1. Reduction involves
   A an increase in atomic number.
   B a decrease in number of electrons.
   C an increase in mass number.
   D a decrease in oxidation number.

2. Oxidation involves
   A a decrease in oxidation number.
   B an increase in oxidation number.
   C a decrease in number of protons.
   D an increase in number of protons.

3. Which of the following statements is INCORRECT?
   A Oxidation and reduction occur at the same time.
   B When a species is reduced, the oxidation number of an element in the species decreases.
   C All oxidations involve loss of electrons.
   D When oxygen is added to a species, the species is oxidized.

4. When zinc forms zinc oxide, zinc
   A gains electrons and is oxidized.
   B loses electrons and is oxidized.
   C gains electrons and is reduced.
   D loses electrons and is reduced.

5. Which of the following statements concerning an oxidizing agent is INCORRECT?
   A An oxidizing agent is oxidized in a redox reaction.
   B An oxidizing agent can oxidize other species in a redox reaction.
   C An oxidizing agent is an electron acceptor.
   D The oxidation number of a certain element in an oxidizing agent decreases in a redox reaction.

6. Which of the following elements in the third period of the periodic table is the *strongest* reducing agent?
   A Aluminium
   B Chlorine
   C Magnesium
   D Sodium

7. Consider the following table.

Element	W	X	Y	Z
Atomic number	3	7	9	18

Which of the above elements is likely to be a reducing agent?
   A W
   B X
   C Y
   D Z

8. Which of the following statements concerning potassium is correct?
   A Potassium is a hard solid at room conditions.
   B Potassium is a stronger reducing agent than sodium.
   C Potassium reacts with chlorine to form a covalent compound.
   D Potassium is less reactive than lithium.

9. Which of the following statements concerning magnesium is INCORRECT?
   A Magnesium is a stronger reducing agent than silver.
   B Magnesium forms ions more readily than silver.
   C Magnesium ion is a stronger oxidizing agent than silver ion.
   D Magnesium can displace silver from silver nitrate solution.

10. What is the oxidation number of Cl in $HClO_2$?
   A –1
   B +1
   C +3
   D –3

11. The oxidation number of vanadium in VO_2^+ is
   A +3.
   B +4.
   C +5.
   D +6.

12. The oxidation number of oxygen in H_2O_2 is
   A –1.
   B –2.
   C +1.
   D +2.

13. What is the oxidation number of rhenium (Re) in ReO_4^-?
   A +1
   B +3
   C +4
   D +7

14. The oxidation number of zinc in $Zn(NH_3)_4^{2+}$ is
   A –2.
   B 0.
   C +2.
   D +4.

15. What is the oxidation number of chromium in the complex ion $[Cr(H_2O)_4Br_2]^+$?
    A –1
    B +1
    C +2
    D +3

16. Which of the following compounds contains a metal in the +1 oxidation state?
    A $Co(NH_3)_4Cl_2$
    B MnO_4^{2-}
    C $[Pb(OH)_4]^{2-}$
    D $Ag(NH_3)_2NO_3$

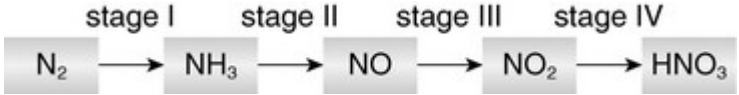
17. In which compound does iodine have an oxidation state of +3?
    A HIO_3
    B NaI_3
    C CrI_3
    D $NaIO_2$

18. In which of the following pairs of substances are the oxidation numbers of sulphur and nitrogen the same?
    A H_2SO_4 and HNO_3
    B H_2SO_3 and NO_2
    C Na_2S and NO
    D FeS and NH_4Cl

19. In which of the following pairs of substances are the oxidation numbers of chlorine and nitrogen the same?
    A HCl and $NaNO_3$
    B HOCl and NO_2
    C $NaClO_3$ and $Ca(NO_3)_2$
    D SCl_2 and NO

20. In which of the following compounds does vanadium (V) exhibit the *highest* oxidation number?
    A VO^{2+}
    B V_2O_3
    C VO_3^-
    D VO_2

21. The manufacture of nitric acid can be represented by the following flow diagram.



    Which stage involves the *greatest* change in the oxidation number of nitrogen?
    A Stage I
    B Stage II
    C Stage III
    D Stage IV

22. Which of the following changes involves an increase in oxidation number of the underlined element?
    A $\underline{Cl}_2(g) \rightarrow \underline{Cl}O_3^-(aq)$
    B $\underline{S}O_2(g) \rightarrow \underline{S}O_3^{2-}(aq)$
    C $\underline{N}O_3^-(aq) \rightarrow \underline{N}O_2(g)$
    D $\underline{O}_2(g) \rightarrow H_2\underline{O}(l)$

23. Which of the following conversions involves the *greatest* change in oxidation number of the underlined element?
    A $\underline{S}(s) \rightarrow \underline{S}O_2(g)$
    B $\underline{Cl}O^-(aq) \rightarrow \underline{Cl}O_2^-(aq)$
    C $\underline{Cr}_2O_7^{2-}(aq) \rightarrow 2\underline{Cr}^{3+}(aq)$
    D $\underline{Br}_2(l) \rightarrow 2\underline{Br}O_3^-(aq)$

24. Which of the following conversions involves the *smallest* change in oxidation number of the underlined element?
    A $\underline{Cl}_2(g) \rightarrow \underline{Cl}^-(aq)$
    B $\underline{S}O_2(g) \rightarrow \underline{S}O_4^{2-}(aq)$
    C $\underline{V}O_2^+(aq) \rightarrow \underline{V}^{3+}(aq)$
    D $Cu_2\underline{S}(s) \rightarrow \underline{S}O_2(g)$

25. A constituent of wood preservative is manufactured by heating the ore chromite ($FeCr_2O_4$) with sodium carbonate in the air.
    $4FeCr_2O_4(s) + 8Na_2CO_3(s) + 7O_2(g) \rightarrow 8Na_2CrO_4(s) + 2Fe_2O_3(s) + 8CO_2(g)$
    In this reaction, the oxidation number of chromium (Cr) changes from
    A +2 to +3.
    B +3 to +6.
    C +2 to +6.
    D +3 to +2.

26. The following equation represents the oxidation of ammonia in an industrial process:
    $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$
    In the process, the oxidation number of nitrogen changes by
    A 2 units.
    B 3 units.
    C 4 units.
    D 5 units.

27. In which of the following series does the oxidation number of chlorine increases from left to right?

A	$HClO_4$	HCl	Cl_2	HOCl
B	$HClO_4$	HOCl	Cl_2	HCl
C	HCl	Cl_2	HOCl	$HClO_4$
D	Cl_2	HOCl	HCl	$HClO_4$

28. In which of the following compounds does sulphur exhibit the *smallest* oxidation number?
    A Cu_2S
    B $(NH_4)_2SO_4$
    C $Na_2S_2O_3$
    D $H_2S_2O_7$

29. The above equation represents the reaction that occurs when ammonium dichromate is heated. Which of the following combinations is correct?

	Oxidation number of nitrogen	Oxidation number of chromium
A	Increases	decreases
B	Increases	increases
C	Decreases	decreases
D	Decreases	increases

30. In which of the following reactions does nitrogen exhibit three different oxidation numbers in the species involved?
    A $NH_3 + HNO_3 \rightarrow NH_4NO_3$
    B $8NH_3 + 3Cl_2 \rightarrow 6NH_4Cl + N_2$
    C $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
    D $2NaOH + NO + NO_2 \rightarrow 2NaNO_2 + H_2O$

31. In which of the following reactions does sulphur exhibit three different oxidation numbers in the species involved?
    A $CaSO_3 + H_2SO_3 \rightarrow Ca(HSO_3)_2$
    B $Zn + 2H_2SO_4 \rightarrow ZnSO_4 + 2H_2O + SO_2$
    C $Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O + S$
    D $Na_2S_2O_7 \rightarrow Na_2SO_4 + SO_3$

32. Which of the following conversions is an oxidation?
    A $S \rightarrow ZnS$
    B $S_2O_3^{2-} \rightarrow S_4O_6^{2-}$
    C $MnO_4^- \rightarrow MnO_2$
    D $CH_3COOH \rightarrow CH_3CH_2OH$

33. Which of the following conversions is a reduction?
    A $Cu(OH)_2 \rightarrow CuO$
    B $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$
    C $H_2S \rightarrow S$
    D $H_2SO_4 \rightarrow SO_2$

34. Which of the following processes is a redox reaction?
    A $Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$
    B $Cu(OH)_2(s) + 4NH_3(aq) \rightarrow [Cu(NH_3)_4](OH)_2(aq)$
    C $MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$
    D $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$

35. Which of the following processes is a redox reaction?

A $BaCl_2(aq) + Na_2CrO_4(aq) \rightarrow BaCrO_4(s) + 2NaCl(aq)$

B $Fe_2(SO_4)_3(aq) + H_2S(g) \rightarrow 2FeSO_4(aq) + S(s) + H_2SO_4(aq)$

C $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$

D $Al(OH)_3(s) + NaOH(aq) \rightarrow NaAl(OH)_4(aq)$

36. Which of the following is NOT a redox reaction?

A $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

B $Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

C $Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

D $ZnO(s) + 2NaOH(aq) + H_2O(l) \rightarrow Na_2[Zn(OH)_4](aq)$

37. Which of the following processes does NOT involve either oxidation or reduction?

A Formation of ammonium sulphate from aqueous ammonia and sulphuric acid

B Formation of nitrogen monoxide from ammonia

C Formation of sulphuric acid from sulphur

D Formation of zinc from zinc blende

38. Consider the following equation:

$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

Which of the following species is being reduced?

A $H^+(aq)$

B $Pb(s)$

C $PbO_2(s)$

D $SO_4^{2-}(aq)$

39. Consider the following equation:

$Fe(s) + 2Cr^{3+}(aq) \rightarrow Fe^{2+}(aq) + 2Cr^{2+}(aq)$

Which of the following combinations is correct?

	Species that is oxidized	Species that is reduced
A	$Cr^{3+}(aq)$	$Fe(s)$
B	$Cr^{2+}(aq)$	$Fe^{2+}(s)$
C	$Fe(s)$	$Cr^{3+}(aq)$
D	$Fe^{2+}(aq)$	$Cr^{2+}(aq)$

40. The equation below shows how hydrogen sulphide could be produced from sulphuric acid in a redox reaction.

$9H_2SO_4(aq) + 8KI(s) \rightarrow H_2S(g) + 8KHSO_4(aq) + 4H_2O(l) + 4I_2(s)$

Which of the following combinations is correct?

	Species being reduced	Species being oxidized
A	H_2S	I_2
B	I_2	H_2S
C	H_2SO_4	KI
D	KI	H_2SO_4

41. Consider the following equation:
$2MnO_4^-(aq) + I^-(aq) + H_2O(l) \rightarrow 2MnO_2(s) + IO_3^-(aq) + 2OH^-(aq)$
Which of the following species is being oxidized?
A $I^-(aq)$
B $MnO_4^-(aq)$
C $IO_3^-(aq)$
D $MnO_2(s)$

42. In which of the following reactions does the underlined substance act as a reducing agent?
A $4\underline{H_2} + Fe_3O_4 \rightarrow 3Fe + 4H_2O$
B $\underline{SO_2} + 2Mg \rightarrow 2MgO + S$
C $\underline{Pb(NO_3)_2} + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
D $Zn + 2\underline{AgNO_3} \rightarrow Zn(NO_3)_2 + 2Ag$

43. In which of the following reactions is hydrogen reduced?
A $CuO + H_2 \rightarrow Cu + H_2O$
B $H_2 + Cl_2 \rightarrow 2HCl$
C $N_2 + 3H_2 \rightarrow 2NH_3$
D $2Na + H_2 \rightarrow 2NaH$

44. In which of the following reactions is the underlined substance oxidized?
A $2CuO(s) + \underline{C}(s) \rightarrow CO_2(g) + 2Cu(s)$
B $3H_2(g) + \underline{N_2}(g) \rightarrow 2NH_3(g)$
C $Mg(s) + \underline{Zn}SO_4(aq) \rightarrow MgSO_4(aq) + Zn(s)$
D $\underline{Ca}CO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

45. In which of the following reactions is the underlined substance reduced?
A $H_2S_2O_7(l) + \underline{H_2O}(l) \rightarrow 2H_2SO_4(l)$
B $2Fe^{2+}(aq) + \underline{Cl_2}(aq) \rightarrow 2Fe^{3+}(aq) + 2Cl^-(aq)$
C $\underline{Al(OH)_3}(s) + OH^-(aq) \rightarrow Al(OH)_4^-(aq)$
D $\underline{C}(s) + O_2(g) \rightarrow CO_2(g)$

46. Which of the following underlined reactants is NOT a reducing agent in the reactions indicated?
A $PbO(s) + \underline{CO}(g) \rightarrow Pb(s) + CO_2(g)$
B $\underline{Zn}(s) + 2Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$
C $Br_2(aq) + 2\underline{I}^-(aq) \rightarrow 2Br^-(aq) + I_2(aq)$
D $\underline{SO_2}(g) + H_2O(l) \rightarrow H_2SO_3(aq)$

1 D	2 B	3 C	4 B	5 A
6 D	7 A	8 B	9 C	10 C
11 C	12 A	13 D	14 C	15 D
16 D	17 D	18 B	19 C	20 C
21 B	22 A	23 D	24 A	25 B
26 D	27 C	28 A	29 A	30 D
31 C	32 B	33 D	34 C	35 B
36 D	37 A	38 C	39 C	40 C
41 A	42 A	43 D	44 A	45 B
46 D				