A-LEVEL PAPER 1 PP11 MS

1. (a) Weigh out a sample (Must be stated) (1)

Add hydrochloric nitric acid to the sample (1)

Until fizzing stops or excess acid added (1)

Filter off SiO_2 (Allow sand) (1)

Add barium chloride(solution) (1)

Until no more precipitation occurs or excess added (1)

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$ (or ionic) (1)

$MgSO_4 + BaCl_2 \rightarrow MgCl_2 + BaSO_4$ (or ionic) (1)

NB Max 4 if H_2SO_4 added rather than HCl
i.e. Weigh sample (1), Filter SiO_2 (1) Two equations (2)

(b) Filter off the barium sulphate (1)

Wash to remove other reagents (1)

Dry (1)

Weigh (1)

Mole $BaSO_4$ = Mass $BaSO_4$/M_r $BaSO_4$ (or 233.4) (1)

Mass SO_4^{2-} = Mole $BaSO_4$ × M_r SO_4^{2-} (or 96.1) (1)

Percentage SO_4^{2-} = Mass SO_4^{2-} / Mass sample × 100 (1)

[15]

2. Reducing power increases 1

SO_2 1

S 1

H_2S 1

(Apply list principle to answers that give more than 3 reduction products)

$2I^- + SO_4^{2-} + 4H^+ \rightarrow I_2 + SO_2 + 2H_2O$ species correct 1

(or $6I^- + SO_4^{2-} + 8H^+ \rightarrow 3I_2 + S + 4H_2O$)

(or $8I^- + SO_4^{2-} + 10H^+ \rightarrow 4I_2 + H_2S + 4H_2O$)

(Starting materials can be HI or NaI instead of I^- or H_2SO_4 instead of H^+)

Balanced equation (one only of the above) 1

[6]

3.

(a)	Enthalpy change when 1 mol of a substance/compound/ionic lattice/product; is formed from its elements; All substances in their standard states;	1 1 1	Allow heat change/heat energy change/heat absorbed Not energy change, not products Or normal states under standard conditions If confused with ionisation energy or combustion or bond enthalpy etc CE=0 Ignore reference to standard conditions only
(b)	O^- repels electrons/both O^- and e^- are negative/idea of repulsion;	1	Allow (O^- ion) forced to accept an electron
(c)	Arrows on cycle and correct ΔH values/correct labels; $-\Delta H$ = +602 +150 +736 +1450 +248 +844 -142 ΔH(*lattice formation*) = -3888 (kJ mol^{-1});	1 1 1	Allow lattice enthalpy arrow going up Correct answer scores 3 +3888 scores 2 -2684 scores 1 Ignore incorrect or missing units
(d)	Ca^{2+} ions are smaller (than Ba^{2+} ions)/Ca^{2+} ions higher charge to size ratio/greater charge density; More attraction for O^{2-}/stronger attraction;	1 1	Must mention ions or M^{2+} Must imply between ions Mark independently CE if mention molecules

[9]

4.

(a)		$\Delta G = \Delta H - T\Delta S$		1
(b)	(i)	Positive/+	1	
		More moles of gas products (2 mol gas gives 3 mol gas);	1	QWC Allow molecules instead of moles
		More disorder/increase in disorder/very disordered;	1	Mark independently even if + not given
	(ii)	ΔH is negative and ΔS is positive/ $T\Delta S$ +ve/ $-T\Delta S$ -ve;	1	
		So ΔG will be negative (at all temperatures);	1	Mark independently and indep. of (b) (i)
	(iii)	Too slow/activation energy too high/speeds up reaction;	1	higher yield is contradiction, scores 0
(c)	(i)	$\Delta H = \Sigma\Delta H$(*formation products*) - $\Sigma\Delta H$(*formation reactants*);	1	Allow correct cycle
		= 4 × -411 – (-720 +4×3);	1	
		= -936 (kJ mol^{-1});	1	3 marks for correct value +936 scores 1 (-924 scores 1 – ie assumed ΔH_f(Na(l) = 0)
		$\Delta S = \Sigma S$(*products*) - ΣS(*reactants*);	1	
		=4 × 72 + 30 – (329 + (4 × 58)) = -243 (J K^{-1} mol^{-1});	1	2 marks for correct value Penalise wrong units If answer - 0.243 must show units kJ K^{-1} mol^{-1}
	(ii)	Limiting condition ΔG = 0/ 0 = $\Delta H - T\Delta S$/ $T = \Delta H/\Delta S$;	1	Using values given (allow use of these with own value for ΔH or ΔS)
		= (-936 × 1000)/-243	1	(-812 × 1000)/-312;
		= 3852 (K) – (allow range 3850 to 3852);	1	2603 (2600 to 2603) Allow consequential on answer to (c)(i) provided not –ve *T*. Penalise wrong units *T* = 3.85 scores M1 only

[15]

5. (a) (i) pp = mole fraction × total pressure (1)

or pp hydrazine = 0.22 × 150

= 33 (kPa) ignore units even if wrong (NB **2** marks for 33) (1)

(ii) pp N_2 + pp H_2 = 150 – 33 = 117 Or mol fn N_2 + mol fn H_2 = 0.78 (1)

pp N_2 = ⅓ ×117 = 39 pp N_2 = 0.26 × 150 = 39 (1)

pp H_2 = ⅔ ×117 = 78 pp H_2 = 0.52 × 150 = 78 (1)

conseq on (i) but must show working

Allow one for pp H_2 = 2 × pp N_2

also allow one for pp H_2 if you can see that their answer has been achieved by subtracting (their ppN_2H_4 + their pp N_2) from 150

(b) (i) $K_p = \frac{P_{N_2} \times P^2_{H_2}}{P_{N_2H_4}}$ Penalise [ ] but mark on

if K_p wrong, no marks for calc (1)

(ii) $K_p = \frac{27 \times 48^2}{75}$ If numbers reversed, score units mark only (1)

= 829 or 830 (or 829 or 830 ×10^6 tied to Pa below) (1)

kPa^2 or conseq on their wrong K_p in (b)(i) (1)

(c) equm moves to fewer (gas) moles (not just to LHS) (1)

to counter increase P or to reduce P (1)

[11]

6. (i) pH = -log[H^+] must be [ ] allow log $\frac{1}{[H^+]}$ (1)

(ii) 0.437 or 0.44 (1)

[2]

7. (a) (i) $K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$ (or H_3O^+) **(1)**

(ii) (1) $K_a = \frac{[H^+]^2}{[CH_3COOH]}$ **(1)**

(2) $[H^+] = \sqrt{1.74 \times 10^{-5} \times 0.220} = 1.96 \times 10^{-3}$ **(1)**

(3) $pH = -\log_{10}[H^+]$ **(1)**

can score independently

(4) pH = 2.71 **(1)**

2 d.p. essential

If forget √ can score (1) and (3) for pH = 5.42

5

(b) (i) moles acid = $\frac{25}{1000} \times 0220$ **(1)** = 5.50×10^{-3}

$= \frac{x}{10^3} \times 0.150$

$\therefore x = 25 \times \frac{0.220}{0.150}$ **or** $5.50 \times 10^{-3} \times \frac{1000}{0.150}$

= 36.7 (or 37) cm^3 (or 36.6) **(1)**

NOT 36 NOR 37.0 units must match

(ii) *Indicator*: thymol blue **(1)**
Explanation: weak acid – strong base **(1)**
equivalent at pH > 7 **(1)**
or high pH

5

(c) (1) mol NaOH added = $\frac{2.0}{40.0}$ = 0.050 **(1)**
If wrong M.: CE ∴ lose marks (1) and (2) then mark on consequentially → max 4

(2) mol CH_3COOH left = 0.220 – 0.050 = 0.170 **(1)**

(3) mol CH_3COO^- formed = 0.050 **(1)**

(4) $[H^+] = Ka \frac{[acid]}{[salt]}$ OR $pH = pKa + \log \frac{[A^-]}{[HA]}$ etc **(1)**
If expression wrong no marks for 4 / 5 / 6
can score (1) to (4) in (5)

(5) $[H^+] = 1.74 \times 10^{-5} \times \frac{(0.170)}{(0.05)}$ OR $pH = 4.76 + \log\left(\frac{0.05}{0.17}\right)$ **(1)**

(6) pH = 4.23 **(1)**
*Correct answer gets **(1)(1)(1)(1)(1)(1)***
Mark (5) is for use of correct values of (acid moles) and (salt moles)
if one wrong allow pH conseq
if both wrong, no further marks
e.g. if candidate forgets substitution in (2)
he loses (2) and (5) but can score (1) (3) (4) (6) = max 4
for pH = 4.12 if $\frac{[acid]}{[salt]}$ *upside down; answer 5.29 scores 3 for (1) (2) (3)*

6

[16]

8. (a) Solar cells do not supply electrical energy all the time

1

Rechargeable cells can store electrical energy for use when the solar cells are not working

1

(b) Prevent pollution of the environment by toxic or dangerous substances / recycling of valuable components
Do not allow 'will not use up landfill sites'.

1

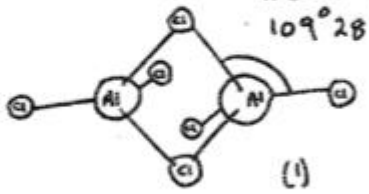
[3]

9.

(a) (i) Shape ..... Trigonal planar ..... (1)

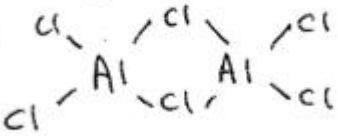
Linked to a correct shape

Bond angle ..... 120° ..... (1)

(ii) 

Predicted 109°28' (Allow 104 – 109.5) (1)

or correct values

Allow 

(1)

(iii) Lone electron pair on chlorine ..... (1)

Electron deficient Al (accepts lone pair) ..... (1)

(b) (i) Observation ..... Dissolves / exothermic reaction ..... (1)

Major aluminium-containing species ..... $[Al(H_2O)_6]^{3+}$ ..... (1)

Mark Separately

pH of final solution ..... 2/3/4 ..... (1)

(ii) Observations ..... Gas evolved ..... (1)

White precipitate formed ..... (1)

Mark Separately

Equation ..... $2[Al(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2[Al(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$

Species (1) Balanced (1)

[13]

10. (a) A catalyst in the same phase/phase as the reactants

1

(b) (i) A reaction in which a product acts as a catalyst

1

(ii) Mn^{2+} or Mn^{3+}

"Self-catalysing" not allowed

1

(c) (i) $2CO + 2NO \rightarrow 2CO_2 + N_2$

or $4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

C not allowed as a product

1

Reducing agent CO

1

(ii) Pt, Pd or Rh

1

Deposited on a ceramic honeycomb or matrix or mesh or sponge

1

To increase surface area of catalyst

1

[8]

11. (a) moles of $Cr_2O_7^{2-}$ per titration = 21.3 × 0.0150 / 1000 = $\underline{3.195 \times 10^{-4}}$

1

($Cr_2O_7^{2-}$ + 14H^+ + 6Fe^{2+} → 2Cr^{3+} + 7H_2O + 6Fe^{3+}) $Cr_2O_7^{2-}$:Fe^{2+} = 1:6

If 1:6 ratio incorrect cannot score M2 or M3

1

moles of Fe^{2+} = 6 × 3.195 × 10^{-4} = 1.917 × 10^{-3}

Process mark for M1 × 6 (also score M2)

1

original moles in 250 cm^3 = 1.917 × 10^{-3} × 10 = 1.917 × 10^{-2}

Process mark for M3 × 10

1

mass of $FeSO_4.7H_2O$ = 1.917 × 10^{-2} × 277.9 = 5.33 (g)

Mark for answer to M4 × 277.9

(allow 5.30 to 5.40)

*Answer **must** be to at least 3 sig figs*

Note that an answer of 0.888 scores M1, M4 and M5 (ratio 1:1 used)

1

(b) (Impurity is a) reducing agent / reacts with dichromate / impurity is a version of $FeSO_4$ with fewer than 7 waters (not fully hydrated)

Allow a reducing agent or compound that that converts Fe^{3+} into Fe^{2+}

1

Such that for a given mass, the impurity would react with more dichromate than a similar mass of $FeSO_4.7H_2O$

OR for equal masses of the impurity and $FeSO_4.7H_2O$, the impurity would react with more dichromate.

Must compare mass of impurity with mass of $FeSO_4.7H_2O$

1

[7]