A-LEVEL
Physics
7408/2

PAPER 2

Mark scheme

June 2017

Version: 1.0 Final

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 Assessment Writer.

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.

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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 not 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 weber/metre^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.

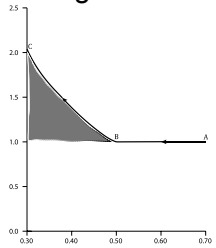
Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme

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

Question	Answers	Additional Comments/Guidelines	Mark
01.1	The volume/size of the gas molecules is negligible/point mass or point molecule Or molecules are point masses Or small compared to the volume/size occupied by of the gas ✓ owtte	No mark for all the same size or spherical. Without the comparison the word used must suggest extremely small. Zero volume is wrong.	1
01.2	(using $N = PV/kT$) $N = (1.0 \times 10^5 \times 0.70 \times 10^{-3}/(1.38 \times 10^{-23} \times 300)$ ✓ (first mark is for converting the temperature to kelvin and using it in a valid equation) $N = 1.7 \times 10^{22}$ molecules ✓ (1.69×10^{22} molecules) Alternatively (using $n = PV/RT$) $n = (1.0 \times 10^5 \times 0.70 \times 10^{-3} / 8.31 \times 300) = 0.028$ mol ✓ (first mark is for converting the temperature to kelvin and using it in a valid equation) N ($= n N_A = 0.028 \times 6.02 \times 10^{23}$) $= 1.7 \times 10^{22}$ molecules ✓ (1.69×10^{22} molecules)	Correct answer scores both marks. Power of 10 issue = AE Temperature conversion = PE	2
01.3	(using $T_B = T_A V_B / V_A$) $T_B = 300 \times 0.50 / 0.70 = 214$ (K) ✓ Change in temperature (= 214 – 300) = (–) 86 (K)✓ Or T_B (= PV/Nk) $= 1.0 \times 10^5 \times 0.50 \times 10^{-3}/(1.38 \times 10^{-23} \times 1.69 \times 10^{22})$ = 214 (K) ✓ Change in temperature (= 214 – 300) = (–) 86 (K)✓ (± 1 K) Or $T_B = (PV/nR) = 1.0 \times 10^5 \times 0.50 \times 10^{-3} /(0.028 \times 8.31)$ = 215 (K) ✓	Correct answer scores both marks. Let the last mark stand-alone provided an attempt at calculating T_B is made. Also allow working in Celsius for this last stand-alone mark.	2

	Change in temperature (= 215 – 300) = (–) 85 (K)✓		

Question	Answers	Additional Comments/Guidelines	Mark
01.4	An appropriate calculation might be: (If the temperature remained constant $P_C = P_B V_B / V_C$) $P_C = 1.0 \times 10^5 \times 0.50 \times 10^{-3} / 0.30 \times 10^{-3} = 1.7 \times 10^5$ (Pa) ✓ (but the pressure at C is higher than this so) the temperature at C is different / higher / not constant ✓ Or (If the temperature remained constant $P_C V_C$ would equal $P_B V_B$) $P_B V_B = 1.0 \times 10^5 \times 0.50 \times 10^{-3} = 50$ $P_C V_C = 2.05 \times 10^5 \times 0.30 \times 10^{-3} = 61$ ✓ (*P V* is not equal) the temperature at C is different / higher / not constant ✓ Or a full calculation can be given using $P V / T$ = constant. $P_B V_B / T_B = 1.0 \times 10^5 \times 0.5 \times 10^{-3} / 214 = (0.234$ J K^{-1}) $T_C = P_C V_C$ / constant $= 2.05 \times 10^5 \times 0.30 \times 10^{-3} / 0.234$ $T_C = 263$ K ✓ the temperature at C is different / higher / not constant ✓	On its own higher temperature scores 0. **Additionally there must be a reference to a correct calculation to obtain the last mark.** The question only requires the candidate to spot a change. The two marks are for each side of a comparison. Complete figures are not always required. For example in the last alternative the common factor 10^5 could be missing. 2nd alternative may come from a ratio. Depending on the sig figs used in the substitution of data the temperature has a range 256 – 270 K *PV* = *NkT* may be used as another alternative. On a few occasions the full paper may be required to view.	2

Question	Answers	Additional Comments/Guidelines	Mark
01.5	work done on gas from **A** to **B** (using $W = P\Delta V$ or W = area under the graph = $1.0 \times (0.70 - 0.50) \times 10^{-3}$) = 20 (J) ✓ giving a reference to the work done being the area under the graph ✓ The third mark can be obtained in the following ways: calculating the area indicated corresponds to the <u>additional work</u> done on the gas from **B** to **C**  (166 mm^2 where 1 mm^2 = 0.05 J) = 8.3 J √ (allow 8.0 – 10.0 J) Or The total work done (566 mm^2 where 1 mm^2 = 0.05 J) = 28.3 (J) ✓ (allow 28.0 – 30.0 J)	This second mark can be obtained from an attempt at an area calculation that involves the curved section of the graph. NB '<u>additional</u> work' must be quoted to give mark for 8 – 10 J. This 3rd mark is for a correct evaluation and not for details of the process.	3
Total			**10**

Question	Answers	Additional Comments/Guidelines	Mark
02.1	Vertically up (third row of table) ✓		1
02.2	(Using Flemings LHR) the configuration of the letters is S N ✓	Answer must be near/on the dashed lines.	1
02.3	The tesla is the (strength) of the magnetic field/flux density that produces a force of 1 newton in a wire of length 1m with 1 ampere (flowing perpendicular to the field). ✓ (owtte but must contain 1N, 1A and 1m)	For mark a reference to 1N, 1A and 1m must be seen. However the word 'unit' is equivalent to '1'. E.g. unit force = 1N. Do not allow definitions based on $F = Bqv$.	1
02.4	Use of ($B = F / I l$) = $m g / I l$ ✓ (mark may come from substitution as in next line) $B = 0.620 \times 10^{-3} \times 9.81 / (3.43 \times 0.0500) = 0.035$ or 0.036 (T) ✓	Treat power of 10 error as an AE so lose one mark only. Lack of use of 'g' is a PE and scores zero.	2
Total			**5**

Question	Answers	Additional Comments/Guidelines	Mark
03.1	It is not possible as the force (due to the magnetic field) is perpendicular to the motion/direction of travel/velocity ✓ (it can only change the charged particle's direction or alternatively no work is done on the proton) Or No component of force in the direction of motion.	The main part being examined is the reference to the force being perpendicular to the motion.	1
03.2	$B\,Q\,v = m\,v^2 / r$ ✓ $t_{\text{semi-circle}}$ (= distance / speed) = $\pi\,r\,/v$ Or use of t_{circle} (= distance / speed) = $2\,\pi\,r\,/v$ ✓(this mark can only be awarded if it follows an attempt to answer the first mark) combining gives ($t_{\text{circle}} = 2\pi\,m\,/\,B\,Q$ so) $t_{\text{semi-circle}} = \pi\,m\,/\,B\,Q$ (which does not contain r / is independent of r) ✓	Accept 'e' if used instead of 'Q' Alternatives can be given for the first two marks. 1st needs a centripetal force term. 2nd is a circular motion expression to enable r to be removed.	3
03.3	(rearranging first equation in 03. 2 or from data booklet $v = B\,Q\,r\,/\,m$) $v = 0.44 \times 1.6 \times 10^{-19} \times 0.55 / 1.67 \times 10^{-27}$ ✓ $v = 2.3 \times 10^{7}$ (m s^{-1}) ✓	Correct answer scores both marks.	2
Total			**6**

Question	Answers	Additional Comments/Guidelines	Mark
04.1	(moderator) - the neutron undergoes an elastic collision/bounces off with less speed/kinetic energy ✓ (Any reference to absorption loses the mark)	Must have the idea that the neutron slow because of collisions	1
04.2	(control rod) – the neutron is absorbed ✓	'stopped' will not get the mark. If alternatives are given all must be correct to gain mark.	1
04.3	the neutron is absorbed/U-236 is formed ✓ (causing) the nucleus (of fuel/uranium) to split into (two smaller) daughter nuclei / nuclei / fragments✓ releasing (several fast-moving) neutrons ✓	1st mark can use words like absorbed/takes in/ 2nd mark: alternative words for nuclei are **not** acceptable (eg daughter ~~products~~) 3rd mark 'neutrons' must be plural.	3

04.4	**Descriptor**	**(Bullet point headings are detailed at the bottom end of the table)**	**Mark**
	High Level – Good to Excellent All three bullet points must be addressed. The source must be identified and two stages in the treatment sequence must be given. Finally three problems encountered in the treatment of waste and how the problems are overcome should be stated. (Note discussion of a problem will often cover a stage of the treatment). *The information presented as a whole should be well organised using appropriate specialist vocabulary. There should only be one or two spelling or grammatical errors for this mark.*	6 marks = At least 6 points made coming from all three of the bullet point headings. (note some written points may count as answers to bullet point headings 2 and 3) 5 marks = 5 points made coming from all three of the bullet point headings. To be in this top band communication skills must be good and the ideas easy to follow.	5–6

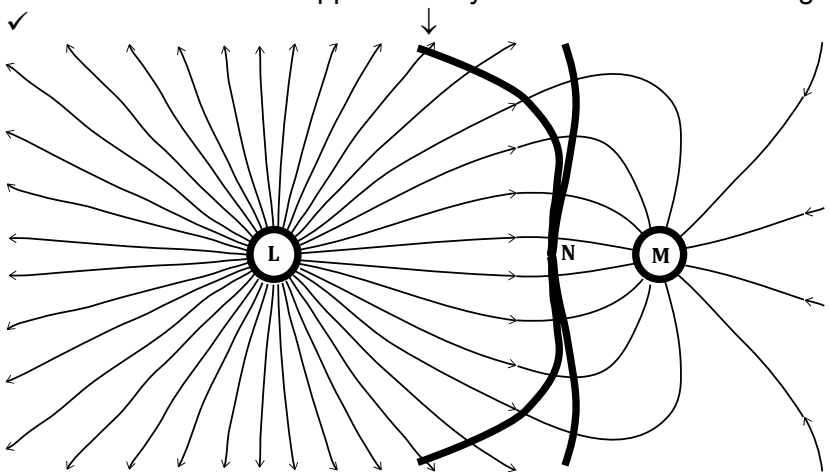
	Intermediate Level – Modest to Adequate All three bullet points must be addressed. The source must be identified as well a stage in the treatment along with a problem encountered in the treatment of waste and how it is dealt with. One additional piece of information must be made from any of the bullet points listed below to be at the top of this band. *The grammar and spelling may have a few shortcomings but the ideas must be clear.*	4 marks = 4 points made coming from at least 2 bullet point headings. 3 marks = 3 points made coming from at least 2 bullet point headings. To be in this moderate band communication skills must good enough to understand the ideas easily even if the order is a little unclear.	3–4
	Low Level – Poor to Limited To be at the top of this band two bullet points must be addressed which must include a problem encountered in the treatment of waste and how it is dealt with. A single mark is awarded if any of the information given in the bullet points listed below is given. *There may be many grammatical and spelling errors and the information may be poorly organised.*	2 marks = Two points made from any bullet point heading. 1 mark = any point made coming from any bullet point heading. Or the script as a whole shows some basic understanding of the issues.	1–2
	The description expected in a competent answer should include: **1st bullet point** The (highly radioactive/ most dangerous) waste are the fission fragments from the fission of uranium-235 or from (spent) fuel rods. **2nd bullet point** The waste is initially placed in cooling ponds/water (close to the reactor for a number of years)		

	plutonium/uranium is separated to be recycled high level waste is vitrified/made solid into (pyrex) glass then placed in (stainless) steel/lead/concrete cylinders/containers/bunkers to be stored **deep** underground (simply stating buried/underground is not enough) **3rd bullet point** (the problem and its solution must both be given, some examples are given below) the waste is (initially) is very hot/generates heat so has to be placed in water/cooling ponds (to remove the heat) the waste (initially) is highly radioactive and needs to be screened in water/cooling ponds (to absorb the radiation) the waste (initially) is highly radioactive and needs to be remotely handled (to avoid human contact with the waste). In liquid form the (high level) waste may leak hence the need to vitrify (and barrel in steel) The waste will be radioactive for hundreds/thousands of years so storage needs to be stable in a container hence the need to vitrify (and barrel in stainless steel) The waste will be radioactive for hundreds/thousands of years so long term storage needs to be in geologically stable areas (deep underground). Transporting waste presents a potential danger to the public so waste is transported enclosed in impact/crash resistant/extra thick and strong casings Or processed onsite or nearby.		

Total			**11**

Question	Answers	Additional Comments/Guidelines	Mark
05.1	(using mass defect = $\Delta m = Z\, m_p + N\, m_n - M_{Co}$) $\Delta m = 27 \times 1.00728 + 32 \times 1.00867 - 58.93320$ (u) ✓ $\Delta m = 0.5408$ (u) ✓ Binding Energy = $0.5408 \times 931.5 = 503.8$ (MeV) ✓ (CE this mark stands alone for the correct energy conversion even if more circular routes are followed.	Look at use of first equation and if electrons are used or mass of proton and neutron confused score = 0. If subtraction is the wrong way round lose 1 mark. Data may come from rest mass eg m_n =939.551 MeV or 1.675×10^{-27} kg or 1.00867 u. So if kg route used $\Delta m = 8.83 \times 10^{-28}$ kg BE = 7.95×10^{-28} J and 497 Mev. Conversion mark (2nd) may come from a wrong value worked through. 0.47(5)	3
05.2	$(2.52 - 1.76) \times 10^{-13} = 7.6 \times 10^{-14}$ J ✓ $7.6 \times 10^{-14} / 1.60 \times 10^{-13} = 0.47$ or 0.48 MeV ✓(0.475 MeV)	Correct answer scores both marks.	2
05.3	6 (specific wavelengths)		1
05.4	(longest wavelength = lowest frequency = smallest energy) $(2.29 \times 10^{-13} - 2.06 \times 10^{-13}) = 2.3 \times 10^{-14}$ (J) ✓ $\lambda\ (= h\,c / E) = 6.63 \times 10^{-34} \times 3.00 \times 10^{8} / 2.3 \times 10^{-14}$ ✓ $\lambda = 8.6 - 8.7 \times 10^{-12}$ (m) ✓ (8.6478×10^{-12} m)	Allow a CE in the second mark only if the energy corresponds to an energy gap including those to the ground state. The allowed energy gaps for CE are: 2.29, 2.06, 1.76, 0.53, 0.30 all x 10^{-13}J Note substitution rather than calculation gains mark. The final mark must be as shown here and not from a CE above.	3
Total			**9**

Question	Answers	Additional Comments/Guidelines	Mark
06.1	Gravitational field lines show the direction (and relative magnitude) of force on a mass (placed in the force field) ✓ Or The direction a stationary/placed mass would (initially) move.		1
06.2	(Lines are closer together so) the field is stronger ✓ (Material forming the Earth) at **K** has a high(er) density (than the surrounding material) ✓	For second mark allow more mass at **K**. 'Force is stronger' does not gain first mark.	2
06.3	The ball will speed up/accelerate (when moving towards **K**) ✓ (because) the potential is lower at **K** ✓ Or the angled field lines between **J** and **K** have a component towards the right ie towards **K**) ✓		2
06.4	A gravitational field should only show attraction to a body / lines of force should only be going to an object / arrow heads (on the left) should point towards **L**. ✓ (owtte)	Reference to positive or negative almost always will lose the mark.	1
06.5	object = L object = L ✓		1

Question	Answers	Additional Comments/Guidelines	Mark
06.6	The drawn line should approximately cross the field lines at right angles ✓  A mark is given if the line is symmetrical top to bottom and it bend to the left. ✓	First mark: Only look at the 4 lines of force close to N. Essentially the range is from a vertical line to one that curves only slightly in order to cross the 4 field lines close to N at right angles. This mark can also be given if a right angle symbol appears on the diagram at any field crossing of the drawn line. Second mark: There must be some bending of the line to the left (beyond the 4 lines close to N) but no more than that indicated by the arrow above the diagram (For reference the range extends to the position of the second field line that is truncated) So a very large circle centred on L and leaving the diagram might get 2nd mark but not the 1st. A vertical line might get the 1st but not the 2nd. A small circle around M will not score. If multiple lines are drawn only mark the line that passes through N.	2
Total			**9**

Question	Answers	Additional Comments/Guidelines	Mark
07.1	(centripetal) force = $m\,r\,(2\,\pi / T)^2$ Or $m\,r\,(\omega)^2$ (is given by the gravitational) force = $G\,m\,M / r^2$ ✓ (mark for both equations) (equating both expressions and substituting for ω if required) $T^2 = (4\pi^2 / GM)\,r^3$ ✓ ($4\pi^2 / GM$ is constant, the constants may be on either side of equation but T and r must be numerators)	First mark is for two equations (gravitational and centripetal) The second mark is for combining.	2
07.2	(use of $T^2 \propto r^3$ so $(T_P / T_E)^2 = (r_P / r_E)^3$) $(T_P / 1.00)^2 = (5.91 \times 10^9 / 1.50 \times 10^8)^3$ ✓ (mark is for substitution of given data into any equation that corresponds to the proportional equation given above) (T_P^2 = 61163) T_P = 250 (yr) ✓ (247 yr)	Answer only gains both marks The calculation may be performed using data for the Sun in $T^2 = (4\pi^2 / GM)\,r^3$ easily spotted from M_s = 1.99 x 10^{30} kg giving a similar answer 247 – 252 yr.	2
07.3	using M (= $g\,r^2 / G$) = $0.617 \times (1.19 \times 10^6)^2 / 6.67 \times 10^{-11}$ ✓ $M = 1.31 \times 10^{22}$ kg ✓ answer to 3 sig fig ✓ (this mark stands alone)	The last mark may be given from an incorrect calculation but not lone wrong answer.	3

07.4	Initial KE = ½ (m) 1400^2 = 9.8 x 10^5 (m) J✓ Energy needed to escape = 7.4 x 10^5 (m) J✓ So sufficient energy to escape. ✓ ***OR*** For object on surface escape speed given by $7.4 \times 10^5 = \frac{1}{2} v^2$✓ escape speed = 1200 m s^{-1}✓(if correct equation is shown the previous mark is awarded without substitution) So sufficient (initial) speed to escape. ✓ ***OR*** escape velocity = $\sqrt{\frac{2GM}{R}}$ substituting *M* from 07.3 ✓ escape speed = 1200 m s^{-1}✓ (1210 m s^{-1}) So sufficient (initial) speed to escape. ✓ ***OR*** escape velocity = $\sqrt{2Rg}$ substituting from data in 07.3 ✓	Third alternative may come from a CE from 07.3 (1.06 x 10^{-8} x $\sqrt{\text{answer } 0.73}$) Conclusion must be explicit for third mark and cannot be awarded from a CE	3
Total			**10**

	Keys to Objective Test Questions (each correct answer is worth 1 mark)												
Q	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	A	C	D	C	A	A	A	A	C	D	C	D
Q	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	

A	A	C	B	B	C	C	D	B	B	A	D	C	