A-LEVEL
PHYSICS
7408/3A

Paper 3 Section A

Mark scheme

June 2022

Version: 1.0 Final

226A7408/3A/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Copyright information

AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Copyright © 2022 AQA and its licensors. All rights reserved.

Physics - Mark scheme instructions to examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.
2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.
2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks can usually be given for a correct numerical answer without working shown unless the question states 'Show your working'. However, if a correct numerical answer can be evaluated from incorrect physics then working will be required. The mark scheme will indicate both this and the credit (if any) that can be allowed for the incorrect approach.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

A calculation must be followed through to answer in decimal form. An answer in surd form is never acceptable for the final (evaluation) mark in a calculation and will therefore generally be denied one mark.

3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are likely to be restricted to calculation questions and should be shown by the abbreviation ECF or *conseq* in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited (eg fizix) **unless** there is a possible confusion (eg defraction/refraction) with another technical term.

3.6 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.7 Ignore / Insufficient / Do <u>not</u> allow

'Ignore' or 'insufficient' is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

'Do **not** allow' means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

3.8 Significant figure penalties

Answers to questions in the practical sections (7407/2 – Section A and 7408/3A) should display an appropriate number of significant figures. For non-practical sections, an A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the **final** answer in a calculation to a specified number of significant figures (sf). This will generally be assessed to be the number of sf of the datum with the least number of sf from which the answer is determined. The mark scheme will give the range of sf that are acceptable but this will normally be the sf of the datum (or this sf -1).

An answer in surd form cannot gain the sf mark. An incorrect calculation **following some working** can gain the sf mark. For a question beginning with the command word 'Show that…', the answer should be quoted to **one more** sf than the sf quoted in the question eg 'Show that X is equal to about 2.1 cm' – answer should be quoted to 3 sf. An answer to 1 sf will not normally be acceptable, unless the answer is

an integer eg a number of objects. In non-practical sections, the need for a consideration will be indicated in the question by the use of 'Give your answer to an appropriate number of significant figures'.

3.9 Unit penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the correct unit for the answer to a calculation. The need for a unit to be quoted will be indicated in the question by the use of 'State an appropriate SI unit for your answer'. Unit answers will be expected to appear in the most commonly agreed form for the calculation concerned; strings of fundamental (base) units would not. For example, 1 tesla and 1 Wb m^{-2} would both be acceptable units for magnetic flux density but 1 kg m^2 s^{-2} A^{-1} would not.

3.10 Level of response marking instructions

Level of response mark schemes are broken down into three levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are two marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Determining a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level. i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2.

The exemplar materials used during standardisation will help you to determine the appropriate level. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks

Question	Answers	Additional comments/Guidelines	Mark	AO
01.1	Y-shift ✓	auto-marked: CAO	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2		speed correct from valid calculation earns $_1$✓$_2$✓$_3$✓		3 x AO2
	use of (transit distance) = 2×0.870 $_1$✓	for $_1$✓ allow 1.74	1	
	use of (contact time) = 6 ± 0.2 major divisions $\times 50 \times 10^{-6}$ $_2$✓	for $_2$✓ allow POT error in time-base value; allow 2.9, $3(.0)$ or 3.1 ($\times 10^{-4}$ s) seen in working	1	
	speed in range 5600 to 6000 (m s^{-1}) using valid speed calculation $_3$✓	for $_3$✓ no credit for $c = f \times \lambda$ approach; speed in range 2800 to 3000 (m s^{-1}) from valid calculation eg $\frac{0.870}{3\times10^{-4}}$ award $_2$✓$_{13}$✓ = 2; speed in range 1120 to 1200 (m s^{-1}) from valid calculation (using minor divisions) eg $\frac{2\times0.870}{5\times3\times10^{-4}}$ award $_1$✓$_{23}$✓ = 2; for speed = length of rod ÷ (0.5 ×time-base) $_1$✓$_2$✗$_3$✗ no credit for speed = length of rod ÷ time-base	1	

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	quantitative effect on (contact) time $_1$✓	for $_1$✓ expect '(contact) time is doubled' / '$600\ \mu s$'	Max 2	2 x AO1
	quantitative effect on waveform $_2$✓	for $_2$✓ expect 'double the number of cycles would be produced' / 'would require 12 divisions'; accept 'waveform extended horizontally $\times\ 2$' 'waveform is twice as long' or wtte; condone 'number of wave(length)s doubled'; reject 'trace is twice as long' / 'wavelength doubled' / 'waveform stretched'; allow 'increased (contact) time so more waves / longer waveform seen' for $_{12}$✓ = 1 MAX		
	waveform extends beyond screen / scale or wtte $_3$✓	for $_3$✓ consequences eg waveform could not be (fully) displayed / would not fit; only penalise 'trace' once		
	adjustment to time-base control $_4$✓	for $_4$✓ allow (any) change time-base; allow 'time (per) div'; condone 'X-scale'	1	2 x AO3
	to $0.1\ \text{ms}\ (\text{div}^{-1})$ $_5$✓	for $_5$✓ CAO	1	
Total			**8**	

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1		give credit for any relevant annotation to Figure 6 or in additional sketch		2 x AO3
	place mirror behind ruler $_1$✓	for $_1$✓ do not insist on contact between mirror and ruler	1	
	adjust position (of eye / head) until pin hides / lines up with its own reflection / image $_2$✓	condone use of (non-hypotenuse) edge of set-square to define horizontal plane $_1$✓ adjust position until horizontal edge of set square meets/is touching pin or wtte $_2$✓ if no other mark given award $_{12}$✓= 1 max for 'read value at eye level' OR move (clamped) ruler closer to pin	1	

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	valid strategy using apparatus in **Figure 5**: y (as the dependent variable) measured (or wtte) for different values of <u>one</u> independent variable (only L or m are acceptable) $_1$✓	for $_1$✓ must refer to variables only using the symbols and/or terms given on page 8; accept 'weight' / mg as independent variable condone mock table as intent / y = 'extension'	1	2 x AO1
	identifies the correct control variable (besides w and t) $_2$✓	for $_2$✓ L = control variable if m = independent variable OR m = control variable if L = independent variable; if L is being varied and $m = 250$ g is stated, this can be taken as m = control variable and therefore known; take a similar approach if m is being varied but in this case L must have a **quoted value** that is ≤ 30 cm; for more than one independent variable, eg variation of both m and L $_{12}$✗✗ but allow ECF for $_4$✓ as long as plot is valid, eg y against mL^3	1	
	suitable measuring instruments for L OR w OR t $_3$✓	ANY ONE of the following (for more than one response mark as LIST) for L: use ruler; for w: use (any type of vernier) callipers; accept micrometer (screw gauge); for t: use micrometer (screw gauge); accept digital / electronic (vernier) callipers	1	AO1

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidelines</th><th>Mark</th><th>AO</th></tr>
<tr><td>02.2
continued</td><td>analysis:
suggests valid plot $_4$✓
identifies correctly how E can be found from a valid plot $_5$✓</td><td>for $_4$✓ plot must involve y [by itself or combined with another factor] on one axis and their independent variable [by itself or combined with another factor] on the other axis; do not insist on y as ordinate
for $_5$✓ E must be the subject; some examples include:
<table>
<tr><th>ordinate</th><th>abscissa</th><th>$E =$</th></tr>
<tr><td>y</td><td>m</td><td>$\frac{4\times L^3\times g}{w\times t^3\times \text{gradient}}$</td></tr>
<tr><td>mg</td><td>y</td><td>$\frac{4\times L^3\times \text{gradient}}{w\times t^3}$</td></tr>
<tr><td>y</td><td>L^3</td><td>$\frac{4\times m\times g}{w\times t^3\times \text{gradient}}$</td></tr>
<tr><td>y</td><td>$\frac{4\times L^3}{w\times t^3}$</td><td>$\frac{m\times g}{\text{gradient}}$</td></tr>
<tr><td>$\log y$</td><td>$\log m$</td><td>$\frac{4\times g\times L^3}{w\times t^3\times 10^{\text{intercept}}}$</td></tr>
<tr><td>$\log y$</td><td>$\log L$</td><td>$\frac{4\times m\times g}{w\times t^3\times 10^{\text{intercept}}}$</td></tr>
</table></td><td>1

1</td><td>2 x AO3</td></tr>
<tr><td>Total</td><td></td><td></td><td>7</td><td></td></tr>
</table>

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	callipers may **reduce** the (reading of the) diameter ✓	treat 'change reading' / 'give incorrect reading' as neutral; accept the idea that the callipers may 'distort' / 'deform' / 'push in' the putty, eg 'change the shape' / 'crush' / 'squash' / 'cut into' / 'squeeze' reject implication that density could change, eg 'volume will change' / 'will compress'; reject 'putty will move' / 'not able to grip the putty hard enough'	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	average d OR uncertainty in d $_1$✓	answers to >3sf rounding to $2.37(\%)$ earns both marks for $_1$✓ either average = $33.8(0)\ (\text{mm})$ OR uncertainty from half range = $0.8(0)\ (\text{mm})$; allow ½ $\times(34.5-32.9)$ seen in working; credit if seen in a percentage uncertainty calculation	1	2 x AO2
	percentage uncertainty $2.37(\%)$ $_2$✓	for $_2$✓ percentage uncertainty to ≥ 3 sf; reject decimal answer or incorrect rounding to 2.36%; reject answers if either 32.9 or 34.5 are (wrongly) rejected as anomalous (leading to 1.62% and 1.64% respectively)	1	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.3	% uncertainty in length correct $_1$✓	for $_1$✓ minimum 2sf CAO; $2.8(2)\%$	1	1 × AO1
	calculates % uncertainty in volume $_2$✓	for $_2$✓ % uncertainty in $V = 2 \times$ their % uncertainty in d + their % uncertainty in L; allow 2.4% for % uncertainty in d minimum 2 sf; expect 7.6 %	1	3 × AO2
	evidence for volume evaluated OR evidence for Δ volume evaluated $_3$✓	for $_3$✓ accept answers including: sub of **all data** in to $V = \frac{\pi \times (\text{their} d)^2 \times L}{4}$ OR recognisable V eg 6.4 ($\times 10^4$) OR sub of **all data** in to $\Delta V = \frac{\pi \times (\text{their} d)^2 \times L}{4}$ × their % uncertainty / ΔV = their volume × their % uncertainty OR recognisable ΔV with POT error	1	
	Δ volume between 4.8 and 4.9×10^3 (mm^3) $_4$✓	answers that round to 4.8 or round to 4.9 are acceptable; $_{34}$✓✓for Δ volume in range and correct POT	1	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.4	ruled line $_1$✓	for $_1$✓ line passing below 5th AND above 4th ie no overlap between line and either **+**; line passing through or extrapolated to $(0, 0)$ to half a minor grid square; withhold this mark if line is poorly-marked (if doing so annotate clip to explain)	1	2 x AO1 1 x AO3 1 x AO2
	gradient calculated $_2$✓	for $_2$✓ gradient calculated from ΔR divided by ΔL^2; minimum $\Delta L^2 = 25\ (\times 10^{-3}\ \text{m}^2)$; allow read-off errors in calculation / allow missing or incorrect POT	1	
	ρ in range 3.72 to $3.84\ (\times 10^{-2})$ $_3$✓	for $_3$✓ accept 2 sf 3.8	1	
	POT and unit correct $_4$✓	for $_4$✓ treat 3.78×10^{-2} and $0.0378\ \Omega\ \text{m}$ as equally acceptable; allow alternative valid answer, eg $37.8\ \Omega\ \text{mm}$	1	
Total			**11**	

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidelines</th><th>Mark</th><th>AO</th></tr>
<tr><td>04.1</td><td>attempts two calculations that would lead to a conclusion $_1$✓

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

<table>
<tr><th>M / kg</th><th>y / mm</th><th>acceptable $M \times y$</th><th>min sf</th></tr>
<tr><td>0.5</td><td>89(.0)</td><td>44.5 / 45</td><td rowspan="2">2</td></tr>
<tr><td>1.0</td><td>82(.0)</td><td>82(.0)</td></tr>
<tr><td>1.5</td><td>76(.0)</td><td>114(.0)</td><td rowspan="4">3</td></tr>
<tr><td>2.0</td><td>71(.0)</td><td>142(.0)</td></tr>
<tr><td>2.5</td><td>66.5</td><td>166(.3)</td></tr>
<tr><td>3.0</td><td>62.5</td><td>187.5 / 188</td></tr>
</table></td><td>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 $_1$✓

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’</td><td>1

1</td><td>1 x AO1
1 x AO2</td></tr>
</table>

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	(as **P** moves down trapped air expands so) pressure (of trapped air) is reduced $_1$✓ pressure less than atmospheric pressure $_2$✓ this leads to an upwards force balancing the weight of **P** OR pressure difference across **P** × area of piston = weight of piston $_3$✓ why **P** falls when the valve is opened $_4$✓	must address situation in Figure 11 for $_1$✓ allow 'pressure reaches lower value' reject 'pressure is low' 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'' 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 for $_4$✓ idea of external and internal pressures equalising; reject 'pressure released / returns to normal'	Max 3	3 x AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	smooth curve of decreasing negative gradient through all 6 points $_1$✓ line with negative gradient extrapolated (backwards) to $M \leq -0.35$ $_2$✓ records y corresponding to $M = -0.7$ $_3$✓ y in range 108 mm to 116 mm $_4$✓ OR for incorrect M (3 MAX) smooth curve etc $_1$✓ 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 97 mm to 103 mm $_{34}$✓	for $_1$✓ must be a single continuous line for $M \geq 0.5$ that overlaps with all 6 **+**; condone poorly-marked line (note that poor line quality may only be penalised in **Question 03.4**) for $_2$✓ condone linear extension of curve with negative gradient for $M < +0.5$ for $_3$✓ curve must extend to where read off is being made award of $_4$✓ is contingent on valid $_3$✓ for $_4$✓ answers that round to nearest mm are acceptable	1 1 1 1	1 × AO1 2 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.4	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 $0.1\ \text{cm}^3$ and not (as question states) $0.2\ \text{cm}^3$' 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	1 x AO1 1 x AO2
	correct reading is 35.8 $_2$✓	for $_2$✓ CAO	1	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.5	gradient from $\Delta \log(V / \mathrm{cm}^3)$ divided by $\Delta \log(p / \mathrm{MPa})$; 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	1 x AO2 2 x AO3
	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 13 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 ≈ $\underline{-1}$ demonstrates inverse proportion or wtte	1	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.6		V_2 in range 10.5 to 11.5 (cm^3) earns $_1$✓$_2$✓$_3$✓		1 x AO2
	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	1	2 x AO3
	applies a workable method $_2$✓	for $_2$✓ creditworthy examples are a calculation of the intercept in **Figure 13** 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 $V = -1 \times$ 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	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.7	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 13**)	1	1 x AO1 1 x AO2
	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	
Total			**19**	