significant figures than the data
or uncertainty of ±0.4 renders more than 2 s.f. meaningless) ..... B1 [1]

(ii) uncertainty in g = ±0.41 / ±0.42 to any number of s.f. C1
g = (9.8 ± 0.4) m s^{-2} ..... A1 [2]

[Total: 6]

3 **(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
= 58 ^{3} = 2.6 $^{-3}$ …(*allow*) 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*)

4	**(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*)	B	[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]
5	**(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]
6	**(a) (i)**	e.g. check for zero error (on micrometer)/zero the micrometer	**B1**	
	(ii)	take readings along the length of the wire/at different points	**B1**	
	(iii)	take readings spirally/around the wire	**B1**	**[3]**
	(b) (i)	4%	**A1**	
	(ii)	8%	**A1**	**[2]**

7	**(a)**	**(i)**	scatter of points (about the line)	B1	
		(ii)	intercept (on t^2 axis) *(note that answers must relate to the graph)*	B1	**[2]**
	(b)	**(i)**	gradient = $\Delta y / \Delta x$ = (100 – 0)/(10.0 – 0.6) gradient = 10.6 (cm s^{-2}) *(allow ±0.2)* (Read points to within $\pm\frac{1}{2}$ square. Allow 1 mark for 11 cm s^{-2} *i.e. 2 sig fig, -1. Answer of 10 scores 0/2 marks)*	C1 A1	**[2]**
		(ii)	$s = ut + \frac{1}{2}at^2$ so acceleration = 2 x gradient acceleration = 0.212 m s^{-2}	B1 B1 B1	**[3]**
				Total	**[7]**

8	**(a)**	**(i)**	acceleration (allow a definition of acceleration).....	B1	
		(ii)	the velocity is decreasing or force/acceleration is in negative direction – accept 'body is decelerating'/'slowing down'.....	B1	[2]
	(b)	**(i)**	e.g. separation of dots becomes constant/does not continue to increase (must make a reference to the diagram).....	B1	
		(ii)	distance = 132 cm.....	B1	
		(ii)	at constant speed, distance travelled in 0.1 s = 25 cm (allow ± 1 cm).....	C1	
			distance = 132 + (4 x 25) = 232 cm	A1	[4]
	(c)		$s = ut + ½at^2$ 1.6 = ½ x 9.8 x t^2 (allow g = 10 m s^{-2} ..... t = 0.57 s..... hence 6 photographs ('bald' answer scores 2 marks only).....	C1 C1 A1	[3]

CHEMISTRY ONLINE
— TUITION —

9	(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 ifuncertainties not"added) ……	A1	
		actual uncertainty = (±) 0.004 ……	A1	[3]
		(do not allow more than 2 sig. fig)		

10	(a	graph: V_H increases from zero when current switched on	B1	
		V_H then non-zero constant	B1	
		V_H returns to zero when current switched off	B1	[3]
	(b) (i)	(induced) e.m.f. proportional to rate	M1	
		of change of (magnetic) flux (linkage)	A1	[2]
	(ii)	pulse as current is being switched on	B1	
		zero e.m.f. when current in coil	B1	
		pulse in opposite direction when switching off	B1	[3]

11	(a)	<u>only</u> curve with decreasing gradient	M1	
		acceptable value near $x = 0$ <u>and</u> does not reach zero	A1	[2]
		(*if graph line less than 4.0 cm do not allow A1 mark*)		
		(*no credit if graph line has positive and negative values of* V_H)		
	(b)	graph: from 0 to 2*T*, two cycles of a sinusoidal wave	M1	
		all peaks above 3.5 mV	C1	
		peaks at 4.95 / 5.0 mV (*allow 4.8 mV to 5.2 mV)*	A1	[3]
	(c)	e.m.f. induced in coil when magnetic field / flux is changing / cutting	B1	
		either at each position, magnetic field does not vary		
		so no e.m.f. is induced in the coil / no reading on the millivoltmeter		
		or at each position, switch off current and take millivoltmeter reading		
		or at each position, rapidly remove coil from field and take meter reading	B1	[2]