N01/420/S(2)M A

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MARKSCHEME

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CHEMISTRY

Standard Level

Paper 2

9 pages

SECTION A

1. (a) $\Delta H_{rxn} = \sum BE_{breaking} - \sum BE_{making}$

$= (BE_{C=C} + BE_{H-H}) - (BE_{C-C} + 2BE_{C-H})$ ***[1]***

$= (612 + 436) - [348 + 2(412)]$ ***[1]***

$= 1048 - 1172$ (**OR** $2696 - 2820$ if all bonds are broken and made)

$= -124 \text{ kJ mol}^{-1}$ (accept -124 kJ) ; ***[1]***

*(+124 kJ mol^{-1} scores **[2]**)*

(b) $2(-124) = -248$ kJ *(allow ECF from (a))* ***[1]***

Has $2\ C = C$, needs $2\ H_2$ / forms twice the bonds ***[1]***

2. (a) $n_C = \frac{40.00}{12.01}$; $n_H = \frac{6.72}{1.01} =$; $n_O = \frac{53.28}{16.0}$

$= 3.333$ $\quad = 6.65$ $\quad = 3.333$ ***[1]***

Empirical formula: CH_2O ***[1]***

(b) $(CH_2O) : (12 + 2 + 16) = 30$; molar mass $= 2 \times$ empirical mass / OWTTE ***[1]***

Therefore $C_2H_4O_2$ ***[1]***

*(Award only **[1]** if reasoning not given)*

(c) CH_3COOH ***[1]***

$HCOOCH_3$ ***[1]***

(Accept other formulas e.g. CH_2OHCHO and CHOH=CHOH)

(d) pH: CH_3COOH pH < 7; $HCOOCH_3$ pH = 7 / ester will be higher / acid will be lower

Smell: CH_3COOH pungent/vinegar smell; $HCOOCH_3$ sweet smell

Boiling point: CH_3COOH higher; $HCOOCH_3$ lower ***[4]***

(***[1]*** *for each test,* ***[1]*** *for results of each test,* ***[4 max]***)

3. (a) Mg : 0 Cu^{2+} : + 2 (*need both for mark*) ***[1]***

(b) Cu^{2+} ***[1]***

(Accept copper / Cu)

(c) Ti (reacts with Ni^{2+} and Cu^{2+}) is a stronger reducing agent than Ni and Cu ***[1]***

But weaker reducing agent than Mg ***[1]***

Therefore, Mg, Ti, Ni, Cu ***[1]***

Total [20]

SECTION B

4. (a) (i) Acid: proton / H^+ donor *[1]*

Base: proton / H^+ acceptor *[1]*

(ii) A pair that differs by a proton / H^+ *[1]*

H_3O^+/H_2O **OR** H_2O/OH^- (*accept other valid answers*) *[1]*

(iii) Both *[1]*

Acid: $HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$ *[1]*

Base: $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$ *[1]*

(States not required; accept single arrow)

(iv) $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$ *[1]*

Undergoes (base) hydrolysis / reacts with water to produce OH^- *[1]*

OR Products of hydrolysis are a weak acid and strong base

(b) Measure pH / use pH meter / use universal indicator *[1]*

Strong acid has lower pH / weak acid has higher pH *[1]*

Measure conductivity *[1]*

Strong acid has higher conductivity / weak acid has lower conductivity *[1]*

React with magnesium / calcium carbonate *[1]*

Strong acid reacts faster / weak acid reacts slower *[1]*

Measure heat change / temperature rise on adding NaOH *[1]*

Strong acid has greater value / weak acid has lower value *[1]*

*(accept any suitable pair of method and difference for **[2]** each)*

Strong acid fully ionized / dissociated *[1]*

Weak acid partly ionized / dissociated *[1]*

(c) (i) Urea first in list and NaOH last *[1]*

Ammonia before caffeine *[1]*

(ii) Each pH unit represents a tenfold change in acidity *[1]*

5 pH units $\Rightarrow 10 \times 10 \times 10 \times 10 \times 10 = 100\,000$ times different *[1]*

$pH = 12 - 5 = 7$ *[1]*

Total [20]

5. (a) (i) $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$ / $2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$ ***[2]***

(States and equilibrium sign needed for second mark)

(ii) Endothermic ***[1]***

Bond breaking needs energy ***[1]***

(iii) Forward reaction ***[1]***

K increases, thus more H^+ / OH^- formed ***[1]***

OR Temperature increase favours forward reaction to use up some of the heat supplied (*second mark not awarded for only saying 'due to Le Chatelier's principle'*).

(Allow ECF from (ii))

(b) (i) All substances are in the same phase / state ***[1]***

(Accept all are gases)

(ii) No further change in temperature / colour (of iodine) / concentrations ***[1]***

(iii) $K_c > 1$: [products] exceed [reactants] at equilibrium / OWTTE ***[1]***

$K_c \ll 1$: reaction hardly proceeds / does not proceed / [reactants] $\gg$ [products] ***[1]***

(iv) Decreasing volume increases pressure / concentration ***[1]***

However no change in equilibrium position ***[1]***

Since number of moles of gases the same in reactants and products ***[1]***

(v) No effect on position of equilibrium ***[1]***

Speeds up both forward and reverse reaction ***[1]***

No effect on K_c ***[1]***

Value of K_c is affected only by T ***[1]***

(c) (One H_2 reacts with one I_2 to form 2HI)

0.25 mol H_2 and 0.25 mol H_2 react to form 0.50 mol HI ***[1]***

Therefore, $[H_2] = 0.15 + 0.25 = 0.40 \text{ mol dm}^{-3}$ ***[1]***

$[I_2] = 0.05 + 0.25 = 0.30 \text{ mol dm}^{-3}$ ***[1]***

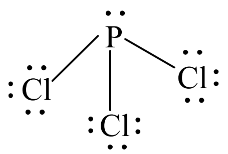
Total [20]

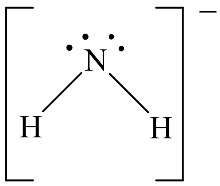
6. (a) (i) Hydrogen bonding *[1]*
A hydrogen atom bonded to a highly electronegative oxygen atom *[1]*
Strong / special type of dipole-dipole interaction *[1]*

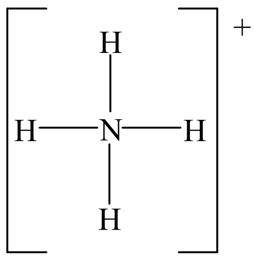
(ii) Van der Waals' / London / dispersion forces *[1]*
Temporary distortion of electron cloud in the non-polar atoms / OWTTE *[1]*
Weak / temporary / instantaneous dipole-dipole interaction *[1]*

(iii) Electrostatic attraction between Na^{+} and Cl^{-} / ions of opposite charge *[1]*
Ions formed due to electron transfer *[1]*

(b) (i)







[1] *[1]* *[1]*

(Penalise only once if charge on ion or lone e^{-} *pairs on terminal atoms are missing)*

(ii) PCl_3: trigonal pyramidal *[1]*
$< 109^{\circ}$ / $\simeq 109^{\circ}$ (but not $109\frac{1}{2}^{\circ}$ or tetrahedral angle) *[1]*

NH_2^{-}: bent / angular / v-shaped *[1]*
$< 109^{\circ}$ / $\simeq 109^{\circ}$ (but not $109\frac{1}{2}^{\circ}$) *[1]*

NH_4^{+}: tetrahedral *[1]*
$109\frac{1}{2}^{\circ}$ *[1]*

(c) III II I *[1]*
Van der Waals' forces between molecules *[1]*
III has the least surface area, therefore, less van der Waals' forces/ *[1]*
I has the largest surface area, therefore, most van der Waals' forces

Total [20]