

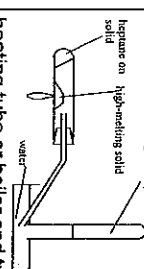

The following annotations may be used when marking:

X	=	incorrect response (errors may also be underlined)
^	=	omission mark
bod	=	benefit of the doubt (where professional judgement has been used)
ecf	=	error carried forward (in consequential marking)
con	=	contradiction (in cases where candidates contradict themselves in the same response)
sf	=	error in the number of significant figures

Abbreviations, annotations and conventions used in the Mark Scheme:

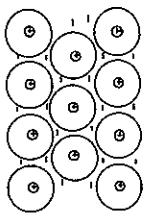
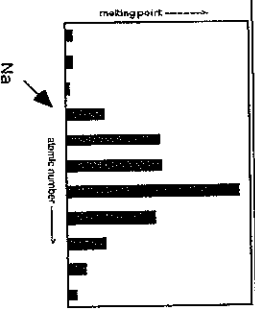
/	=	alternative and acceptable answers for the same marking point
;	=	separates marking points
NOT	=	answers not worthy of credit
()	=	words which are not essential to gain credit
<u>ecf</u>	=	key words which must be used
AW	=	allow error carried forward in consequential marking
ora	=	alternative wording
	=	or reverse argument

1 a i	C-12 6 6 6	C-13 6 7 6	(1) (both correct) (2) (1 each) <i>ecf</i> from protons (1) (both correct) <i>ecf</i> from protons	4
1 a ii	atomic number 6 (<i>ecf</i> from protons above); mass number 12. (ALLOW 12.0)			2
1 b	isotope(s)			1
1 c	3 from 4: (electro)magnetic field); deflects/attracts/repels/bends/anything implying change of direction particles NOT separates (IGNORE type of particle); according to their mass/weight/charge ratio/heavy light; (wrong way is CON); NOT large/small varying the magnetic field brings the particles on to D. (marks can be scored for labels on diagram)			3
1 d	(98.89 x 12) + (1.11 x 13) (= 1201.11) (1) ÷ 100 = 12.01(1)(1) <i>ecf</i> No units. ALLOW amu/g mol ⁻¹ ONLY; 3 decimal places (<i>mark separately provided answer starts with 12</i>)(1)			3
1 e i	C → e/β (1) + (1)N ((1) for consistent symbol and Z, <i>except carbon</i>) extra info added to otherwise correct equation (IGNORE γ) scores max (2) – e/β on left OK. Otherwise electron on left can only score consistent symbol-Z mark. IGNORE minus charge on e.			3
1 e ii	Any four from: β-particles/γ-rays are ionising/ oxidising (1) destroy DNA/cause mutations/cancer/ damage cells/skin/tissue (AW) NOT people/us etc NOT harmful (1); β can penetrate skin/stopped by (any) metal (foil)/stone/concrete(1) γ great penetration/ (only) stopped/absorbed by lead (1) lead container needed to protect (1)			4

2 a i	alkanes(s)	1
2 a ii	CH ₃ -CH ₂ -CH ₂ -CH ₂ -CH ₂ -CH ₂ -CH ₃ etc (or full structural or combination - ALLOW skeletal)	1
2 a iii	Five carbon backbone (1) Correct branches NOT CH ₃ (1) Max (1) for "blobs", allow dots.	2
2 b	structure (as a ii) (1); name (must match structure of carbon backbone) (ignore commas, dashes, gaps) (1)	2
2 c	97% 2,2,4-trimethylpentane and 3% heptane	1
2 d i	alkene(s) (1); cycloalkane(s) (1)	2
2 d ii	C only (1); has a benzene ring/delocalised electrons/is benzene/arene (1) depends on first being scored	2
2 e	 <p>heating tube or boiler and tube with solid, connected without leaks to... (1) CON If sealed: collection tube (or gas syringe) (1) mark separately labels, minimum heptane, catalyst (ignore qualification)/ alumina/pot, catalyst heated (1) (can award label mark if catalyst in heptane) IGNORE condensers</p>	3
2 f i	 <p>double bond (any combination of two dots and two crosses or other symbols)(1); single bonds (1)</p>	2
2 f ii	P = 109 (±2) (1) Q = 120 (±3) (1) (degree sign not needed)	2

2 g i	$C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$ products(1); reactants (1) any balanced equation	2																				
2 g ii	<table border="0"> <tr> <td>Broken</td> <td>2 x C-C 694</td> <td>Made</td> <td>8 x C=O 6440</td> </tr> <tr> <td></td> <td>8 x C-H 3304</td> <td></td> <td>8 x O-H 3712</td> </tr> <tr> <td></td> <td>1 x C=C 612</td> <td></td> <td></td> </tr> <tr> <td></td> <td>6 x O=O 2988</td> <td></td> <td></td> </tr> <tr> <td>Total</td> <td>7598 (1)</td> <td></td> <td>10152 (1)</td> </tr> </table> ecf from equation above Broken - made (1) = 7598 - 10152 = -2554 kJ mol ⁻¹ (1) including sign and unit, ecf	Broken	2 x C-C 694	Made	8 x C=O 6440		8 x C-H 3304		8 x O-H 3712		1 x C=C 612				6 x O=O 2988			Total	7598 (1)		10152 (1)	4
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2 g iii	Average/approx bond enthalpies used/vary between molecules (1); Standard states not used/ reference to H ₂ O (1) (1)	2																				
2 g iv	NOT /mol ⁻¹ ALLOW -2550 kJ mol ⁻¹ (C-C has a) smaller bond enthalpy/weaker bond/less energy to break ORA IGNORE any extra qualification. Must be a comparison.	1																				

3 a i	nitrogen and oxygen react/ combine/bond (together)/ nitrogen is oxidised/ burns /combusts (or correct equation)(1); in the <u>heats/park / high temperature</u> of the engine (1) IGNORE pressure	2
3 a ii	two sets from: acid rain (1); which damages/ life/ corrodes buildings/causes eutrophication (1) smogs/ozone production/ irritates/ respiratory track(1); harmful to life/ toxic*(1) greenhouse gases (1); which cause global warming *(1) dissolves in water/courses (etc) (1); causes algal bloom /eutrophication (1) destroys stratospheric ozone/ozone layer (1); which removes protection from/ increases u.v./causes sunburn/skin cancer (1) ALLOW second mark on its own if <i>stratospheric</i> omitted. ALLOW second mark without first only where shown or where ""	4
3 b	Incomplete combustion/ burning/ oxidation (of fuel) or carbon released/ produced from fuel/hydrocarbon during combustion/reaction/decomposition of fuel	1
3 c i	different state/phase (from reactants)	1
3 c ii	$C + 2NO_2 \rightarrow CO_2 + 2NO$ correct formulae(1) ; balanced (1) second mark depends on first being scored ALLOW doubled or halved	2
3 c iii	A: C/CO ₂ NO ₂ B: CO ₂ NO	2

4 a	M_r Pb(C ₂ H ₅) ₄ = 323 (1) stated or implied % = $207 \times 100/323 = 64(\%)$ ecf IGNORE significant figures	2
4 b i	 lattice of metal particles (minimum two rows and three particles in all) labelled (or indicated) as positive (up to 4+) (1) IGNORE any description of particles electrons labelled between (1) (e or e ⁻) can be labelled "pool of electrons"	2
4 b ii	held together by attraction between electrons and ions/ nuclear/positive residue/particles NOT just "electrostatic attraction". Other bonding descriptions are CON	1
4 c i	atomic/proton number(s)	1
4 c ii	(relative) atomic mass/weight NOT mass number	1
4 d i	falls/ gets weaker (AW) rises and falls (but rises to any element except Al is CON)	1
4 d ii	 Na correctly identified (1); reason (follows low value for noble gas/ worked back from silicon) (1)	2
4 d iii	$Na(g) \rightarrow Na^+(g) + e^-$ (1) for some ionisation of sodium (to positive ion) (not necessarily balanced or including electrons) (1) for correct equation ALLOW nuclear symbols (1) for state symbols for Na and ions	3
4 d iv	Chlorine (1) ALLOW Cl/ Cl ₂ It has the most protons/ highest atomic number/ highest Z (1); more attraction for electrons/ held more tightly/ harder to remove (1) only if second mark correct or if "smallest atom" mentioned. "I.E. Increases across period" scores (1)	3