Post-IGCSE Physics Course: Experimental Physics using Data Loggers and Computers

Dr Andrew French P5 6 Winchester College

Thermodynamics

Last updated April/May 2017

Run #1
Voltage (V)

0.05

200

Boyle experimental setup

Windows PC running CAPSTONE software



Movement of plunger using vice changes the resistance of a resistor in a potential divider circuit. Hence voltage measured is proportional to displacement of plunger

2V DC power supply for potential divider

assembly (not heavy duty!)



Don't get caught out – these data-loggers need to be switched on manually!



Pressure sensor attatchment



Carefully turn the vice screw to release or depress the syringe plunger.

Don't force the plunger beyond about 80% of it's maximum compression

Load up CAPSTONE software and choose Table and Graph option

Drag a display on below.	to the page or choo	se one of the QuickSt	tart templates	
Table & Graph	Graph & Digits	1.23 1.23 Two Large Digits	A L	
Two Displays	One Small, One Large	Two Small, One Large	Four Displays	
	ызыву	Display		
	Drag a display on below. Table & Graph Two Displays	Drag a display onto the page or chooseLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLowLow	Drag a display onto the page or choose one of the QuickStructureImage: ConstructureImage: Constructure	

e Edit Workbook Display Journal Help

a 🖙 🐰 e

R Page #

Tools X

Hardware Setup

Data Summary

Caliburtan

Calculator



- 88

Recording

- 18 -

Analysis Export the data from CAPSTONE to **Excel** as a **.csv** file.

Determine (using the dimensions of the syringe) the linear relationship between voltage and air volume, and hence **calibrate** the voltage measurement.



Air volume is \mathcal{X} Therefore expect **Boyles' Law** to hold if one assumes
negligible air leakage. Compression is slow enough
for thermal equilibrium to always be established.

Air pressure /Pa $\rightarrow Px = \text{constant}$



Calculating the measurements

Plotting P vs 1/x should yield a straight line through the origin

(Perhaps a *different* gradient for compression and release).

	A B	С	D	E	F (G H		J	K	L	Μ	N	0	Р	Q	R S	Т	
1																		
2	Datalogging Experiment 04: Boyle (Thermodynamics)						Voltage a	at maximu	m plunger	position	2.05		Maximun	n plunger p	position /ml	70		
3	Winchester College. April 24th 2017. A. French & A. Chesters					Voltage a	Voltage at minimum plunger position		0	Minimum plunger position /ml 18								
4																		
5	Absolute Pressure (kPa)	Voltage (V)	Volume x /ml	1/x														4_
6	102.095 0)	70	0.014285714		D.,		<i>.</i>					Dree					L
7	102.119 0)	70	0.014285714		Pr	essur	e vs vc	nume				Pres	sure	VS 1/	volume		-
8	102.108)	70	0.014285714	- 40	0						400						+
9	102.13)	/0	0.014285/14	40							400			+			-
10	102.069	ן ר	70	0.014285/14											rigi	insition!	19	-
.1	102.137	<u>ן</u>	70	0.014285714	25	io —						350				ji ji		-
.2	102.113	ן ר	70	0.014285714								550				a a a a a a a a a a a a a a a a a a a	18	+
.3	102.155	<u>י</u> ר	70	0.014285714														-
.4	102.111	<i>י</i> ו	70	0.014203714	30	0 + + 0						300					i /	-
6	102.100	,)	70	0.014285714														-
7	102.100 0	,)	70	0.014285714							H			ompr	essioi	ny 👔		
8	102.084	,)	70	0.014285714	25	io					\vdash \vdash	250						
9	102.161)	70	0.014285714	Ъ		\					Ба						
0	102.106	-)	70	0.014285714	×							×						
1	102.148)	70	0.014285714	n 20	0					\vdash	5 200				/		
2	102.135)	70	0.014285714	essi							ess			11			
3	102.128)	70	0.014285714	Ľ.							Å			1/			
4	102.135)	70	0.014285714	15	io			\mathbf{N}		\vdash	150	+					
5	102.144)	70	0.014285714					\sqrt{N}									
6	102.108)	70	0.014285714														
7	102.183 0)	70	0.014285714	10	0 +					\vdash	100	+	_//				
8	102.093)	70	0.014285714										17				
9	102.177 0)	70	0.014285714														
0	102.093 0)	70	0.014285714	5	0					\vdash	50						
1	102.183 0)	70	0.014285714									11	Rele	ease			
2	102.192 0)	70	0.014285714								•						
3	102.348 0)	70	0.014285714		U +				-		0	4					
4	102.399 0)	70	0.014285714		0	20	40	6	0	80		0	0.0	02	0.04	0.06	
5	102.572 0)	70	0.014285714				Volume /	/ml						1/Volur	me		
6	102.761 0)	70	0.014285714														
7	102.981	0.01	69.74634146	0.01433767														
8	103.113	0.01	69.74634146	0.01433767														
9	103.316	0.01	69.74634146	0.01433767														
1	103.489	J.U2	69.49268293	0.014390004														
1	103.63	0.02	69.49268293	0.014390004														
2	103.657	J.UZ	69.49268293	0.014390004														
3	103.749	0.02	60.49268293	0.014390004														
4	102.009	0.02	60 40268202	0.014390004														
4	b b row data Boylo												1.4					÷