1 **(a) (i)**

aqueous solution	tin Sn	manganese Mn	silver Ag	zinc Zn
tin(II) nitrate		R	NR	R
manganese(II) nitrate	NR		NR	NR
silver(I) nitrate	R			R
zinc nitrate	NR	R	NR	

[1] for each [3]
ignore anything written in blank space

(ii) $Sn + 2Ag^+ \rightarrow Sn^{2+} + 2Ag$ [2]
all species correct [1]
accept equation with Sn^{4+}

(iii) Mn to Mn^{2+} need both species [1]
electron loss **or** oxidation number increases [1]

(iv) covered with oxide layer [1]
makes it unreactive **or** protects **or** aluminium oxide unreactive [1]

(b) (potassium has one valency electron [1]
or loses one electron
calcium has two valency electrons
or loses two electrons [1]

(ii) potassium hydroxide → no reaction [1]
calcium hydroxide → calcium oxide and water [1]
ACCEPT metal oxide

2 **(a) (i)** air would react (with the magnesium **or** titanium)
OR argon would not react (with the metals) [1]
NOT argon is inert

(ii) any metal higher than magnesium in reactivity series [1]

(iii) add water (to dissolve salt) [1]
filter **or** centrifuge [1]

(b) (i) electron loss [1]

(ii) hydrogen [1]

(iii) oxygen [1]
chlorine [1]

(iv) it cannot lose electrons (because) [1]
it receives electrons (from the battery) [1]

OR reduction occurs at the cathode [1]
oxidation at the anode (not cathode) [1]

OR electrons are "pushed" to rig [1]
preventing it from being oxidised [1]

for comments of the type – rusting needs oxygen, it is formed on titanium not iron **ONLY** [1]

NOT the idea that titanium is more reactive etc

(v) **SET 1**
sacrificial protection is a cell
does not need electricity
cathodic protection is electrolysis
cathodic protection needs electricity

SET 2
sacrificial protection needs a more reactive metal (in contact with iron or steel)
this metal corrodes instead of steel
cathodic protection needs an inert electrode accept unreactive or less reactive metal as an electrode
has to be **ONE** comment from each set [2]
all comments about oxide layers and coating are neutral

[Total: 12]

3 **(a) (i)** bleach for wood pulp **or** preserving food **or** sterilising
or in wine making **or** as a refrigerant **or** in metallurgy **or**
(liquid) sulphur dioxide is used in the petroleum industry
or kill microbes(etc) **or** insecticide [1]

(ii) (react with) oxygen **or** air [1]
NOT burnt/burn in air/oxygen
450°C [1]
vanadium oxide catalyst (if oxidation state given has to be correct) **or** platinum [1]
If four conditions are given which include high pressure then **MAX** [2]
High pressure is incorrect **MAX** 10 atm.

(iii) ammonium sulphate **or** superphosphate [1]
or potassium sulphate **or** magnesium sulphate

(b) (vaporisation **or** boiling **or** evaporation [1]
condensation **or** liquefaction [1]
NOTE order in which changes are given is not important
NOT liquid => gas => liquid

(ii) to get maximum yield of zinc **or** reduce all zinc oxide [1]
NOTE the above mark is awarded for why add excess carbon moves equilibrium to right **or** to favours the products **or** removes CO_2 from equilibrium [1]
NOTE this mark is awarded for how does the addition of excess carbon give max yield of zinc
NOTE Allow any coherent explanation flexibly based on the above ideas
EXAMPLES:
moves equilibrium to right [1] because carbon dioxide removed [1]
to get maximum yield of zinc [1] as equilibrium moves to right [1]
NOT just to make CO from CO_2

(c) $Zn^{2+} + 2e = Zn$ [1]

(ii) $4OH^- - 4e = O_2 + 2H_2O$ [2
or $4OH^- = O_2 + 2H_2O + 4e$
or $2H_2O = 4H^+ + O_2 + 4e$
or $2H_2O - 4e = 4H^+ + O_2$
oxygen as product [1]

(iii) sulphuric acid [1]
NOTE there are no alternative answers to the above

(d) prevent iron from rusting **NOT** with galvanising **or** sacrificial protection
making brass **or** making alloys **NOT** bronze
electroplating **or** as an electrode in electrolysis
cells
roofing
sacrificial protection
coinage
TWO uses [2]

[Total: 15]

4 **(a** X
W
Z
Y **[2]**
For most reactive X and least Y [1] **ONLY**
All other responses [0]

(b) magnesium W **[1]**
copper **[1]**

(c) **(i)** goes "pop" with burning splint **[1]**
or mixed with air and ignited goes pop
NOT glowing splint

(ii) test and observable result **[1]**
universal indicator goes blue
or pH paper goes blue
or high pH, accept 13, 14
or ammonium ion gives off ammonia
or with metallic cations forms a precipitate **[1]**
NOT litmus
ONLY accept - neutralises acids with an observable result, e.g. becomes warm.

(iii) Group 1 **[1]**

(iv) electrolysis **[1]**
COND molten **[1]**

[TOTAL = 10]

5 **(a)** 4 Ge atoms around 1 Ge **[1]**
Looks tetrahedral **or** stated to be **[1]**

(b) **(i)** Graphite has layers **[1]**
COND that can move/slip
or weak bonds between layers **[1]**

Graphite has delocalised/free/mobile electrons **[1]**

(ii) property and use **[1]**

soft	lubricant **or** pencils
OR good conductor	electrodes **or** in electric motors

(c) CO_2 and SiO_2 **or** XO_2 **[1]**

(ii) CO_2 molecular **or** simple molecules **or** simple covalent **[1]**
SiO_2 macromolecular **or** giant covalent **[1]**

(d) Ge_2H_6 **[1]**

[TOTAL = 10]