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***

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

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

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]