Practice 1: P1

A Level Physics B (Advancing Physics)
H557/03 Practical skills in physics

MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 60

Final

MARKING INSTRUCTIONS

Generic version as supplied by OCR Sciences

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

SECTION A

Question			Answer	Marks	Guidance
1	a	(i)	Uncertainty = half scale division normally 1 mm ✓	1	
		(ii)	$V = 7.6^3 = 4.39 \times 10^2$ cm^3 ✓	1	
		(iii)	% uncertainty in length = (0.05/7.60) x 100 $= 6.58 \times 10^{-1}$ % ✓ % uncertainty in volume = 3 x 6.58 x 10^{-1} = 1.97 % ✓	2	OR calculate $V_{max} = 4.48 \times 10^2$ cm^3 % uncertainty in V = $(((4.48 - 4.39) \times 10^2)/4.39 \times 10^2) \times 100$ = 2.05 %
	(b)	(i)	Volume of paper remains constant / V = At	1	
		(ii)	$t = 4.39 \times 10^2/152^2 = 1.9 \times 10^{-2}$ cm ✓ % uncertainty in side length = (0.05/152) x 100 $= 3.29 \times 10^{-2}$ % ✓ % uncertainty in t = 1.97 + 2(3.29 x10^{-2}) = 2.04 % ✓	3	OR calculate t_{max} etc.
		(iii)	Measure total thickness of 400 sheets and divide total thickness by 400 ✓	1	
	(c)	(i)	$V = 4\pi r^3/3$ and r = d/2 $V = \pi d^3/6$ $\pi d^3/6 = \pi D^2 t/4$ manipulation to $t = 2d^3/3D^2$ ✓	1	
		(ii)	Patch is only approximately circular so D varies hence mean value required✓ *d* leads to greatest uncertainty as it is cubed in the relationship so tripling the % uncertainty associated with it ✓ Measure *d* with a travelling microscope ✓	3	Allow: d is the smallest measurement so has the largest % uncertainty Use larger apparatus and a bigger d value
			Total	**13**	

Question			Answer	Marks	Guidance
2	(a)	(i)	Place glass slide on a microscope slide with a piece of graph paper as a reference scale. ✓	1	Credit plausible alternatives
		(ii)	Reference to $\lambda = dx / L$ ✓ Smaller slit spacing gives larger fringe spacing ✓	2	Allow use of $n\lambda = d \sin\theta$
	(b)		$\lambda/d = \sin\theta$, $x/L = \tan\theta$ ✓ if $L >> \lambda$, $\sin\theta \approx \tan\theta \approx \theta$ (if θ is measured in radians) ✓ $\lambda/d \approx x/L$	2	Both equations should be seen. Accept if $d > \lambda$ OR if there are many wavelengths between the slits and the screen.
	(c)		Fringe spacing = 1.3/8 = 0.16 cm ✓ $\lambda = d \sin\theta = 1 \times 10^{-3} \times 0.16 \times 10^{-2} / 3$ ✓ $= 5.4 \times 10^{-7}$ ✓	3	OR $\lambda = dx / L$

	(d)		**Level 3 (5-6 marks)** ✓✓ Addresses all four points with reasoned comments regarding practicality and disadvantages. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** ✓✓ Addresses each point but may not appreciate the associated difficulty in some cases *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1-2 marks)** ✓✓ Comments on at least two points with a least one difficulty described. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**6**	e.g. Increasing the distance between slits and screen will have the desired effect of increasing the fringe spacing but the intensity of the fringes may become so low that fewer if any are clearly visible, making measurement difficult. Increasing the slit width to increase the intensity of light reaching the screen will allow more light to reach the screen but the larger slits will allow less diffraction to occur at each slit so the waves from each slit are less likely to superimpose and fringes will not be formed. Reduce the distance between the light source and the slits to increase the intensity of the fringes. More diffraction at the first slit will be required in order for both the secondary slits to be illuminated. Therefore narrower slit required and lower light intensity will result. Use coloured filters to enable the wavelengths of specific colours to be measured. A useful improvement but filters will reduce the intensity of light reaching the screen so the fringes may not be visible.
			Total	**16**	

3	**(a)**	**(i)**	Any three crosses at a maximum (10 V) or minimum (-10 V) ✓	**1**	Accept any cross **vertically** above or below the trace.
		(ii)	Emf = - $\frac{dN\varphi}{dt}$ 10 = (-) 300 $\frac{d\varphi}{dt}$ $\frac{d\varphi}{dt}$ =10 / 300 = 0.033 (Wb s^{-1}) ✓	**1**	Evidence of the calculation must be seen
		(iii)	Φ goes from **zero** to maximum in ¼ cycle (5 x 10^{-3} s) ✓ dΦ = Φ_{max} = $\frac{d\varphi}{dt}$.dt = 3.3 x 10^{-2} x 5 x 10^{-3} Φ_{max} = 0.165 mWb ✓	**2**	Accept Φ goes from minimum to maximum in half a cycle 2 Φ_{max} = 3.3 x 10^{-2} x 10 x 10^{-3} Accept sinusoidal integration giving Φ_{max} = 0.105 mWb for full credit
	(b)		**Level 3 (5-6 marks)** ✓✓ Experiments V_s against V_p and V_s against N_p both described in detail, including graphs expected and the interpretation of them leading to the expression $V_s/V_p = N_s/N_p$ *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** ✓✓ Experiments V_s against V_p and V_s against N_p both described or one in detail, including graphs expected and some interpretation of them leading to the expression $V_s/V_p = N_s/N_p$ *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1-2 marks)** ✓✓ Either experiments V_s against V_p or V_s against N_p described	**6**	**Indicative points include:** V_s against V_p identified as additional experiment. V_s against N_p identified as additional experiment. Statement of variables held constant for each experiment. Details of graphs plotted : e.g. V_s against V_p showing direct proportion V_s against $1/N_p$ indicating inverse proportion between V_s and N_p Clear link to $V_s/V_p = N_s/N_p$

			with some interpretation of results leading to an appreciation of the relationship, $V_s/V_p = N_s/N_p$ *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.		
			Total	**10**	

SECTION B

Question			Answer	Marks	Guidance
4	(a)	(i)	Points plotted correctly ✓ uncertainty bars for temperature plotted correctly✓ uncertainty bars for volume plotted correctly✓ Straight line of best fit plotted going through <u>all</u> of the error bars✓	4	± ½ square ± ½ square ± ½ square
		(ii)	1/30 = 0.033 or 3.3%✓ 5/130 = 0.038 or 3.8%✓	2	Accept as a decimal Accept as a decimal. Accept to 1 sf.
		(iii)	Calculation of the gradient = 4.29 x 10^{-10} ✓ Gradient shown to be equivalent to $\frac{Nk}{P}$ or $\frac{nR}{P}$✓ Correct values substituted in; $\frac{4.5\times10^{-6}\times6.022\times10^{23}\times1.38\times10^{-23}}{P} = 4.29\times10^{-10}$ Or $\frac{4.5\times10^{-6}\times8.31}{P} = 4.29\times10^{-10}$✓ Evaluation, P = 87.2 kPa✓	4	Must be clearly shown that graph was used rather than the data. Gradient within the range 4.0 x 10^{-10} – 5.1 x 10^{-10} Penalise small triangles Gives answer within range 73.3 - 93.5 kPa
	(b)	(i)	Suitable line of best fit drawn with x-intercept in the range -260 to -280. ✓	1	Only straight LOBF given credit.
		(ii)	Particles slow down to zero speed✓ as the average energy of particles reduces ✓ Gas will liquefy/solidify✓ As inter-molecular bonds will form✓	4	OWTTE Zero velocity will not be achieved/particles will continue to vibrate Absolute zero cannot be reached
		(iii)	$\frac{\text{b(i)} - -273}{-273}$ (x 100 %) ✓	1	Must be the candidate's value from **b(i)** Accept a decimal accepted value must be the denominator

Question			Answer	Marks	Guidance
		(iv)	Meaningful comparison of percentage uncertainty and percentage difference. ✓ Correct conclusion. ✓	2	Expect % uncert > % diff accurate
		(v)	If accurate from **b(iv)** yes (no mark) As T is **directly** proportional to V ✓	1	If inaccurate from **b(iv)** no (no mark) As T is **not directly** proportional to V
		(vi)	Calculation of molecular mass = $\frac{28}{6..0\times10^{23}} = 4.7 \times 10^{-23}$g✓ Equation of $pV = nRT$ and $pV = ⅓Nm\overline{c^2}$ re-arranged to $\sqrt{\overline{c^2}} = \frac{3kT}{m}$✓ Calculation of $\sqrt{\overline{c^2}}$ for both temperatures: For T = 293 K, $\sqrt{\overline{c^2}} = 508\ ms^{-1}$ A For T = 77 K, $\sqrt{\overline{c^2}} = 260\ ms^{-1}$ ✓ Ratio 1.95 : 1 ✓	4	Accept use of KE = 1/2 $m\overline{c^2}$ and *KE = 3/2 kT* Accept 1.95
			Total	**21**	