**Name of the Student**:_____
**Max. Marks : 19 Marks** **Time : 19 Minutes**

Mark Schemes

## Q1.

(a) attempts two calculations that would lead to a conclusion $_1$✔

*for $_1$✔ the result of at least one calculation of $M \times y$ must be correct (see table) otherwise withhold both marks;*

*allow use of $y$ in m but reject POT error*

*allow use of correct read-offs from valid BFL;*

*condone use of two rows of data to show that when $M$ doubles, $y$ does not halve;*

*award of $_2$✔ is contingent on valid $_1$✔*

**1**

a reasoned judgement explaining why $y$ not inversely proportional to $M$ $_2$✔

| $M$ / kg | $y$ / mm | acceptable $M \times y$ | min sf |
|---|---|---|---|
| 0.5 | 89(.0) | 44.5 / 45 | 2 |
| 1.0 | 82(.0) | 82(.0) | |
| 1.5 | 76(.0) | 114(.0) | 3 |
| 2.0 | 71(.0) | 142(.0) | |
| 2.5 | 66.5 | 166(.3) | |
| 3.0 | 62.5 | 187.5 / 188 | |

*for $_2$✔ two correct calculations of $M \times y$*

*see table for min sf in result for $M \times y$*

*OR*

*one correct calculation of $M \times y$ and an appropriate reverse-working calculation;*

*statement rejecting inverse-proportion supported by suitable quantitative reasoning, eg calculation of the percentage difference between the results of their calculations;*

*condone 'large' / 'significant differences' (between calculation results) / use of >> etc;*

*reject 'values are different' / 'not same' / 'not constant' / 'not close enough' use of > etc;*

*reasoning must be based on the data points, eg reject 'best-fit line crosses y-axis'*

**1**

(b) (as **P** moves down) trapped air expands so)
pressure (of trapped air) is reduced $_1$✔

*must address situation in **Figure 3***

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*for $_1$✔ allow 'pressure reaches lower value' reject 'pressure is low'*

pressure less than atmospheric pressure $_2$✔

*for $_2$✔ allow 'there is a pressure difference across **P** ' / 'external pressure > pressure of trapped air'*

*award $_1$✔$_2$✔ for pressure of air reduced below atmospheric*

this leads to an upwards force balancing the weight of **P**

OR

pressure difference across **P** × area of piston = weight of piston $_3$✔

*for $_3$✔ allow any **correct** idea about how two opposing forces act to produce equilibrium;*

*'no resultant force' is not enough*

*reject 'weight = gravity' / ideas about 'suction' / equating pressure with force*

why **P** falls when the valve is opened $_4$✔

*for $_4$✔ idea of external and internal pressures equalising;*

*reject 'pressure released / returns to normal'*

**Max 3**

(c) smooth curve of decreasing negative gradient through all 6 points $_1$✔

*for $_1$✔ must be a single continuous line for $M$ > 0.5 that overlaps with all 6 +;*

**1**

line with negative gradient extrapolated (backwards) to $M \leq -0.35$ $_2$✔

*condone poorly-marked line (note that poor line quality may only be penalised in **(d)**)*

records $y$ corresponding to $M = -0.7$ $_3$✔

$y$ in range 108 mm to 116 mm $_4$✔

*for $_2$✔ condone linear extension of curve with negative gradient for $M$ < +0.5*

**1**

OR

for incorrect $M$ (3 MAX)

smooth curve etc $_1$✔

*for $_3$✔ curve must extend to where read off is being made*

**1**

line with negative gradient extrapolated (backwards) to $M \leq -0.35$ $_2$✔

records $y$ corresponding to $M = -0.35$;

$y$ in range 101 mm to 107 mm $_{34}$✔

OR

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for linear graph (2 MAX)

ruled line with negative gradient extrapolated (backwards) to $M \leq -0.35$ $_{12}$✔

records $y$ corresponding to $M = -0.7$;

$y$ in range 101 mm to 107 mm $_{34}$✔

*award of $_4$✔ is contingent on valid $_3$✔*

*for $_4$✔ answers that round to nearest mm are acceptable*

**1**

(d) correctly identifies error $_1$✔

*for $_1$✔ reading has been taken at / from the top of the **meniscus** / top of coloured oil / top of liquid*

*OR*

*should have taken / did not take reading from the bottom / lowest point of the **meniscus** / lowest point on **surface** of coloured oil*

*OR*

*'(student thinks) sub-divisions are 0.1 $cm^3$ and not (as question states) 0.2 $cm^3$'*

*reject 'should have read from bottom of coloured oil' / 'failed to read meniscus properly' / 'read at the top of the air' / 'has read divisions incorrectly' or wtte*

**1**

correct reading is 35.8 $_2$✔

*for $_2$✔ CAO*

**1**

(e) gradient from $\Delta \log(V / \text{cm}^3)$ divided by $\Delta \log(p / \text{MPa})$; evaluated to ≥ 3 sf result between −1.05 and −1.01 $_1$✔

*don't insist on large steps / read off accuracy*

*accept result that rounds to 3sf between −1.05 and −1.01; sign essential*

**1**

relevant algebra enabling comparison with $y = mx + c$ $_2$✔

*for $_2$✔ (eg Boyle's Law written as)*

*log $V$ = − log $p$ + constant*

*condone variation based on Ideal Gas Law in which case must establish that $(nR)T$ / $(Nk)T$ is constant (which then implies Boyle's Law) (recognisable data book symbols only)*

*OR*

*(**Figure 5** shows)*

*log $V$ = gradient × log $p$ + constant;*

*accept (log) $k$, (log) c etc as recognisable symbols for the constant;*

*condone (any) numerical value given for the constant eg $10^{1.685}$;*

*accept m as recognisable symbol for the gradient*

**1**

why gradient ≈ $\underline{-1}$ confirms Boyle's Law $_3$✔

*for $_3$✔ allow gradient is / equals / should be −1*

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*if $_2$✔ not given accept 'gradient ≈ −1 demonstrates inverse proportion or wtte*

**1**

(f) reads off and attempts to make use of log $p_1$ AND log $V_1$ for any point on the line $_1$✔

*for $_1$✔ check log $V_1$ is within half a grid square of correct position for their log $p_1$ or vice-versa;*

*'make use of' excludes use in a gradient calculation*

*$V_2$ in range 10.5 to 11.5 ($cm^3$) earns $_1$✔$_2$✔$_3$✔*

**1**

applies a workable method $_2$✔

*for $_2$✔ creditworthy examples are*

*a calculation of the intercept in **Figure 5***

*eg log $V$ + log $p$ = 0.585*

*OR*

*use of gradient = $\frac{\Delta \log V}{\Delta \log p}$ (eg similar triangles idea)*

*OR*

*a calculation of $p \times V$ (by any means)*

*OR*

*use of log $V$ = −1 × log 0.34 + their intercept*

*no credit for claiming 1.685 (or 1.170) are intercepts; this cannot earn $_2$ ✔*

**1**

further manipulation to determine unknown $V_2$ $_3$✔

*for $_3$✔ accept result that rounds to 10.5 or 11.5;*

*accept 2sf 11 ($cm^3$)*

**1**

(g) temperature (of air) $_1$✔

*for $_1$✔ accept 'mean ke of air molecules' (or wtte) / vapour pressure <u>of air</u>'*

*'keep mass of air constant' is neutral (this information is given below **Figure 5**)*

**1**

change the pressure of the gas slowly or wtte

OR

wait (after a change) between taking readings / until the oil level stabilises $_2$✔

*award of $_2$✔ is contingent on valid $_1$✔*

*for $_2$✔ condone 'keep lab temperature constant';*

*'use a water bath' is neutral*

*reject 'do the experiment slowly' / 'do not heat the apparatus' / 'keep windows closed' etc*

**1**

**[19]**

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