MARKSCHEME

November 2006

CHEMISTRY

Standard Level

Paper 3

13 pages

Subject Details: **Chemistry SL Paper 3 Markscheme**

General

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- Alternative answers are separated by a slash (/) – this means that either answer is acceptable.
- Words underlined are essential for the mark.
- Material in brackets (…) is not needed for the mark.
- The order in which candidates score marks does not matter (unless stated otherwise).
- The use of ***OWTTE*** in a markscheme (the abbreviation for "or words to that effect") means that if a candidate's answer contains words different to those in the markscheme, but which can be interpreted as having the same meaning, then the mark should be awarded.
- Please remember that many candidates are writing in a second language, and that effective communication is more important than grammatical accuracy.
- In some cases there may be more acceptable ways of scoring marks than the total mark for the question part. In these cases, tick each correct point, and if the total number of ticks is greater than the maximum possible total then write the maximum total followed by **MAX**.
- In some questions an answer to a question part has to be used in later parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in later parts then "follow through" marks can be scored. Show this by writing **ECF** (error carried forward). This situation often occurs in calculations but may do so in other questions.
- Units for quantities should always be given where appropriate. In some cases a mark is available in the markscheme for writing the correct unit. In other cases the markscheme may state that units are to be ignored. Where this is not the case, penalize the omission of units, or the use of incorrect units, once only in the paper, and show this by writing **–1(U)** at the first point at which it occurs.
- Do not penalize candidates for using too many significant figures in answers to calculations, unless the question specifically states the number of significant figures required. If a candidate gives an answer to fewer significant figures than the answer shown in the markscheme, penalize this once only in the paper, and show this by writing **–1(SF)** at the first point at which this occurs.
- If a question specifically asks for the name of a substance, do not award a mark for a correct formula; similarly, if the formula is specifically asked for, do not award a mark for a correct name.
- If a question asks for an equation for a reaction, a balanced symbol equation is usually expected. Do not award a mark for a word equation or an unbalanced equation unless the question specifically asks for this. In some cases, where more complicated equations are to be written, more than one mark may be available for an equation – in these cases follow the instructions in the mark scheme.
- Ignore missing or incorrect state symbols in an equation unless these are specifically asked for in the question.
- Mark positively. Give candidates credit for what they have got correct, rather than penalizing them for what they have got wrong.
- If candidates answer a question correctly, but by using a method different from that shown in the markscheme, then award marks; if in doubt consult your Team Leader.

Option A – Higher physical organic chemistry

A1. (a) symmetrical/planar /hexagonal structure;
delocalisation of electrons / resonance hybrid;
C-C bond length same/ C-C bond strength the same;
angle 120°;
carbon is sp2 hybridized; ***[4 max]***
*Award **[1]** each for any four points.*

(b) one;
all the hydrogens in benzene are equivalent / *OWTTE*; ***[2]***

(c) -360 kJ mol^{-1}; ***[1]***

(d) benzene is more stable because of delocalisation / does not contain three double bonds; ***[1]***

A2. (a) first order;
constant half life; ***[2]***

(b) rate $= k[\text{HI}][\text{H}_2\text{O}_2]$; ***[1]***
ECF from(a).

(c) 47 sec;
Accept answer in range 45 to 49.
$\left(t_{\frac{1}{2}} = \dfrac{0.693}{k}\right) = 0.015$;
Accept answer in range 0.014-0.015.
ECF from half life. ***[2]***

A3. (a) $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$; ***[1]***
Ignore state symbols and accept →.

(b) $K_\text{b} = \dfrac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$; ***[1]***

(c) $[\text{OH}^-] = 2.1 \times 10^{-3}$;
$\text{pOH} = 2.7 \ / \ [\text{H}^+] = 4.8 \times 10^{-12}$;
$\text{pH} = 11.3$; ***[3]***
Allow ECF for the value of pOH and pH.

(d) $\text{pOH} = 4.75 \ / \ [\text{H}^+] = 5.8 \times 10^{-10}$;
$\text{pH} = 9.2(5)$; ***[2]***

Option B – Medicines and drugs

B1. (a) (tertiary) amine; ***[1]***

(b) amide; ***[1]***

(c) basic;
N atoms can accept H^+ ions from water / forms OH^- ions in the solution; ***[2]***

(d) anxiety;
irritability;
sleeplessness;
increase in urine output;
Award ***[1]*** *for any two.* ***[1 max]***

(e) increased heart rate;
increased blood pressure;
reduction in urine output; ***[1]***
Award ***[1]*** *mark for any two*.

(f) symphathomimetic drug mimics the effect of adrenalin / stimulates the sympathetic nervous system;
amphetamine/ methamphetamine/speed/estasy; ***[2]***

B2. (a) injection (parenteral);
Oral;
Rectal;
inhalation; ***[3]***
Award ***[3]*** *for 4 correct,* ***[2]*** *for 3 correct,* ***[1]*** *for 2 correct.*
Accept different types of injection method once only.

(b) psychosomatic response to substance given / positive response to an ineffective substance or treatment / *OWTTE*; ***[1]***

B3. (a) $C_{16}H_{18}O_4N_2S$; ***[1]***
Accept elements in any order.

(b) prevents deactivation by stomach acid/more resistant to stomach acid;
prevents deactivation by the enzyme penicillinase (produced by bacteria) / increases resistance/tolerance to penicillinase; ***[2]***

(c) broad spectrum – effective against many types/strains of bacteria
and
narrow spectrum – effective only for certain type of bacteria; ***[1]***

(d) penicillin interferes with the cell wall formation;
cells can expand/burst/disintegrate / bacteria die; ***[2]***

(e) makes penicillin less effective;
destroys useful/beneficial bacteria;
allows resistant population to build up; ***[2]***
*Award **[1]** each for any two.*

Option C – Human biochemistry

C1. (a) *low pH*
C;
high pH
A; ***[2]***

(b) (i) place sample on gel;
with (buffer) solution of known pH;
apply voltage/potential difference;
Do not accept current applied.
develop / spray with ninhydrin;
measure distance moved / compare with known iso-electric point / compare with standards; ***[3]***
*Award **[1]** each for any three.*

(ii) *positive electrode*
glutamic acid;

negative electrode
arginine; ***[2]***

(c) all (can be metabolised to) produce energy; ***[1]***

C2. (a) 761.7 g of I_2 / 274÷253.8 = 1.08 mol;
3 mol of I_2 / 6 mol of I atoms / 100÷278 = 0.360 mol;
(1.08÷0.360 =) 3 double bonds; ***[3]***
Some correct working must be shown.
Allow ecf if M_r of iodine used as 126.9 used instead of 253.8.
Accept correct alternative methods.

(b) palmitic acid has no C=C bonds / saturated;
stronger intermolecular forces / chains pack closely; ***[2]***

C3. (a) recovery from injury/surgery/starvation/illness/disease;
increased rate of protein synthesis / tissue/muscle building / increase in muscle mass; ***[2]***

(b) enhances performance/strength unfairly; ***[1]***

(c) mimics the action of progesterone in pregnancy;
prevents release of the egg / no ovulation;
prevents release of FSH and LH by the pituitary gland; ***[2 max]***
*Award **[1]** each for any two.*

(d) hydroxyl/alcohol/alkanol;
alkyne/triple bond; ***[2]***
Must name groups - formulas are not sufficient.

Option D – Environmental chemistry

D1. (a) rain with pH less than 5.6; ***[1]***

(b) HNO_3 / nitric acid / HNO_2 / nitrous acid;
H_2SO_4 / H_2SO_3 / sulfuric acid / sulfurous acid;
(NO) high temperature in internal combustion/jet engine / reaction between N_2 and O_2 at high temperature;
(SO_2) from burning of coal / smelting plants / sulfuric acid plants; ***[4]***
Do not accept combustion of fossil fuels.

(c) $SO_2 + H_2O \rightarrow H_2SO_3$ / $SO_3 + H_2O \rightarrow H_2SO_4$ / $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ /
$4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$; ***[1]***

(d) heat from coal decomposes (finely powdered) limestone;
$CaCO_3 \rightarrow CaO + CO_2$;
(lime absorbs SO_2) $CaO + SO_2 \rightarrow CaSO_3$ / $2CaO + 2SO_2 + O_2 \rightarrow CaSO_4$ /
$CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$; ***[3]***

D2. (a) earths temperature may be increased / global warming / thermal expansion of ocean / melting of polar icecaps / coastal flooding; ***[1]***
Do not accept greenhouse effect but increased greenhouse effect is acceptable.

(b) short wavelength / high frequency / high energy radiation reaches earth / not absorbed by CO_2;
longer wavelength / low frequency radiation / infrared absorbed by CO_2;
re-radiated back to earth's surface; ***[2 max]***
*Award **[1]** each for any two points.*

(c) dissolving in H_2O / photosynthesis / absorbed by green plants;
$CO_2 + H_2O \rightarrow H_2CO_3$ / $H^+ + HCO_3^-$ / $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$; ***[2]***

D3. (a) aeration / adding O_2 /air;
bacteria / microbes; ***[2]***

(b) detergents / washing powders; ***[1]***

(c) precipitation;
$Pb^{2+}(aq) + H_2S(aq) \rightarrow PbS(s) + 2H^+(aq)$;
$PO_4^{3-}(aq) + Al^{3+}(aq) \rightarrow AlPO_4(s)$ / $2PO_4^{3-}(aq) + 3Ca^{2+}(aq) \rightarrow Ca_3(PO_4)_2(s)$; ***[3]***
Ignore state symbols.
Accept ionic equation for the first marking point.

Option E – Chemical industries

E1. (a) $H_2S(g) + CO_3^{2-}(aq) \rightleftharpoons HS^-(aq) + HCO_3^-(aq)$; ***[1]***

Ignore state symbols and reversible sign.

(b) (i) (crude oil) vaporized/heated;
rises up a column/tower;
temperature gradient;
mixture separated due to different boiling points;
lighter fractions/smaller molecules condense higher up / heavier fractions condense lower down;
vapour phase is always richer in the more volatile component; ***[4 max]***
*Award **[1]** each for any four*.

(ii) (non polar molecules with) only weak van der Waal's/London/dispersion/intermolecular forces; ***[1]***

(c) $C_{16}H_{34} \rightarrow C_8H_{18} + C_8H_{16}$; ***[1]***

E2. (a) HDPE;
no/very few branches;
chains pack closer together;
stronger intermolecular forces; ***[4]***
Allow converse argument e.g. LDPE has more branches, so its chains are further apart and the intermolecular forces are weaker.

(b) produced from fossil fuel/non-renewable natural source;
non-biodegradable / ends up in landfill / non-reactive; ***[1 max]***

(c) *named polymer 1*
plasticizers added to polyvinyl chloride;
polymer chains become more flexible;

named polymer 2
volatile hydrocarbons in the formation of expanded polystyrene;
reduced density / light, very good thermal insulator;

named polymer 3
air in the manufacture of polyurethane foams;
low-density foam; ***[4 max]***
*Award **[2]** each for any two polymers.*

E3. (a) electrolysis;
molten salt / fused compound; ***[2]***

(b) $2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$;
$PbO + C \rightarrow Pb + CO$ / $2PbO + C \rightarrow 2Pb + CO_2$; ***[2]***

Option F – Fuels and energy

F1. (a) atomic number 88;
mass number 222; ***[2]***

(b) 5 half-lives;
250 dpm; ***[2]***
*Award **[2]** for correct final answer.*

F2. (a) *disadvantages*
requires very high temperature / containment of reaction very expensive;

advantages
fuel deuterium is abundant and cheap;
small amount of radioactive waste; ***[3]***

(b) (i) fission of (^{235}U) by neutrons / mass converted to energy;
combustion of coal/oil/gas (with air); ***[2]***

(ii) *advantages*
produces large amounts of energy;
consumes small amount of fuel;
produces little/no CO_2;
*Award **[2 max]** for advantages.*

disadvantages
production/storage of radioactive waste;
meltdown / loss of control / explosion;
high capital costs;
weapons of mass destruction; ***[4 max]***
*Award **[2 max]** for disadvantages.*

F3. (a) (i) photosynthesis; ***[1]***

(ii) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$; ***[1]***

(b) (i) methane / CH_4 ;
anaerobic/bacterial decay of organic matter; ***[2]***

(ii) enzyme (present in yeast);
absence of air/O_2; ***[2]***

(iii) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$; ***[1]***