1 **(a (i)** (mass at t =0) – (mass at t = 5) [1]
NOTE: must have mass at t = 5 not final mass

(ii) fastest at origin
slowing down between origin and flat section gradient = 0
where gradrient = 0
three of above in approximately the correct positions [2]

(iii) 3 correct comments about gradient = [2]
2 correct comments about gradient = [1]
1 correct comment about gradient = [0] [2]

(b) start at origin and smaller gradient [1]
same final mass just approximate rather than exact [1]

(c) smaller surface area [1]
lower collision rate [1]

(ii) molecules have more energy [1]
collide more frequently / more molecules have enough energy to react [1]

(d) number of moles of HCl in 40 cm^3 of hydrochloric acid,
concentration 2.0 mol / dm^3 = 0.04 × 2.0 = 0.08 [1]
maximum number of moles of CO_2 formed = 0.04 [1]
mass of one mole of CO_2 = 44 g [1
maximum mass of CO_2 lost = 0.04 × 44 = 1.76 g [1

[Total: 15]

2 **(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

3 **(a** a transition element has more than one oxidation state or valency [1]
accept different oxidation states

(b) by removing oxygen concentration of O_2 decreases [1]
prevents the back reaction / equilibrium shifts to right [1]

(c) oxidation number reduced (from (+) 4 to 0) [1]
accept accepts electrons **or** accepts four electrons
if number given must be 4

(d) low density / lightweight / light [1]
propellers / fittings on ships / inert anodes in electrolysis / hip replacements / ship building / chemical plants / cathodic protection / diving equipment [1]

(e) **(i)** percentage of oxygen = 31.6% [1

(ii) calculate the number of moles of atoms for each element

number of moles of Ti = 31.6/48 = 0.66

number of moles of O = 31.6/16 = 1.98 **accept** 2 [1]
both correct for one mark

(iii) the simplest <u>whole number ratio</u> for moles of atoms:

Fe	:	Ti	:	O
1		1		3

[1]

(iv) formula is $FeTiO_3$ **accept** $TiFeO_3$ [1]
must be whole numbers from **(iii)** or cancelled numbers from **(iii)**
mark **ecf** throughout

4 **(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]