1 (a) decreases

number of levels increases or the shielding increases or the atomic size increases
therefore there is weaker attraction by nucleus on bonding pair of electrons in the covalent bond

(b) (i) increases

(ii) concentrated sulfuric acid

c (i) white precipitate
soluble in ammonia
cream precipitate
partially soluble / insoluble in ammonia

(d) \( \text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O} \)
bleach
disinfectant or steriliser or kills bacteria

2 (a) reduction is gain of electrons
a reducing agent donates electrons

(b) (i) sulfur dioxide
  oxidation state +4
  sulfur
  oxidation state 0
  hydrogen sulfide
  oxidation state −2

(ii) any two from:
  • sulfur dioxide is a choking gas or has a pungent odour
  • sulfur is a yellow solid
  • hydrogen sulfide has a smell of bad eggs

(iii) any two from:
  \( \text{SO}_4^{2−} + 4\text{H}^+ + 2e^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O} \)
  \( \text{SO}_4^{2−} + 8\text{H}^+ + 6e^- \rightarrow \text{S} + 4\text{H}_2\text{O} \)
  \( \text{SO}_4^{2−} + 10\text{H}^+ + 8e^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} \)

Answers Marks Examiner’s tips
---
1 (a) decreases 1 Learn the trend since you will lose the next marks if the trend is wrong.
1 number of levels increases or the shielding increases or the atomic size increases
1 therefore there is weaker attraction by nucleus on bonding pair of electrons in the covalent bond
1 Think of this as the halide ion that can be oxidised itself the most easily. This may help.
1 increases
1 concentrated sulfuric acid
1 You really need to learn the colours of the precipitates. Silver chloride is a white solid and silver bromide is cream. The question only asks about the effect of dilute ammonia so don’t say that ‘the cream precipitate dissolves in conc. ammonia’. Just answer the question.
(d) \( \text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O} \)
1 bleach
1 disinfectant or steriliser or kills bacteria
1
2 (a) reduction is gain of electrons
1 a reducing agent donates electrons
1 Or reducing agents give electrons away. Do not say electron pairs!
1 sulfur dioxide
1 oxidation state +4
1 sulfur
1 oxidation state 0
1 hydrogen sulfide
1 oxidation state −2
1 This is often answered very badly since candidates do not learn the reduction products well. You can always work out the oxidation states if you do not want to learn them.
1 any two from:
2 • sulfur dioxide is a choking gas or has a pungent odour
2 • sulfur is a yellow solid
2 • hydrogen sulfide has a smell of bad eggs
2 any two from:
2 \( \text{SO}_4^{2−} + 4\text{H}^+ + 2e^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O} \)
2 \( \text{SO}_4^{2−} + 8\text{H}^+ + 6e^- \rightarrow \text{S} + 4\text{H}_2\text{O} \)
2 \( \text{SO}_4^{2−} + 10\text{H}^+ + 8e^- \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} \)
2 Equations with H₂SO₄ are allowed.
2 Make sure the equations match up to the products you choose.
### Chapter 11

**Answers to examination-style questions**

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</table>
| (c) Cl₂ + H₂O → H⁺ + Cl⁻ + HOCl  
   or Cl₂ + H₂O → 2H⁺ + Cl⁻ + OCt⁻  
   or Cl₂ + H₂O → HCl + HOCt  
   water is not oxidised  
   the oxidation states of O (−2) and H (+1) remain unchanged | 1 | If you say the water is not oxidised – it is reduced – you lose the mark because water is neither oxidised nor reduced. |
| 3 (a) increase  
   van der Waals forces between molecules  
   increase with size or M<sub>r</sub> or surface area  
   more energy needed to overcome these forces | 1 | If you do not mention molecules somewhere in the answer you will lose one mark. If the trend is wrong you lose all the marks in (a). |
| (b) (i) brown / yellow / orange solution  
   Cl₂ + 2Br⁻ → 2Cl⁻ + Br₂  
   (ii) cream precipitate, precipitate dissolves (since the question asks about conc. ammonia)  
   Br⁻ + Ag⁺ → AgBr  
   (iii) orange / brown fumes / gas, white / misty fumes, choking gas (any 2 for 1 mark)  
   2H⁺ + H₂SO₄ + 2Br⁻ → SO₂ + Br₂ + 2H₂O | 1 | You must state the colour and the fact that it is a solution.  
  1 | If you cannot complete the equation you must always do as much as you can. Just getting the products SO₂ and Br₂ will get you one of the marks, and balance the equation if you can. |
| (c) any two from:  
   H₂S and 8e⁻ + 8H⁺ + H₂SO₄ → H₂S + 4H₂O or equation with SO₄<sup>2⁻</sup>  
   S and SO₄<sup>2⁻</sup> + 8H⁺ + 6e⁻ → S + 4H₂O or equation with H₂SO₄  
   SO₂ and SO₄<sup>2⁻</sup> + 4H⁺ + 2e⁻ → SO₂ + 2H₂O or equation with H₂SO₄ | 2 |  
| 4 (a) decreases  
   increase in shielding / increase in atomic radius  
   less attraction for bonding pair of electrons | 1 | Iodine is a black solid but gives a brown solution. You must not refer to iodine as purple since that is iodine gas / vapour. |
| (b) brown solution or black solid  
   Cl₂ + 2KI → 2KCl + I₂ | 1 | You can write an ionic equation here instead. |
### Answers to examination-style questions

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| **(c)** | SO₂  
SO₄²⁻ + 4H⁺ + 2e⁻ → SO₂ + 2H₂O  
S  
SO₄²⁻ + 8H⁺ + 6e⁻ → S + 4H₂O | 1 | You can have H₂S and its equation as an alternative. You need two out of S, SO₂ and H₂S for 2 marks and the correct associated equations for another 2 marks.  
H₂S  
SO₄²⁻ + 10H⁺ + 6e⁻ → H₂S + 4H₂O | 1 |
| **(d)** | Cl₂ + 2NaOH → NaCl + NaOCl + H₂O  
sodium chloride  
−1  
sodium chlorate(I)  
+1 | 1 | The name shows the +1 oxidation state of the chlorine in NaOCl | 1 |

5  
(a) fluorine or F₂ or F  
(b) I⁻  
(c) observation with NaF(aq): no change or colourless solution  
observation with NaI(aq): yellow solid / precipitate  
equation: I⁻(aq) + Ag⁺(aq) → AgI(s)  
or NaI(aq) + AgNO₃(aq) → NaNO₃(aq) + AgI(s)  
(d) observation: steamy / white / misty fumes  
Equation: NaCl + H₂SO₄ → NaHSO₄ + HCl  
(e) any two from:  
black solid or purple gas / choking fumes / yellow solid / smell bad eggs  
the equation can be one of a choice of three. one example is 2NaI + 2H₂SO₄ → Na₂SO₄ + 2H₂O + I₂ + SO₂  
(2) The smell must be of bad eggs not just an eggy smell.  
The second mark is for completing and balancing the equation.
## Answers to examination-style questions

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<td>6 (a) increases from fluorine to iodine sizes of molecules increase magnitude of intermolecular forces increases or more van der Waals forces more energy required to separate molecules or more energy to break intermolecular forces</td>
<td>1</td>
<td>This is the energy needed to overcome the forces between the molecules not the bonds in the molecules.</td>
</tr>
<tr>
<td>(b) with NaCl: when aqueous silver nitrate added white precipitate formed soluble in dilute aqueous ammonia</td>
<td>1</td>
<td>You must state the colour and that there is a precipitate or solid.</td>
</tr>
<tr>
<td>(c) oxidising ability decreases from chlorine to iodine ( \text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2 ) ( \text{Br}_2 ) brown / yellow/orange liquid or solution</td>
<td>1</td>
<td>If precipitate clearly refers to wrong substance, e.g. NaCl dissolving, then this will not get the mark.</td>
</tr>
<tr>
<td>( \text{Cl}_2 + 2\text{I}^- \rightarrow 2\text{Cl}^- + \text{I}_2 ) ( \text{I}_2 ) brown solution / black solid</td>
<td>1</td>
<td>The question refers to dilute aqueous ammonia only.</td>
</tr>
<tr>
<td>( \text{Br}_2 + 2\text{I}^- \rightarrow 2\text{Br}^- + \text{I}_2 ) yellow/orange/brown solution goes brown/darker brown solution / black solid</td>
<td>1</td>
<td>State liquid or solution. Bromine cannot be solid so don’t say brown solid because you will lose the mark.</td>
</tr>
<tr>
<td>7 (a) to kill bacteria or sterilise water</td>
<td>1</td>
<td>This is not to purify water.</td>
</tr>
<tr>
<td>(b) equation: ( \text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HClO} + \text{HCl} ) identity of substance: chlorine or ( \text{Cl}_2 )</td>
<td>1</td>
<td>No reference to purple at all. That would be iodine vapour and this is in solution.</td>
</tr>
<tr>
<td>8 (a) decrease number of shells increases or atomic radius increases increased nuclear shielding or less attraction for bond pair of electrons</td>
<td>1</td>
<td>If the trend is wrong then this is a chemical error and you will lose all three marks.</td>
</tr>
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Chapter 11

Chemistry

AS Extension teacher notes

Answers to examination-style questions

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<tr>
<td><strong>(b)</strong> (i) observation: brown solution or black solid</td>
<td>1</td>
<td>Do not make reference to purple. This would be iodine vapour and this is wrong.</td>
</tr>
<tr>
<td>equation: ( \text{Br}_2 + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{Br}^- )</td>
<td>1</td>
<td>If you do not like ionic equations then you could use NaI or KI instead of just I(^-) here.</td>
</tr>
<tr>
<td>(ii) ( \text{Br}_2 ) is a weaker oxidising agent than ( \text{Cl}_2 )</td>
<td>1</td>
<td>You could say ( \text{Br}_2 ) is less reactive than ( \text{Cl}_2 )</td>
</tr>
<tr>
<td><strong>(c)</strong> observation with ( \text{KF(aq)} ): no change</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>observation with ( \text{KBr(aq)} ): cream / off-white ppt / solid</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>(d)</strong> ( \text{KF} + \text{H}_2\text{SO}_4 \rightarrow \text{KHSO}_4 + \text{HF} )</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>or ( 2\text{KF} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{HF} )</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>(e)</strong> ( 2\text{H}_2\text{SO}_4 + 2\text{Br}^- \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O} + \text{SO}_4^{2-} )</td>
<td>2</td>
<td>One mark is for the products ( \text{SO}_2 + \text{Br}_2 ) and the second mark for completing and balancing the equation. ( 2\text{H}_2\text{SO}_4 + 2\text{NaBr} \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O} + \text{Na}_2\text{SO}_4 ) is allowed.</td>
</tr>
</tbody>
</table>

**9 (a)** (i) \(-2\)  
(ii) Na\(_1\) or NaAt or \( \Gamma^- \) or iodide or At\(^-\) or astatide  
(iii) smell of bad eggs  
(iv) \( 8\text{e}^- + 8\text{H}^+ + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} \)  
\( \text{or} 8\text{e}^- + 10\text{H}^+ + \text{SO}_4^{2-} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O} \)  
1  
1  
1  
1

(b) (i) HF or HCl  
(ii) NaF or NaCl or F\(^-\) or Cl\(^-\)  
(iii) a proton donor  
(iv) \( \text{H}^+ + \text{F}^- \rightarrow \text{HF} \)  
\( \text{or} \text{H}_2\text{SO}_4 + \text{NaF} \rightarrow \text{NaHSO}_4 + \text{HF} \)  
\( \text{or} \text{H}_2\text{SO}_4 + 2\text{NaF} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HF} \)  
1  
1  
1  
1

Nelson Thornes is responsible for the solution(s) given and they may not constitute the only possible solution(s).