

In 2005 the *particles* and *thermochemistry* topics were examined in two separate achievement standards (90697: Describe selected atomic, molecular and ionic properties, and 90699: Describe and use thermochemical principles). From 2006 those two standards were combined in a new Chemistry 3.4 (90780: Describe properties of particles and thermochemical principles).

This paper combines those questions from the two 2005 papers which are still relevant.

Chemistry 3.4 and 3.6 2005

90780 Describe properties of particles and thermochemical principles

Credits: Five

You should answer ALL the questions in this booklet.

Show all working for calculations.

If you need more space for any answer, add in extra pages and clearly number the question.

A periodic table is provided on the final page of this booklet.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Achievement Criteria		
Achievement	Achievement with Merit	Achievement with Excellence
Describe properties of particles and thermochemical principles. <input type="checkbox"/>	Explain and apply properties of particles and thermochemical principles. <input type="checkbox"/>	Discuss properties of particles and thermochemical principles. <input type="checkbox"/>
Overall Level of Performance		<input type="checkbox"/>

You are advised to spend 60 minutes answering the questions in this booklet.

QUESTION ONE: ATOMIC PROPERTIES

- a** State the trend in atomic radius and in first ionisation energy (IE) down Group 2 from Be to Ca. Give an explanation for these trends.

Trend in atomic radius from Be to Ca: _____

Trend in first IE from Be to Ca: _____

Explanation:

- b i** Write the electron configuration using *s*, *p*, *d* notation for:

F . _____

F⁻ _____

Na⁺ _____

- ii** Compare the relative sizes of the F atom and the F⁻ ion, and explain the difference in their radii.

- iii Compare the relative sizes of the F^- atom and the Na^+ ion, and explain the difference in their radii.

QUESTION TWO: STRUCTURE AND PROPERTIES OF COMPOUNDS

- a i Draw Lewis diagrams for nitrate (NO_3^-) and iodate (IO_3^-) ions.

- ii Identify the shapes of these two ions and explain why their shapes are different.

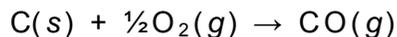
NO_3^- _____

IO_3^- _____

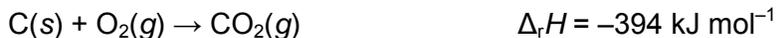
QUESTION FOUR: EXTRACTION OF HYDROGEN

The following reactions are involved in the extraction of hydrogen from coal.

- a Coal is converted to carbon monoxide according to the following equation.



Calculate the enthalpy change for the reaction above using the following information.



- b The carbon monoxide produced above is reacted with steam to produce hydrogen gas.



Bond	Bond enthalpy (kJ mol ⁻¹)
O–H	463
H–H	436
C=O	743

- i The bond enthalpies for the carbon to oxygen bonds in CO₂ and CO are different. Use the bond enthalpies in the table and the enthalpy of the reaction to calculate the bond enthalpy of the carbon to oxygen bond in carbon monoxide.

ii Why are bond enthalpy values always positive?

iii Explain the difference between the following bond enthalpies.

Bond	Bond enthalpy (kJ mol^{-1})
C=O	743
C-O	351

QUESTION FIVE: FIREWORKS

- a** Barium nitrate is one of the components of 'sparklers'. The standard enthalpy of formation ($\Delta_f H^\circ$) of solid barium nitrate, $\text{Ba}(\text{NO}_3)_2$, is -992 kJ mol^{-1} .

Write the balanced equation for the reaction that gives the enthalpy of formation of $\text{Ba}(\text{NO}_3)_2$. Include the state of each species in this reaction.

- b** The reaction that occurs when 'sparklers' burn is:

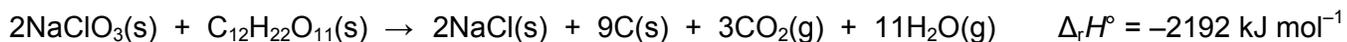


Calculate the enthalpy change for this reaction using the data given below.

Compound	$\Delta_f H^\circ$ (kJ mol^{-1})
$\text{Ba}(\text{NO}_3)_2(s)$	-992
$\text{BaO}(s)$	-554
$\text{Al}_2\text{O}_3(s)$	-1676

- c The principle of a fireworks-type explosion can be demonstrated by igniting a sucrose jelly-baby with sodium chlorate, NaClO_3 .

The equation for the explosion reaction is:



- i Calculate the quantity of heat released when one jelly-baby containing 4.56 g of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) is exploded. $M(\text{C}_{12}\text{H}_{22}\text{O}_{11}) = 342 \text{ g mol}^{-1}$

- ii The heat released by the explosion can be used to vaporise strontium chloride to give the fireworks colour.

The heat required to convert SrCl_2 from the solid to the gas state is 343 kJ mol^{-1} .

Use your answer to i above to calculate the mass of solid SrCl_2 that can be vaporised by exploding one jelly-baby containing 4.5 g of sucrose. $M(\text{SrCl}_2) = 159 \text{ g mol}^{-1}$

PERIODIC TABLE OF THE ELEMENTS

																		18		
1	2											13	14	15	16	17	2			
3 Li 6.9	4 Be 9.0	Atomic Number										5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2	1 H 1.0	Atomic Mass	
11 Na 23.0	12 Mg 24.3	3	4	5	6	7	8	9	10	11	12	13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.0	17 Cl 35.5	18 Ar 40.0			
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.6	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 78.9	35 Br 79.9	36 Kr 83.8			
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98)	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131			
55 Cs 133	56 Ba 137	71 Lu 175	72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 Tl 204	82 Pb 207	83 Bi 209	84 Po 210	85 At 210	86 Rn 222			
87 Fr 223	88 Ra 226	103 Lr 262	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt												

Lanthanide Series	57 La 139	58 Ce 140	59 Pr 141	60 Nd 144	61 Pm 147	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173
Actinide Series	89 Ac 227	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu 239	95 Am 241	96 Cm 247	97 Bk 249	98 Cf 251	99 Es 254	100 Fm 257	101 Md 258	102 No 255