N01/420/S(2)M

INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

MARKSCHEME

November 2001

CHEMISTRY

Standard Level

Paper 2

10 pages

SECTION A

1. (a) Reaction rate is faster. *[1]*
Increase in pressure increases concentration of reactants / same amount in less volume, and the rate increases as the number of collisions per unit volume increases. *[1]*

Equilibrium position does not change. *[1]*
K is independent of concentration / depends on T only. *[1]*

(b) $[I_2]$: Decreases slightly, then becomes constant. *[1]*
[HI]: Increases slightly, then becomes constant. *[1]*

2. (a) $2C_2H_5OH + 7O_2 \rightarrow 4CO_2 + 6H_2O$

*(Award **[1]** for correct reactants and products, **[1]** for correct balancing. States **not** required; do **not** accept* C_2H_6O *; accept with half the coefficients.)* *[2]*

(b) (i) $M_r = 88$ *[1]*
$\Delta H_c^{\ominus} = -3325 \pm 25 \text{ kJ mol}^{-1}$ *(allow for ECF)* *[1]*

(ii) The value should be (about) the same. *[1]*
Same (number and type of) bonds are being broken and made. *[1]*

*(Do **not** accept: "the compounds have the same relative molecular masses or same formulas".)*

3. (a) B: 2.3; Al: 2.8.3 *(need both for mark)* ***[1]***

Electron being removed in Al is in $n = 3$ / further away from the nucleus and easier to remove. ***[1]***

(b) Valence electron in Si is in the same main energy level. ***[1]***

Greater nuclear charge holds valence electrons more tightly. ***[1]***

(Thus needs more energy to remove electron.)

4. (a) Solid: No **ions** to move about. ***[1]***

Molten: Ions are free to move about. ***[1]***

(b) Anode: $2Cl^{-}(l) \rightarrow Cl_2(g) + 2e^{-}$ (*state symbols needed*) ***[1]***

Cathode: $Pb^{2+}(l) + 2e^{-} \rightarrow Pb(l)$ (*state symbols needed*) ***[1]***

SECTION B

5. (a) NaCl; HCl (*need both for mark*) ***[1]***

NaCl: Each Na atom **transfers** an electron to each Cl atom ***[1]***
thus producing Na^+ and Cl^- / cations and anions with (strong) attraction between oppositely charged ions. ***[1]***

HCl: Each H atom **shares** an electron with an electron from each Cl (thus producing a covalent bond in which bonding electrons are under the influence of both nuclei). ***[1]***
Due to difference in electronegativity / large difference: ionic / smaller difference: covalent. ***[1]***

(b) NaCl will have a **much higher** melting point than HCl. ***[1]***

Ionic bonding is a network / 3D arrangement of oppositely charged ions ***[1]***
attracting each other strongly. ***[1]***

HCl is polar (simple molecular) substance with weaker dipole–dipole interaction between molecules. ***[1]***

(c) Neither will conduct in the solid state because there are no (mobile) ions present. ***[1]***
NaCl conducts in the liquid state as ions can move (thus carrying charge). ***[1]***
HCl liquid will not conduct as there are no (mobile) ions (or free electrons). ***[1]***

(d) Water is a highly polar molecule (with $H^{\delta+}$ and $O^{\delta-}$ ends). ***[1]***

The δ^- of the water surrounds the Na^+ ions, and the δ^+ of the water surrounds the Cl^- ions / OWTTE. ***[1]***
The resulting (dipole–ion) attraction overcomes the attractive forces between the ions, and the compound dissolves. ***[1]***

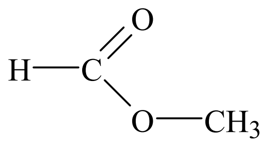
HCl is a polar molecule (due to different electronegativities). ***[1]***
Polar water molecules surround HCl (in a similar way), ***[1]***
and the dipole–dipole attractions are sufficient to break the HCl covalent bond. ***[1]***

(e) CCl_4 is a non-polar molecule. ***[1]***
There is no possibility of any $CCl_4 - H_2O$ interactions to compensate for breaking water–water interactions. ***[1]***

6. (a)

	C	H	O	
	$n_C = \dfrac{0.400}{12.01}$	$n_H = 0.0666$	$n_O = \dfrac{2.02\times10^{22}}{6.02\times10^{23}}$	***[1]***
	$= 0.0333$	$= 0.0666$	$= 0.0334$	***[1]***

Empirical formula is CH_2O ***[1]***

(b) (i) $HCOOCH_3$ **OR**  ***[1]***

Heat ***[1]***
Acid catalyst / H^+ ***[1]***
HCOOH / methanoic acid ***[1]***
CH_3OH / methanol ***[1]***
$HCOOH + CH_3OH \rightleftharpoons HCOOCH_3 + H_2O$ (*accept if* $\rightarrow$ *used*) ***[1]***

(ii) CH_3COOH (*but not* $C_2H_4O_2$) ***[1]***
Physical:

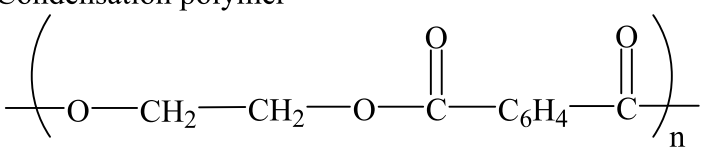
Boiling point: higher for acid / lower for ester
pH: acid < 7; ester = 7 (*need both for mark*). ***[1]***
OR Smell: acid: vinegar/pungent smell; ester: sweet smell. ***[1]***

Chemical:

acid reacts with OH^- to form salt and water. ***[1]***
Ester reacts with OH^- to form salt plus methanol / acid can be esterified; ester cannot ***[1]***

(c) (i) When two (small) molecules combine to form a larger one **with** the elimination of a smaller molecule (such as water). ***[1]***
The need for two functional groups on each of the two monomers. ***[1]***
Addition polymerisation: process in which unsaturated monomers combine to form a polymer **without** the elimination of any atoms/molecules. ***[1]***

(ii) Condensation polymer ***[1]***



*(Award **[1]** for ester group and **[1]** for alkanol and acid groups.)* ***[2]***

7. (a) pH of 7 will be NaCl; NaCl is a neutral salt *[1]*
pH of 13 is NaOH; it is a strong base (fully ionised). *No mark for 'high pH'* *[1]*
pH of 1 is HCl; it is a strong acid (fully ionised). *No mark for 'low pH'* *[1]*
pH of about 11 for NH_3; a weak base (partially hydrolysed, less OH^-) *[1]*
pH of about 3 will be CH_3COOH; a weak acid (partially ionised, less H^+) *[1]*
(for NH_3 *accept 13 < pH > 7; for* CH_3COOH *7 < pH > 1)*

(b) (i) $HCO_3^- + OH^- \rightleftharpoons H_2O + CO_3^{2-}$ (*states **not** required; accept molecular equation*) *[1]*
The reaction decreases $[OH^-]$ in the solution and the pH decreases. *[1]*

(ii) $HCO_3^- + H_3O^+ \rightleftharpoons H_2O + H_2CO_3$ (*accept* $H_2O + CO_2$ *in place of* H_2CO_3)
*(States **not** required. Accept* H^+ *in place of* H_3O^+*.)* *[1]*

The reaction decreases $[H^+]$ in the solution and the pH increases. *[1]*

(c) in (b) (i): HCO_3^- : proton donor, acid; (OH^- : proton acceptor, base) *[1]*
in (b) (ii): HCO_3^- : proton acceptor, base; (H_3O^+ : proton acceptor, acid) *[1]*

(d) (i) Strong acid: Acid 1 / acid with high conductivity / *[1]*
Weak acid: Acid 2 / acid with lower conductivity.
Strong acid is (almost) fully / 100 % dissociated *[1]*
as [acid] increases, the number of ions increases, and so does the conductivity. *[1]*

Weak acid is only partially dissociated producing fewer ions in solution. *[1]*
As [acid] increases, the number of ions increases initially until an equilibrium is established. *[1]*
The concentration of ions becomes constant and the conductivity remains constant as well. *[1]*

(ii) Both reactions produce gas / H_2 *[1]*
The acid that reacts more quickly / producing more bubbles is the strong acid (the other is the weak acid). *[1]*

*(If gas produced is implicit in the second answer, award **[2]**.)*

(iii) Same volume (10.0 cm^3) required. *[1]*