CHEMISTRY 12 EQUATIONS

A. Write equations, showing only the species that react, that occur when the following substances are mixed. State what observations you would make. (Make sure you note all observations).

1. Copper II sulfate solution and sodium hydroxide solution.
2. Aluminium metal and hydrochloric acid.
3. Calcium hydroxide solid and nitric acid.
4. Silver nitrate solution and barium chloride solution.
5. Copper II carbonate solid and sulfuric acid.
6. Sodium metal and ethanol.
7. Potassium permanganate solution and acidified iron II sulfate.
8. Zinc metal and copper II nitrate solution.
9. Aluminium metal and sodium hydroxide solution.
10. Concentrated sulfuric acid added to water.
11. Ammonia gas and hydrogen chloride gas.
12. Sodium hydroxide solution and sulfuric acid.
13. Sodium hydroxide solution and solid ammonium chloride are heated.
14. Hydrogen peroxide and manganese IV oxide (manganese dioxide).
15. Sodium chloride solution and concentrated sulfuric acid.
16. Sodium bromide solution and chlorine water.
17. Potassium iodide solution and bromine water.
18. Zinc metal and potassium hydroxide solution.
19. Solid Aluminium oxide and potassium hydroxide solution.
20. Iron metal and hydrochloric acid.
21. Lead metal and silver nitrate solution.
22. Zinc sulfate solution and sodium hydroxide solution (2 eqns and 2 sets of observations).
23. Sodium ethanoate solid and water and phenolphthalein.
24. Solid sodium oxide and water and phenolphthalein.
25. Sulfur dioxide gas and water and methyl orange.
26. Hydrogen peroxide solution and acidified potassium permanganate solution.
27. Lead II nitrate solution and potassium iodide solution.
28. Barium chloride solution and copper II sulfate solution.
29. Solid zinc hydroxide and sodium hydroxide solution.
30. Potassium permanganate solution and ethanol.
31. Zinc metal and copper II sulfate solution.
32. Hydrogen sulfide gas bubbled through chlorine water.
33. 1 mole HCl solution and 1 mole $Na[Al(OH)_4]$ solution.
34. Chlorine water and sodium sulfide solution.
35. Ammonium phosphate solution and magnesium chloride solution.
36. Copper II nitrate solution and sodium sulfide solution.
37. Ethanoic acid and acidified ethanol is heated.
38. Ammonia gas is added to water containing methyl orange.
39. Acidified sodium dichromate is added to heated oxalic acid.
40. Acidified potassium dichromate added to 2-butanol.
41. Sodium carbonate solution and barium hydroxide solution.
42. Hydrochloric acid and silver nitrate solution.
43. Chlorine water added to magnesium iodide solution.
44. Copper II sulfate solution is added to an ammonia solution. *
45. Solid silver chloride is added to ammonia solution. *

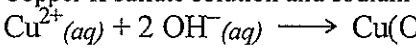
46. Potassium dichromate solution and sodium hydroxide solution.
47. Potassium chromate solution and sulfuric acid.
48. Potassium permanganate and conc. hydrochloric acid.
49. Zinc sulfate solution and ammonia solution. *
50. Solid gold added to a potassium cyanide solution with air bubbled through.
51. Copper metal and concentrated nitric acid.
52. Lead metal and dilute nitric acid.
53. Iron metal in the presence of air and water.
54. Copper I chloride and water.
55. Solid copper II hydroxide and ammonia solution.
56. Iron III oxide solid heated in the presence of charcoal.
57. Hydrogen peroxide is heated.
58. Iron metal is added to iron III chloride solution.
59. Hypochlorous acid is added to lithium iodide solution.
60. Solid zinc hydroxide is added to ammonia solution.

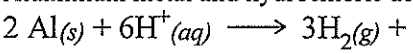
B. Describe briefly a **chemical** test that you would use to distinguish between the following pairs of substances listed. List observations (NO EQNS.). Assume substances are solid unless otherwise stated.

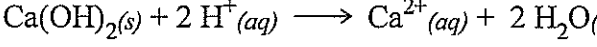
1. $ZnO_{(s)}$, $FeO_{(s)}$
2. $Mg(OH)_{2(s)}$, $Zn(OH)_{2(s)}$
3. $Al(OH)_{3(s)}$, $SiO_{2(s)}$
4. $Na_2CO_{3(s)}$, $NaNO_{3(s)}$
5. $AgNO_3$, NH_4Cl
6. Conc. HNO_3, conc. H_2SO_4.
7. Ethanol, 2-methyl-2-propanol
8. H_2O_2, H_2O
9. NaCl, NH_4Cl
10. NaCl, NaI
11. Butanal, butanone
12. Zn, Fe
13. $FeSO_4$, $MgSO_4$
14. $NH_{3(aq)}$, $NaOH_{(aq)}$
15. $Cl_{2(aq)}$, $F_{2(aq)}$
16. NaCl, $MgCl_2$
17. KOH, $Ba(OH)_2$
18. $Mg(NO_3)_2$, $Pb(NO_3)_2$
19. $NH_{3(g)}$, $HCl_{(g)}$
20. NaCl, NaBr
21. Hexane, 1-hexanol
22. 2-hexanol, 2-methyl-2-hexanol
23. sodium oxalate ($Na_2C_2O_4$), $FeSO_4$
24. distilled water, tap water
25. $Al(OH)_3$, $Zn(OH)_2$
26. Na_2O, P_4O_{10}
27. Cu, Au
28. Soap($C_{17}H_{35}COO^-Na^+$), detergent ($C_{17}H_{35}SO_3^-Na^+$)

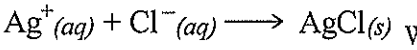
CHEMISTRY 12 EQUATIONS

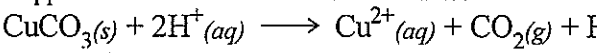
A. Write equations, showing only the species that react, that occur when the following substances are mixed. State what observations you would make. (Make sure you note all observations).

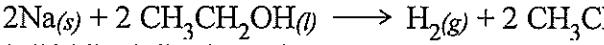
1. Copper II sulfate solution and sodium hydroxide solution.

Pale blue ppt

2. Aluminium metal and hydrochloric acid.

Solid dissolves, colourless gas evolves.

3. Calcium hydroxide solid and nitric acid.

White solid dissolves

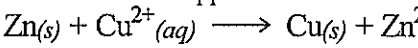
4. Silver nitrate solution and barium chloride solution.

White ppt forms

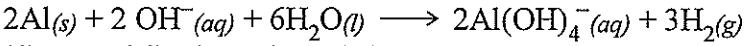
5. Copper II carbonate solid and sulfuric acid.

Green solid dissolves, blue solution forms, colourless gas evolves.

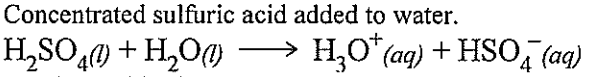
6. Sodium metal and ethanol.

Solid (silver) dissolves, c'less gas evolves

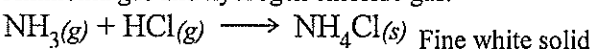
7. Potassium permanganate solution and acidified iron II sulfate.

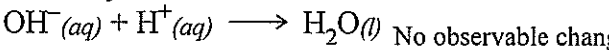
Purple solution turns c'less.

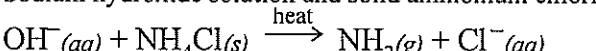
8. Zinc metal and copper II nitrate solution.

Blue soln turns c'less, brown/black coat on silver metal

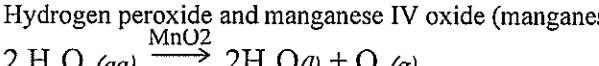
9. Aluminium metal and sodium hydroxide solution.

Silver metal dissolves, c'less solution forms, c'less gas evolves.

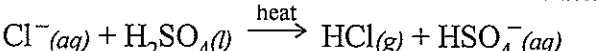
10. Concentrated sulfuric acid added to water.

No observable change, solution gets very hot.

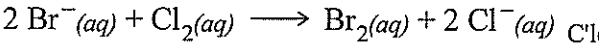
11. Ammonia gas and hydrogen chloride gas.

Fine white solid (gaseous appearance) forms.

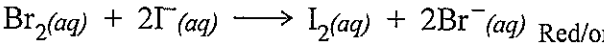
12. Sodium hydroxide solution and sulfuric acid.

No observable change. (soln warms)

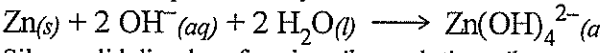
13. Sodium hydroxide solution and solid ammonium chloride are heated.

C'less gas with choking odour

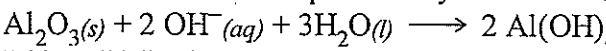
14. Hydrogen peroxide and manganese IV oxide (manganese dioxide).

C'less gas evolves.

15. Sodium chloride solution and concentrated sulfuric acid are heated.

C'less gas with biting/sour odour

16. Sodium bromide solution and chlorine water.

C'less solution turns orange.

17. Potassium iodide solution and bromine water.

Red/orange solution turns brown.

18. Zinc metal and potassium hydroxide solution.

Silver solid dissolves forming c'less solution, c'less gas evolves.

19. Solid Aluminium oxide and potassium hydroxide solution.

White solid dissolves forming c'less solution.

20. Iron metal and hydrochloric acid.
$Fe_{(s)} + 2H^+_{(aq)} \longrightarrow Fe^{2+}_{(aq)} + H_{2(g)}$ C'less gas evolves, pale green (c'less) solution.

21. Lead metal and silver nitrate solution.
$Pb_{(s)} + 2Ag^+_{(aq)} \longrightarrow Pb^{2+}_{(aq)} + 2Ag_{(s)}$ Grey solid dissolves, silver coating/metal forms.

22. Zinc sulfate solution and sodium hydroxide solution (2 eqns and 2 sets of observations).
$Zn^{2+}_{(aq)} + 2OH^-_{(aq)} \longrightarrow Zn(OH)_{2(s)}$ $Zn(OH)_{2(s)} + 2OH^-_{(aq)} \longrightarrow Zn(OH)_4^{2-}{}_{(aq)}$
White solid forms which dissolves on adding excess

23. Sodium ethanoate solid and water and phenolphthalein.
$CH_3COONa_{(s)} + H_2O_{(l)} \xrightarrow{pp} Na^+_{(aq)} + CH_3COOH_{(aq)} + OH^-_{(aq)}$ soln turns pink

24. Solid sodium oxide and water and phenolphthalein.
$Na_2O_{(s)} + H_2O_{(l)} \xrightarrow{pp} 2Na^+_{(aq)} + 2OH^-_{(aq)}$ soln turns pink

25. Sulfur dioxide gas and water and methyl orange.
$SO_{3(g)} + H_2O_{(l)} \xrightarrow{mo} 2H^+_{(aq)} + SO_4^{2-}{}_{(aq)}$ soln turns red

26. Hydrogen peroxide solution and acidified potassium permanganate solution.
$5H_2O_{2(aq)} + 2MnO_4^-{}_{(aq)} 6H^+_{(aq)} \longrightarrow 5O_{2(g)} + 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}$ purple soln turns c'less, c'less gas evolved

27. Lead II nitrate solution and potassium iodide solution.
$Pb^{2+}_{(aq)} + 2I^-_{(aq)} \longrightarrow PbI_{2(s)}$ yellow solid forms

28. Barium chloride solution and copper II sulfate solution.
$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)}$ white solid forms, blue soln becomes less intense

29. Solid zinc hydroxide and sodium hydroxide solution. (see 22)

30. Potassium permanganate solution and ethanol.
$5C_2H_5OH + 2MnO_4^-{}_{(aq)} + 6H^+_{(aq)} \longrightarrow 5CH_3CHO + 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}$
Pink solution turns colourless, change in odour

31. Zinc metal and copper II sulfate solution. (see q 8)

32. Hydrogen sulfide gas bubbled through chlorine water.
$H_2S_{(g)} + Cl_{2(aq)} \longrightarrow 2H^+_{(aq)} + 2Cl^-_{(aq)} + S_{(s)}$ creamy/yellow solid forms

33. 1 mole HCl solution and 1 mole $Na[Al(OH)_4]$ solution.
$H^+_{(aq)} + Al(OH)_4^-{}_{(aq)} \longrightarrow Al(OH)_{3(s)} + H_2O_{(l)}$ white solid forms

34. Chlorine water and sodium sulfide solution.
$Cl_{2(aq)} + S^{2-}_{(aq)} \longrightarrow S_{(s)} + 2Cl^-_{(aq)}$ creamy/yellow solid forms

35. Ammonium phosphate solution and magnesium chloride solution.
$2PO_4^{3-}{}_{(aq)} + 3Mg^{2+}_{(aq)} \longrightarrow Mg_3(PO_4)_{2(s)}$ white solid forms

36. Copper II nitrate solution and sodium sulfide solution.
$Cu^{2+}_{(aq)} + S^{2-}_{(aq)} \longrightarrow CuS_{(s)}$ black solid forms, blue soln becomes c'less

37. Ethanoic acid and acidified ethanol is heated.
$CH_3COOH_{(aq)} + C_2H_5OH_{(l)} \xrightarrow{H+} CH_3COOC_2H_{5(aq)} + H_2O_{(l)}$ sweet smelling odour forms

38. Ammonia gas is added to water containing methyl orange.
$NH_{3(g)} + H_2O_{(l)} \xrightleftharpoons{mo} NH_4^+{}_{(aq)} + OH^-_{(aq)}$ soln turns orange

39. Acidified sodium dichromate is added to heated oxalic acid.
$Cr_2O_7^{2-}{}_{(aq)} + 3H_2C_2O_{4(aq)} + 8H^+_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 6CO_{2(g)} + 7H_2O_{(l)}$
orange soln turns green, c'less gas evolves

40. Acidified potassium dichromate added to 2-butanol.
$3CH_3CHOHCH_2CH_3 + Cr_2O_7^{2-}{}_{(aq)} + 8H^+_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)} + 3CH_3COCH_2CH_3$
Orange solution turns green, change in odour

41. Sodium carbonate solution and barium hydroxide solution.
$CO_3^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} \longrightarrow BaCO_{3(s)}$ white solid forms

42. Hydrochloric acid and silver nitrate solution.
$Ag^+_{(aq)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)}$ white solid forms (turns mauve in light)

43. Chlorine water added to magnesium iodide solution.
$Cl_{2(aq)} + 2I^-_{(aq)} \longrightarrow I_{2(aq)} + 2Cl^-_{(aq)}$ orange/brown solution forms

44. Copper II sulfate solution is added to an ammonia solution. *
$Cu^{2+}_{(aq)} + 2NH_{3(aq)} + 2H_2O_{(l)} \longrightarrow Cu(OH)_{2(s)} + 2NH_4^+(aq)$, $Cu(OH)_{2(s)} + 4NH_{3(aq)} \longrightarrow Cu(NH_3)_4^{2+}{}_{(aq)} + 2OH^-_{(aq)}$
pale blue ppt forms, dissolves to form deep blue soln with excess

45. Solid silver chloride is added to ammonia solution. *
$2Ag^{+}(aq) + 2NH_3(aq) + H_2O(l) \longrightarrow Ag_2O(s) + 2NH_4^{+}(aq)$, $Ag_2O(s) + 4NH_3(aq) + H_2O(l) \longrightarrow 2Ag(NH_3)_2^{+}(aq) + 2OH^{-}(aq)$
brown ppt forms, redissolves in excess forming c'less soln

46. Potassium dichromate solution and sodium hydroxide solution.
$Cr_2O_7^{2-}(aq) + 2OH^{-}(aq) \longrightarrow 2CrO_4^{2-}(aq) + H_2O(l)$ orange soln turns yellow

47. Potassium chromate solution and sulfuric acid.
$2CrO_4^{2-}(aq) + 2H^{+}(aq) \longrightarrow Cr_2O_7^{2-}(aq) + H_2O(l)$ yellow soln turns orange

48. Potassium permanganate and conc. hydrochloric acid.
$2MnO_4^{-} + 10Cl^{-}(aq) + 16H^{+}(aq) \longrightarrow 2Mn^{2+}(aq) + 5Cl_2(g) + 8H_2O(l)$
purple soln turns c'less, pale green gas with choking odour evolves

49. Zinc sulfate solution and ammonia solution. *
$Zn^{2+}(aq) + 2NH_3(aq) + 2H_2O(l) \longrightarrow Zn(OH)_2(s) + 2NH_4^{+}(aq)$, $Zn(OH)_2(s) + 4NH_3(aq) \longrightarrow Zn(NH_3)_4^{2+}(aq) + 2OH^{-}(aq)$
white solid forms which dissolves to c'less soln on addition of excess

50. Solid gold added to a potassium cyanide solution with air bubbled through.
$O_2(g) + 2H_2O(l) + 4Au(s) + 8CN^{-}(aq) \longrightarrow 4Au(CN)_2^{-}(aq) + 4OH^{-}(aq)$ gold metal dissolves

51. Copper metal and concentrated nitric acid.
$Cu(s) + 2NO_3^{-}(aq) + 4H^{+}(aq) \longrightarrow Cu^{2+}(aq) + 2NO_2(g) + 2H_2O(l)$
'pink' metal dissolves, soln turns blue, brown gas with choking odour evolved

52. Lead metal and dilute nitric acid.
$3Pb(s) + 2NO_3^{-}(aq) + 8H^{+}(aq) \longrightarrow 3Pb^{2+}(aq) + 2NO(g) + 4H_{20}(l)$
solid (grey) dissolves, c'less gas evolves

53. Iron metal in the presence of air and water. (see rusting)

54. Copper I chloride and water.
$2Cu^{+}(aq) \longrightarrow Cu(s) + Cu^{2+}(aq)$ Brown solid forms with blue solution

55. Solid copper II hydroxide and ammonia solution. (see q44)

56. Iron III oxide solid heated in the presence of charcoal.
$2Fe_2O_3(s) + 6C(s) + 3O_2(g) \longrightarrow 4Fe(l) + 6CO_2(g)$ liquid metal formed, c'less gas evolved

57. Hydrogen peroxide is heated.
$2H_2O_2(aq) \xrightarrow{heat} 2H_2O(l) + O_2(g)$ c'less gas evolved

58. Iron metal is added to iron III chloride solution.
$Fe(s) + 2Fe^{3+}(aq) \longrightarrow 3Fe^{2+}(aq)$ grey solid dissolves, brown soln turns green

59. Hypochlorous acid is added to lithium iodide solution.
$HClO(aq) + H^{+}(aq) + 2I^{-} \longrightarrow H_2O(l) + I_2(aq) + Cl^{-}(aq)$ orange/brown solution forms

60. Solid zinc hydroxide is added to ammonia solution. (see Q 49)

B. Describe briefly a **chemical** test that you would use to distinguish between the following pairs of substances listed. List observations (NO EQNS.). Assume substances are solid unless otherwise stated. Please note that these answers are not the only possibilities. If you have any questions, please ask your teacher.

1. $ZnO_{(s)}$, $FeO_{(s)}$ Add NaOH, ZnO dissolves, FeO does not
2. $Mg(OH)_{2(s)}$, $Zn(OH)_{2(s)}$ Add NaOH, $Zn(OH)_2$ dissolves, $Mg(OH)_2$ does not
3. $Al(OH)_{3(s)}$, $SiO_{2(s)}$ Add NaOH, $Al(OH)_3$ dissolves, SiO_2 doesn't
4. $Na_2CO_{3(s)}$, $NaNO_{3(s)}$ Add acid (HCl) bubbles from Na_2CO_3, NR from $NaNO_3$
5. $AgNO_3$, NH_4Cl Add NaCl to solutions, white ppt with AgCl, NR from NH_4Cl
6. Conc. HNO_3, conc. H_2SO_4. Add Cu metal. Brown gas from HNO_3 - c'less gas from H_2SO_4
7. Ethanol, 2-methyl-2-propanol Add acidified MnO_4-, change of colour with ethanol, NR with other
8. H_2O_2, H_2O Add MnO_2, bubbles from H_2O_2 NR with other
9. NaCl, NH_4Cl Add $Ca(OH)_2$ and heat, gas with choking odour from NH_4Cl NR with other
10. NaCl, NaI Add Cl_2(aq) Orange brown soln with NaI, NR NaCl
11. Butanal, butanone Add acidified MnO_4-, change of colour with butanal, NR with other
12. Zn, Fe Add NaOH and heat, bubbles with Zn, NR with Fe
13. $FeSO_4$, $MgSO_4$ Add NaOH, green ppt with $FeSO_4$, white ppt with $MgSO_4$
14. $NH_{3(aq)}$, $NaOH_{(aq)}$ Add $CuSO_4$, Deep blu soln with $NH_{3(aq)}$, pale blue ppt with $NaOH_{(aq)}$
15. $Cl_{2(aq)}$, $F_{2(aq)}$ Add $F_{2(aq)}$ to both, reaction (green gas) with $Cl_{2(aq)}$, NR with $F_{2(aq)}$
16. NaCl, $MgCl_2$ Add Na_2CO_3 soln to solns of both, white ppt with $MgCl_2$, NR with NaCl
17. KOH, $Ba(OH)_2$ Add Na_2SO_4 to both, NR with KOH, white ppt with $Ba(OH)_2$
18. $Mg(NO_3)_2$, $Pb(NO_3)_2$ Add NaI to both, NR with $Mg(NO_3)_2$, yellow ppt with $Pb(NO_3)_2$
19. $NH_{3(g)}$, $HCl_{(g)}$ Add to $CuSO_4$ soln, deep blue soln with $NH_{3(g)}$, NR with $HCl_{(g0}$ (use litmus)
20. NaCl, NaBr Add Cl_2(aq) NR with NaCl, yellow/orange with NaBr
21. Hexane, 1-hexanol Add acidified MnO_4-, change of colour with 1-hexanol, NR with hexane

22. 2-hexanol, 2-methyl-2-hexanol Add acidified MnO_4-, change of colour with 2-hex, NR with other
23. sodium oxalate, $FeSO_4$ Add acidified MnO_4-, change to brown with $FeSO_4$ to c'less other as well as bubbles
24. distilled water, tap water Add $AgNO_3$, tap water milky, NR distilled
25. $Al(OH)_3$, $Zn(OH)_2$ Add excess $NH_{3(aq)}$, NR $Al(OH)_3$, solid dissolves with $Zn(OH)_2$
26. Na_2O, P_4O_{10} Add to water and litmus. Turns blue with Na_2O, red with P_4O_{10}
27. Cu, Au Add both to $Au^{3+}_{(aq)}$ NR with Au, metal displacement with Cu, and blue soln
28. Soap($C_{17}H_{35}COO^-Na^+$), detergent ($C_{17}H_{35}SO_3^-Na^+$) Add 'hard' water, scum with soap, NR det.