

**Assigning Oxidation Numbers**  
(Student textbook page 606)

11. Determine the oxidation number of the atoms of the specified element in the following: N in  $\text{NF}_3(\text{g})$

**What Is Required?**

You must determine the oxidation number of an atom of nitrogen in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{NF}_3(\text{g})$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

<b>Plan Your Strategy</b>	<b>Act on Your Strategy</b>
Apply rule 5: the oxidation number of the more electronegative element is the same as the charge it would have as an ion. Determine the electronegativity of the two elements.	Since F is more electronegative, the fluorine ion is assigned a value of $-1$ .
The oxidation number of N is unknown, but you know that the compound has a net charge of zero. Therefore, apply rule 6: the oxidation numbers must add to zero. Let $x$ represent the oxidation number of N.	$1 \text{ N atom} + 3 \text{ F atoms} = 0$ $x + 3(-1) = 0$ $x - 3 = 0$ $x = +3$

The oxidation number of nitrogen is  $+3$ .

**Check Your Solution**

The rules were followed and the answer is logical.

12. Determine the oxidation number of the atoms of the specified element in the following: S in  $S_8(s)$

**What Is Required?**

You must determine the oxidation number of an atom of sulfur in a given compound.

**What Is Given?**

You are given the chemical formula  $S_8(s)$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
Apply rule 1: A pure element has an oxidation number of zero.	Since $S_8(s)$ is made up only of sulfur atoms, each atom has an oxidation number of zero.

**Check Your Solution**

The rules were followed and the answer is logical.

13. Determine the oxidation number of the atoms of the specified element in the following: Cr in  $CrO_4^{2-}(aq)$

**What Is Required?**

You must determine the oxidation number of an atom of chromium in a given compound.

**What Is Given?**

You are given the chemical formula  $CrO_4^{2-}(aq)$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
$CrO_4^{2-}(aq)$ contains oxygen. Apply rule 4.	The oxidation number of oxygen is $-2$ .
Apply rule 7: the sum of the oxidation numbers of all atoms in a polyatomic ion equals the charge on the ion. Let $x$ represent the oxidation number of Cr.	$1 \text{ Cr atom} + 4 \text{ O atoms} = -2$ $x + 4(-2) = -2$ $x - 8 = -2$ $x = +6$

The oxidation number of Cr is  $+6$ .

**Check Your Solution**

The rules were followed and the answer is logical.

14. Determine the oxidation number of the atoms of the specified element in the following: P in  $\text{P}_2\text{O}_5(\text{s})$

**What Is Required?**

You must determine the oxidation number of an atom of phosphorus in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{P}_2\text{O}_5(\text{s})$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

<b>Plan Your Strategy</b>	<b>Act on Your Strategy</b>
$\text{P}_2\text{O}_5(\text{s})$ contains oxygen. Apply rule 4.	The oxidation number of oxygen is $-2$ .
The oxidation number of P is unknown, but you know that the compound has a net charge of zero. Therefore, apply rule 6: the oxidation numbers must add to zero. Let $x$ represent the oxidation number of P.	$2 \text{ P atoms} + 5 \text{ O atoms} = 0$ $2x + 5(-2) = 0$ $2x - 10 = 0$ $2x = 10$ $x = +5$

The oxidation number of P is  $+5$ .

**Check Your Solution**

The rules were followed and the answer is logical.

15. Determine the oxidation number of the atoms of the specified element in the following: C in  $C_{12}H_{22}O_{11}(s)$

**What Is Required?**

You must determine the oxidation number of an atom of carbon in a given compound.

**What Is Given?**

You are given the chemical formula  $C_{12}H_{22}O_{11}(s)$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
$C_{12}H_{22}O_{11}(s)$ contains oxygen and hydrogen. Apply rules 3 and 4.	The oxidation number of oxygen is $-2$ and the oxidation number of hydrogen is $+1$ .
The oxidation number of C is unknown, but you know that the compound has a net charge of zero. Therefore, apply rule 6: the oxidation numbers must add to zero. Let $x$ represent the oxidation number of C.	$12 \text{ C atoms} + 22 \text{ H atoms} + 11 \text{ O atoms} = 0$ $12x + 22(+1) + 11(-2) = 0$ $12x + 22 - 22 = 0$ $12x = 0$ $x = 0$

The oxidation number of C is 0.

**Check Your Solution**

The rules were followed and the answer is logical. Because there are 12 carbon atoms in the molecule and they are not all bonded to atoms of other elements in the same way, the oxidation number, 0, is an average of the 12 atoms and not the exact oxidation number of each carbon atom.

16. Determine the oxidation number of the atoms of the specified element in the following: H in  $\text{CaH}_2(\text{s})$

**What Is Required?**

You must determine the oxidation number of an atom of hydrogen in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{CaH}_2(\text{s})$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
$\text{CaH}_2(\text{s})$ contains hydrogen, so apply rule 3.	This is a metallic hydride, so the oxidation number of hydrogen is $-1$ .

**Check Your Solution**

The rules were followed. The oxidation number is logical because the oxidation numbers of the two hydride ions add to  $-2$  and the oxidation number of calcium is  $+2$ . The total is zero and the compound is neutral.

17. Determine the oxidation number of each of the atoms in the following compound:  $\text{H}_2\text{SO}_3(\text{aq})$

**What Is Required?**

You must determine the oxidation number of each of the atoms in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{H}_2\text{SO}_3(\text{aq})$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
$\text{H}_2\text{SO}_3(\text{aq})$ contains oxygen and hydrogen. Apply rules 3 and 4.	The oxidation number of oxygen is $-2$ , and the oxidation number of hydrogen is $+1$ .
The oxidation number of C is unknown, but you know that the compound has a net charge of zero. Therefore, apply rule 6: the oxidation numbers must add to zero. Let $x$ represent the oxidation number of C.	$2 \text{ H atoms} + 1 \text{ S atom} + 3 \text{ O atoms} = 0$ $2(+1) + x + 3(-2) = 0$ $2 + x - 6 = 0$ $x = 6 - 2$ $x = +4$

The oxidation number of H is  $+1$ , the oxidation number of O is  $-2$  and the oxidation number of S is  $+4$ .

**Check Your Solution**

The rules were followed and the answer is logical.

18. Determine the oxidation number of each of the atoms in the following compound:  $\text{OH}^-$ (aq)

**What Is Required?**

You must determine the oxidation number of each of the atoms in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{OH}^-$ (aq). You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
$\text{OH}^-$ (aq) contains oxygen and hydrogen. Apply rules 3 and 4.	The oxidation number of oxygen is $-2$ , and the oxidation number of hydrogen is $+1$ .

**Check Your Solution**

The rules were followed and the answer is logical.

19. Determine the oxidation number of each of the atoms in the following compound:  $\text{HPO}_4^{2-}$ (aq)

**What Is Required?**

You must determine the oxidation number of each of the atoms in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{HPO}_4^{2-}$ (aq). You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
$\text{HPO}_4^{2-}$ (aq) contains oxygen and hydrogen. Apply rules 3 and 4.	The oxidation number of oxygen is $-2$ , and the oxidation number of hydrogen is $+1$ .
Apply rule 7: the sum of the oxidation numbers of all atoms in a polyatomic ion equals the charge on the ion. Let $x$ represent the oxidation number of P.	$1 \text{ H atom} + 1 \text{ P atom} + 4 \text{ O atoms} = -2$ $+1 + x + 4(-2) = -2$ $x - 7 = -2$ $x = +5$

The oxidation number of H is  $+1$ , the oxidation number of O is  $-2$ , and the oxidation number of P is  $+5$ .

**Check Your Solution**

The rules were followed and the answer is logical.

20. Determine the oxidation number of oxygen in the following:  $O_2(g)$

**What Is Required?**

You must determine the oxidation number of an atom of oxygen in a given compound.

**What Is Given?**

You are given the chemical formula  $O_2(g)$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
Apply rule 1: A pure element has an oxidation number of zero.	Since $O_2(g)$ is made up only of oxygen atoms, each atom has an oxidation number of zero.

**Check Your Solution**

The rules were followed and the answer is logical.

21. Determine the oxidation number of oxygen in the following: the peroxide ion,  $O_2^{2-}(aq)$

**What Is Required?**

You must determine the oxidation number of an atom of oxygen in a given compound.

**What Is Given?**

You are given the chemical formula  $O_2^{2-}(aq)$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
Apply rule 7: the sum of the oxidation numbers of all atoms in a polyatomic ion equals the charge on the ion. Let $x$ represent the oxidation number of O.	$2 \text{ O atoms} = -2$ $2x = -2$ $x = -1$

The oxidation number of O is  $-1$ .

**Check Your Solution**

The rules were followed. Rule 4 also says that the oxidation number of oxygen in peroxides and superoxides is not  $-2$ .

22. Determine the oxidation number of each element in the following ionic compound by considering the ions separately:  $\text{Al}(\text{HCO}_3)_3(\text{s})$

**What Is Required?**

You must determine the oxidation number of each element in a given compound.

**What Is Given?**

You are given the chemical formula  $\text{Al}(\text{HCO}_3)_3(\text{s})$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
Separate the ions in the compound.	$\text{Al}(\text{HCO}_3)_3$ is made up of $\text{Al}^{3+}$ and $\text{HCO}_3^-$
Apply rule 2 to $\text{Al}^{3+}$ : The oxidation number of an element in a monoatomic ion equals the charge on the ion.	The oxidation number of $\text{Al}^{3+}$ is +3.
Apply rule 7 to $\text{HCO}_3^-$ : the sum of the oxidation numbers of all atoms in a polyatomic ion equals the charge on the ion. Let $x$ represent the oxidation number of C.	$1 \text{ H atom} + 1 \text{ C atom} + 3 \text{ O atoms} = -1$ $+1 + x + 3(-2) = -1$ $x - 5 = -1$ $x = +4$

The oxidation number of Al is +3, the oxidation number of H is +1, the oxidation number of C is +4, and the oxidation number of O is -2.

**Check Your Solution**

The rules were followed and the answer is logical.

23. Determine the oxidation number of each element in the following ionic compound by considering the ions separately:  $(\text{NH}_4)_4\text{PO}_4(\text{aq})$

**What Is Required?**

You must determine the oxidation number of each element in a given compound.

**What Is Given?**

You are given the chemical formula  $(\text{NH}_4)_4\text{PO}_4(\text{aq})$ . You can refer to the rules in **Table 9.3** on page 604 of the student textbook.

Plan Your Strategy	Act on Your Strategy
Separate the ions in the compound.	$(\text{NH}_4)_4\text{PO}_4(\text{aq})$ is made up of $\text{NH}_4^+$ and $\text{PO}_4^{3-}$
Apply rule 7 to $\text{NH}_4^+$ and $\text{PO}_4^{3-}$ : the sum of the oxidation numbers of all atoms in a polyatomic ion equals the charge on the ion. Let $x$ represent the oxidation number of N and let $y$ represent the oxidation number of P.	$1 \text{ N atom} + 4 \text{ H atoms} = +1 \quad 1 \text{ P atom} + 4 \text{ O atoms} = -3$ $x + 4(+1) = +1 \quad y + 4(-2) = -3$ $x + 4 = +1 \quad y - 8 = -3$ $x = -3 \quad y = +5$

The oxidation number of N is  $-3$ , the oxidation number of H is  $+1$ , the oxidation number of P is  $+5$ , and the oxidation number of O is  $-2$ .

**Check Your Solution**

The rules were followed and the answer is logical.