

MARKSCHEME

May 2001

CHEMISTRY

Standard Level

Paper 3

12 pages

OPTION A – HIGHER ORGANIC CHEMISTRY

- A1.** (a) (i) Free radical: species with an *unpaired electron* / single electron [1];
Cl atom / Cl• / C₂H₅• [1].

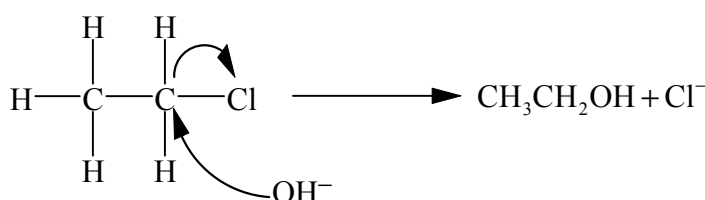
[2 max]

- (ii) Homolytic fission: breaking of a (covalent) bond to give two fragments with an electron each. [1]

(Allow credit for suitable equation **OR** representation.)

- (b) (i) **Nucleophilic** substitution / **nucleophilic** displacement reaction / S_N1 / S_N2. [1]

(ii)



- Both curly arrows correctly drawn [1];
- Correct products [1].

[2 max]

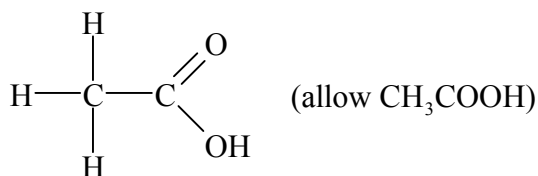
Note:

- Do not award the first mark if curly arrow originates on the negative charge or on the hydrogen.
- Chloride ion must be given for second mark.

- (iii) Bimolecular / molecularity = 2 [1];
Some reference to **primary** compound / carbon atom (accept correct reference to reaction not being unimolecular) [1].

[2 max]

- (c) (i)



[1]

Accept CH₃CHO.

- (ii) Accept
 CH_3COOH is more acidic **[1]**;
 $\text{C}=\text{O}$ group weakens $\text{O}-\text{H}$ bond / makes it more polar / attracts electrons from it **[1]**;
 CH_3COO^- anion is more stable / negative charge is delocalised in CH_3COO^- **[1]**.

If CH_3CHO is chosen in (c) (i), an alternative (ii) is:

CH_3CHO is less acidic / $\text{CH}_3\text{CH}_2\text{OH}$ more acidic **[1]**;
 No polar bonding involving H / no H joined to O **[1]**;
 Effect of $\text{C}=\text{O}$ not enough to break $\text{C}-\text{H}$ bond **[1]**.

[3 max]

- (d) (i) Three signals / peaks / absorptions **[1]**;
 Three different proton environments / types of hydrogen (ECF from 1st mark) **[1]**.

[2 max]

- (ii) Ratio 3 : 2 : 1 (*in any order*).

[1]

OPTION B – HIGHER PHYSICAL CHEMISTRY

B1. *Note: in this question, award consequential marks in (c) and (d) where appropriate.*

- (a) Zero order / 0 *[1]*;
Change in $[Y]$ has no effect on rate (provided that there is some reference to experiments 1 and 2 or 0.02 and 0.05) *[1]*.
[2 max]
- (b) Second order / 2 *[1]*;
(If experiments 1 or 2 are compared with 3.) Change in $[X]$ causes rate to increase $\times 16$ *[1]*.
OR
(If experiments 1 or 2 are compared with 4.) Change in $[X]$ causes rate to increase $\times 9$.
[2 max]
- (c) Second order / 2 (ECF from (a) and (b)). *[1]*
- (d) Rate = $k[X]^2$ or $k[X]^2[Y]^0$ (ECF from (c)). *[1]*
- (e) Slowest step (accept slow). *[1]*

- B2.** (a) (i) Disorder / chaos. *[1]*
- (ii) 1 mol gas \rightarrow 2 mol gas / increase in gas moles *[1]*;
Therefore going to a more disordered state / gas more disordered than liquid *[1]*;
Increase (in entropy) / ΔS positive *[1]*.
[3 max]
- (b) (i) Negative / minus. *[1]*
- (ii) Spontaneous. *[1]*
- (iii) Low temperature *[1]*;
 $T\Delta S^\ominus < \Delta H^\ominus$ or word equivalent *[1]*.
[2 max]

OPTION C – HUMAN BIOCHEMISTRY

C1. (a) Chemical messenger / OWTTE. [1]

(b) (i) Testes. [1]

(Note: Do not award [1] for ovaries, since in humans the production of testosterone by the ovaries is extremely low in comparison with the testes.)

(ii) Use (e.g. treatment of wasting illness / to regain muscle tissue, treatment of eczema) [1];

Abuse (e.g. increase muscle mass to enhance performance / increase strength) [1];

Second use or second abuse [1].

[3 max]

(c) Two groups circled correctly [1];
Two correct corresponding names [1].

Accept any two from the following:

- Alkanol / alcohol / hydroxyl;
- Alkene;
- Alkanone / ketone / carbonyl.

(Do not accept CH₃ / methyl / alkyl group or 'hydroxide')

[2 max]

(d) *Allow any one from:*

- Cholesterol has an OH group instead of the C = O group in testosterone;
- Cholesterol has an alkyl / hydrocarbon side-chain instead of the OH group in testosterone;
- There is no carbonyl group present in cholesterol;
- The position of the C = C bond is different in cholesterol compared to testosterone.

(Or any other correct answer, relating to structural differences.)

[1 max]

C2. (a) Glycerol / propane-1,2,3-triol (*accept correct structure*). [1]

(b) Fatty acid(s) / salt of acid / soap / carboxylic acid / alkanoic acid / carboxylate. [1]

(c) Heat with base / alkali / KOH / NaOH (*both needed*). [1]

(d) Heat produced = (mass × specific heat capacity × ΔT) (*can be scored by implication*) [1];
= (500 × 4.18 × 67.5) [1];
= 141.075 / 141075 J [1].

$$\text{Calorific value of bar} = \frac{50.0}{10.0} \times 141.075 ;$$

$$= 705.4 \text{ (kJ) / 705 (kJ) (accept correct value in J) [1].}$$

[4 max]

OPTION D – ENVIRONMENTAL CHEMISTRY

- D1.** (a) Water / CFCs / dinitrogen oxide (N_2O or nitrous oxide / O_3 / HCFCs / HFCs / SF_6). **[1]**
(Accept correct formula instead of a name).
- (b) (i) *Any two sources, [1] each*
 e.g. Respiration (by animals) / decay of plants or animals / oxidation of soil humus / forest fires caused by lightning / volcanoes / combustion of fossil fuels and wood / burning trash (rubbish). **[2 max]**
- (ii) *Any two sources, [1] each*
 e.g. Bacterial fermentation / bogs or marshes / digestive tracts of ruminants. Rotting waste in land-fill sites. **[2 max]**
- (c)
 - Lower energy / longer wavelength / infrared radiation from the Earth **[1]**;
 - Greenhouse gases absorb / retain / trap this energy **[1]**;
 - Some reference to how the gases absorb this energy e.g. vibration **[1]**.**[3 max]**
- D2.** (a) (i)
 - Solid objects / example of this (e.g. rock) **[1]**;
 - Grids / screens / sand bed (*do not accept filter*) **[1]**.**[2 max]**
- (ii)
 - Metal ions / phosphate **[1]**;
 - Alkali / sulfide / Ca^{2+} / calcium ions (accept a named calcium compound) **[1]**.**[2 max]**
- (b) (i) *Any two of the following [1] each*
 - Similar anti-bacterial action achieved with smaller $[\text{O}_3]$;
 - O_3 more effective than Cl_2 (against waterborne viruses);
 - O_3 imparts no chemical taste to water;
 - O_3 does not form harmful chlorine containing organic compounds.**[2 max]**
- (ii) O_3 must be produced on site (because of high reactivity) / O_3 has a shorter retention time. **[1]**

OPTION E – CHEMICAL INDUSTRIES

E1. (a) Heats the furnace / OWTTE [1].

Any valid reaction involving coke, *e.g.* reduces iron oxide / is converted to carbon monoxide [1].

[2 max]

(b) (i) Oxygen is blown through (the molten iron). (*Do not accept 'air' here*) [1];
It oxidises / converts the carbon into carbon dioxide gas (which escapes) [1].

[2 max]

(ii) Calcium oxide / lime is added (to the molten iron). (*Allow limestone*) [1];
Calcium oxide reacts (with the silica) to form calcium silicate / slag [1].

[2 max]

E2. (a) Any appropriate equation (*must have alkane and alkene as products*) [1];
One use of an alkane (*e.g.* fuel) [1];
One use of an alkene (*e.g.* polymer or name of polymer) [1].

[3 max]

(b) (i) Silica / aluminium oxide / zeolites.

[1]

(ii) Heat / high temperature / temperature above 300 °C .

[1]

(c) Catalytic cracking produces a mixture of **alkanes and alkenes** [1];
Hydrocracking produces **alkanes** only [1].

[2 max]

E3. Any reasonable answer *e.g.* the products of refining are **flammable** and hence there is a risk of fire.

[1]

Any reasonable answer *e.g.* the gas produced in the furnace must not be released as it contains poisonous carbon monoxide.

[1]

OPTION F – FUELS AND ENERGY

- F1.** (a) (i) 1 % **[1]**
- (ii) Inappropriate wavelengths **[1]**;
Reflected / heats the surface / not all areas covered by plants **[1]**.
[2 max]
- (b) (i) Photosynthesis. **[1]**
- (ii) $6\text{H}_2\text{O} + 6\text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ **[1]**
(No marks if not balanced.)
- (c) (i) Any two of the following, **[1]** each
 - Combustion;
 - Production of biogas;
 - Production of ethanol / fermentation.**[2 max]**
- (ii) (Allow **[1]** for any reasonable advantage and **[1]** for any reasonable disadvantage.)
[2 max]
- (d) (i)
 - Heat **[1]**;
 - Pressure **[1]**;
 - Absence of oxygen **[1]**.**[3 max]**
- (ii) Any three of the following, **[1]** each
 - Specific example of pollution (e.g. oil spills);
 - Cost of production / transport;
 - Non-renewable;
 - More valuable as a feedstock.**[3 max]**
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