1 **(a** giant covalent; [1]
or: polymer made from monomers;

(b) (any three from:
high mp / bp;
hard;
brittle;
insoluble (in water);
poor conductor of electricity / heat; [3]

(ii) carbon / diamond / silicon / boron; [1]
not: graphite

(c) (sodium hydroxide / any named alkali / reactive metal; [1]

(ii) named acid; [1]
zirconium oxide; [1]

[Total: 8]

2 **(a** 3 bp and 1nbp around phosphorus [1]
1 bp and 3nbp around each chlorine [1]

(b) (i) $PCl_3 + 3H_2O \rightarrow 3HCl + H_3PO_3$ [1]

(ii) acid solutions same concentration [1]
measure pH/pH paper/Universal indicator [1]
hydrochloric acid lower pH [1]

colours of Universal indicator can be given as red<orange<yellow
ignore precise pH values as long as HCl is lower than H_3PO_3

OR Acid solutions same concentration [1]
add magnesium or any named metal above Hydrogen in reactivity series but not above magnesium
calcium carbonate or any insoluble carbonate [1]
hydrochloric acid react faster/shorter time [1]

OR acid solutions same concentration [1]
measure electrical conductivity [1]
hydrochloric acid better conductor/bulb brighter [1]

OR acid solutions same concentration [1]
add sodium thiosulphate [1]
hydrochloric acid forms precipitate faster/less time [1]

(iii) sodium hydroxide/sodium carbonate [1]
titration **cond** on correct reagent [1]
second mark scores for mention of titration /burette/pipette/indicator.
experimental detail not required

any named soluble calcium salt e.g. calcium chloride/nitrate/hydroxide [1]

precipitation/filter/decant/centrifuge

3 **(a) (i)** lithium oxide / strontium oxide [1]

(ii) sulfur dioxide / nitrogen dioxide [1]

(iii) aluminium oxide [1]

(iv) carbon monoxide [1]
accept: correct formulae

(b) sulfur dioxide [1]
burn (fossil) fuel containing sulfur / volcanoes [1]
nitrogen dioxide [1]
reaction of nitrogen and oxygen [1]
high temperatures / in car engine [1]
not: exhaust

(c) (i) strontium oxide [1]
accept: aluminium oxide

(ii) use correct formula [1]
cond: charges on ions
6x and 2o around oxygen [1]
ignore: electrons around Li

4 **(a) (i)** to neutralise all the acid / so all acid reacts [1]
not: reaction goes to completion

(ii) remove excess carbonate / removes unreacted carbonate [1]
not: remove solid

(iii) need water of crystallisation / hydrated crystals / to get crystals [1]

(iv) filter / decant / wash crystals [1]
dry with filter paper or tissues etc. [1]
accept: in warm oven / warm place / in sun
not: just heat

(b) (potassium carbonate is soluble / both salts soluble [1]

(ii) use potassium carbonate solution [1]
accept: implication of solution – in pipette / burette / 25 cm^3
titrate / titration term required [1]
use an indicator **accept:** any named acid/base indicator [1]
repeat without indicator / use carbon to remove indicator [1]

(c) mass of hydrated magnesium sulfate = 1.476 g
mass of barium sulfate formed = 1.398 g
the mass of one mole of $BaSO_4$ = 233 g
the number of moles of $BaSO_4$ formed = 0.006 [1]
the number of moles of $MgSO_4.xH_2O$ used in experiment = 0.006 [1]
the mass of one mole of $MgSO_4.xH_2O$ = 1.476/0.006 = 246 g [1
the mass of xH_2O in one mole of $MgSO_4.xH_2O$ = 246 – 120 = 126 g [1
x = 126/18 = 7 [1]
if x given without method = max 1
note: apply ecf but x must be an integer and less than 10

5 **(a) (** Tl_2S [1]

(ii) $TlCl_3$ [1]

(b) filter / centrifuge / decant
wash the precipitate
dry the solid / heat the solid (in oven) / press between filter paper [3]

all three stated but not in correct order = [2]
two out of three stated in any order = [1]

(c) (i) silver chloride / silver bromide [1]
photography / cameras / films / photo chromic lenses / sunglasses [1]

(ii) increase distance between lamp and paper **or** put lamp far away /
put a screen **or** translucent **or** semi-opaque material between them /
use a less powerful **or** low voltage **or** dim lamp /
lower the temperature
any **two** [2]

(d) (thalium sulfate + ammonia + water [1]

(ii) $2TlOH + H_2SO_4 \rightarrow Tl_2SO_4 + 2H_2O$ [2
not balanced = [1]
incorrect formula = [0]

(iii) green precipitate **or** solid (ignore shades of green but not bluey green etc.) [1]
$Fe^{2+} + 2OH \rightarrow Fe(OH)_2$ **accept** multiples [1]

6 **(a** filter / centrifuge / decant [1]
(partially) evaporate / heat / boil [1]
allow to crystallise / cool / let crystals form [1]
dry crystals / dry between filter paper / leave in a warm place to dry [1]
"dry" on its own must be a verb
evaporate to dryness only marks 1 and 2
note if discuss residue only mark 1

(b) number of moles of HCl used = 0.04 × 2 = 0.08
number of moles $CoCl_2$ formed = 0.04
number of moles $CoCl_2.6H_2O$ formed = 0.04
mass of one mole of $CoCl_2.6H_2O$ = 238 g
maximum yield of $CoCl_2.6H_2O$ = 9.52g [4]
accept 9.5 g
mark ecf to moles of HCl
do **not** mark ecf to integers

to show that cobalt(II) carbonate is in excess

number of moles of HCl used = 0.08 must use value above **ecf**
mass of one mole of $CoCO_3$ = 119g
number of moles of $CoCO_3$ in 6.0g of cobalt(II) carbonate = 6.0/119 = 0.050 [1]
reason why cobalt(II) carbonate is in excess 0.05 > 0.08/2 [1]

[Total: 10]