

MARKSCHEME

May 2006

CHEMISTRY

Higher Level

Paper 3

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of IBCA.*

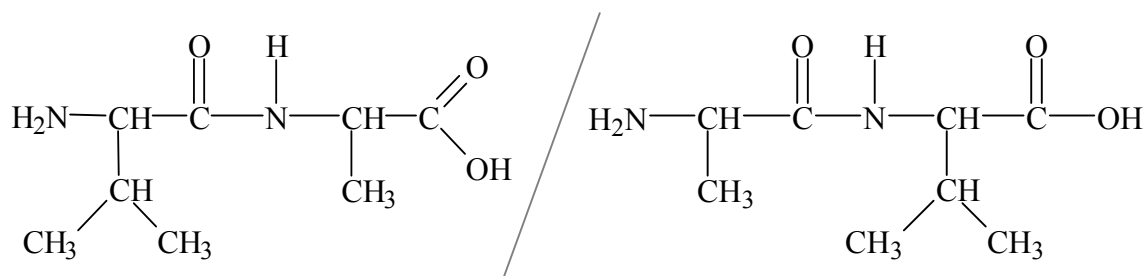
Option B – Medicines and drugs

- B1.** (a) a moderate dose may induce sedation / reduce anxiety or tension / slower mental activity / slows CNS / causes drowsiness;
a high dose may induce sleep / coma / unconsciousness / death; **[1]**
Award [1] for both.
- (b) orange to green;
Cr³⁺ / chromium(III); **[2]**
- B2.** (a) amphetamines / stimulants;
increased heart rate / increased blood pressure / increased breathing rate / dilation of pupils / constriction of arteries / sweating / increased alertness / decreased appetite; **[2]**
- (b) (i) nicotine; **[1]**
Accept nicotin.
- (ii) increased heart rate;
increased blood pressure;
reduced urine output;
increased concentration / stimulating effect; **[2 max]**
Award [1] each for any two.
- (iii) increased risk of cancer;
increased risk of stroke / (coronary) thrombosis / heart disease;
ulcers;
emphysema/bronchitis/shortage of breath;
coughing / bad breath / yellowing of teeth or fingers;
effect on pregnancy; **[2 max]**
Award [1] each for any two.
- B3.** (a) viruses are smaller;
viruses do not have nuclei/cell wall / bacteria do have nuclei/cell wall;
viruses do not have cytoplasm / bacteria do have cytoplasm;
viruses do not feed/excrete/grow / bacteria do feed/excrete/grow;
viruses use cell material of the invaded cell to reproduce themselves; **[2 max]**
Award [1] each for any two.
- (b) stops virus replication;
acyclovir becomes part of DNA of virus / mimics nucleotide or guanine / alters virus DNA / prevents other nucleotides from attaching; **[2]**
- (c) if receptor site is modified/altered, HIV virus could not bind to cells;
drug prevents HIV from losing the protein coat;
reverse transcriptase can be blocked (to avoid converting the virus into a structure that can enter the nucleus of the host cell);
the production of new viral RNA and proteins can be blocked;
drug stops viruses leaving the cells; **[2 max]**
Award [1] each for any two.

- B4.** (a) nitrous oxide is not very powerful / some side effects;
ethoxyethane is flammable;
halothane is potentially harmful to the ozone layer/is a CFC/is toxic; [3]
- (b) (i) $(0.8+0.3+0.1)=1.2$ atm; [1]
- (ii) (applying $p_{O_2} = X_{O_2} P_{total}$) $X_{O_2} = 0.25$ / $\frac{1}{4}$ / 25 %; [1]
If necessary apply (U-1) to (b).
- B5.** one enantiomer has beneficial/desired effect;
the other enantiomer no effect/harmful effect/waste of material/more clinical trials necessary;
thalidomide;
one thalidomide enantiomer relieves symptoms of morning sickness while the other isomer
can cause birth defects;
Accept alternatives, e.g.
ibuprofen;
one enantiomer much more effective;
taxol;
one enantiomer much more effective; [4]

Option C – Human biochemistry

C1. (a) (i)



[2]

Award [1] for the correct peptide bond and an additional [1] if the rest of the structure is correct.

Accept $\begin{array}{c} \text{O} \\ \parallel \\ \text{---C---N---} \end{array}$ or $\begin{array}{c} \text{O} \\ \parallel \\ \text{---C---NH---} \end{array}$ for the peptide bond.

(ii) condensation;
H₂O / water;

[2]

(b) mixture placed on gel/paper;
use of buffer solution;
potential difference applied;
amino acids move differently (depending on pH / isoelectric point);
develop/spray with ninhydrin;
compare distances travelled with standards (OWTTE) / compare the isoelectric points;

[4 max]

Award [1] each for any four.

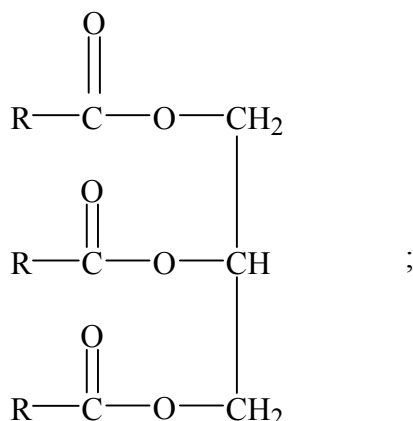
(c) (i) sequence/chain of amino acids;

[1]

(ii) α -helix = intramolecular/spiral/OWTTE;
 β -sheet = attraction between chains (accept intermolecular) / OWTTE;
Accept suitable diagrams.

[2]

C2. (a)



[1]

Accept ---COO--- in place of $\begin{array}{c} \text{O} \\ \parallel \\ \text{---C---O---} \end{array}$

- (b) there are no more double bonds / all single bonds (in the R group);
 molecules pack closer together/straighter chains / regular structure / fewer kinks / *OWTTE*;
 stronger van der Waals' forces;
 Accept London / dispersion forces / vdW but not intermolecular.

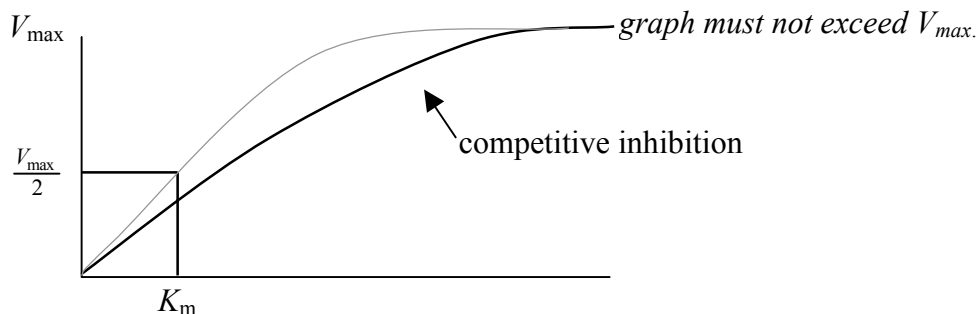
[3]

- C3. (a) reaction slows down;
 V_{\max} unchanged;
 K_m increased;
 inhibitors occupy active sites;
 substrate molecules prevented from binding to enzyme;

[4 max]

- (b) position of K_m must show derivation (using $\frac{1}{2} V_{\max}$).
 correct line must show slower rate but need not extend to V_{\max} .

[2]



C4. (a) Ringing and labelling one of the two nucleotides;

[1]

(b) for the other nucleotide:

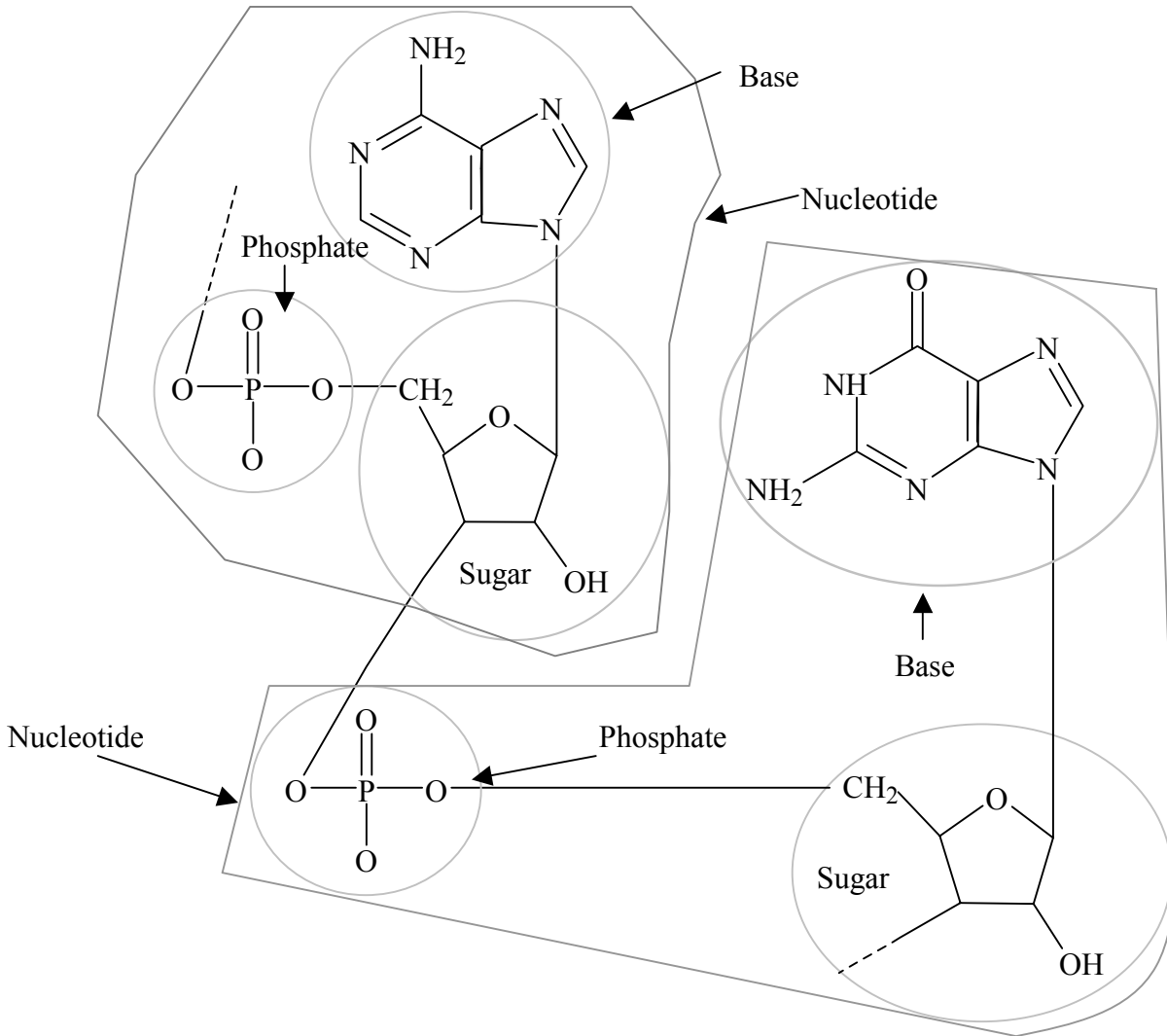
circling and labelling base;

circling and labelling sugar / pentose / ribose (*accept deoxyribose*);

circling and labelling either phosphate;

If the same nucleotide is used award [2] max.

[3]



Option D – Environmental chemistry

- D1.** melting of polar ice caps;
thermal expansion of oceans/seas;
rise in sea level/coastal flooding;
Award [2] max.
- climate change;
changes in agriculture / biodiversity; *[3 max]*
Award [1] max.
- D2.** (a) (i) agriculture / irrigation **and** industry; *[1]*
Both uses needed.
- (ii) oceans/seas; *[2]*
glaciers;
Accept ice caps / polar regions / Antarctica or Arctic.
If more than two answers are given wrong answers cancel out correct answers.
- (b) (i) Passed through resins containing silicates / zeolites;
Na⁺ replaced by H⁺ ;
Cl⁻ replaced by OH⁻ ;
H⁺ + OH⁻ → H₂O ; *[4]*
If positive ions and negative ions given in place of Na⁺ and Cl⁻ , award [1] max for second and third points.
- (ii) no heating/fuel needed;
resins need to be replaced/regenerated; *[2]*
- (c) amount of oxygen to decompose/oxidize the organic/biological matter;
in 5 days / in a given time / at a fixed temperature;
lower BOD for pure water / higher BOD for water containing organic waste; *[3]*
- D3.** (a) internal combustion engines;
Do not accept car exhaust.
burning coal/oil; *[2]*
- (b) (photochemical smog contains) oxides of nitrogen / hydrocarbons;
(reducing smog contains) soot/fly ash/particulates / sulfur dioxide; *[2]*
- (c) convection currents get cut/pollutants cannot escape to higher altitudes *OWTTE*;
concentration of pollutants increase/damage they can do lasts longer; *[2]*

- D4.** (a) contains conjugated double bonds / delocalised electrons;
u.v. light/radiation is absorbed; [2]
- (b) A; [2]
D;

Option E – Chemical industries

E1. environmental impact;
 distance from sources of raw materials / transport links;
 availability of energy/water;
 labour force;
 availability of investment / existence of markets; **[2 max]**
 Award **[2]** for any three, **[1]** for any two.

E2. (a) limestone/ CaCO_3 ;
 coke/C/carbon;
Do not accept coal.
 air / air enriched with hydrocarbons; **[2]**
Do not accept oxygen.
 Award **[2]** for all three, **[1]** for two.

(b) (i) contains too much carbon/4%C;
 (and so it is) brittle / has low malleability / *OWTTE*; **[2]**

(ii) adding oxygen / converting impurities to their oxides;
 $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ / $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$ / $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$ / $\text{Si} + \text{O}_2 \rightarrow \text{SiO}_2$; **[2]**

(c) negative effect on the landscape;
 high demand for electricity / factory sited near power source;
 much aluminium is recycled / saving energy / reducing landfill sites;
 CO_2 produced / greenhouse gas / global warming;
 fluoride emissions; **[4]**
 Award **[1]** each for any four.

E3. (a) as a chemical feedstock / as a source of other chemicals (plastics, dyes, *etc*); **[1]**

(b) (i) petroleum originated from living things / some amino acids contain sulfur; **[1]**

(ii) burning produces SO_2 / SO_3 / acid rain;

Or

it poisons catalysts; **[1 max]**

- E4.** (a) brine/salt/sodium chloride; [1]
- (b) negative electrode
 $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^- / 2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$;
- positive electrode
 $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$; [2]
- Accept e instead of e⁻.*
Award [1] for two correct equations at the wrong electrodes.
- (c) NaOH / sodium hydroxide;
sodium ions are present in the solution, and OH⁻ ions are also produced / *OWTTE*; [2]
- E5.** (a) 750 K / temperature in range 700-800 K;
 ΔG for the decomposition becomes negative; [2]
- (b) (i) 1450-1500 K;
 $\text{Cr}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Cr} + 3\text{CO}$; [2]
- (ii) ΔG for the reaction is positive at all temperatures / lines do not cross; [1]

Option F – Fuels and energy

- F1.** (a) energy to be released at practical/reasonable rates / not too fast and not too slow / controllable;
 minimal pollution / no health hazards;
Must mention pollution do not accept clean or environmentally friendly.
 cheap / plentiful / accessible;
 renewable; **[2]**
Award [1] each for any two.
- (b) (i) *Nuclear fusion:*
 technology not yet developed / OWTTE / releases too much energy in a very short period of time / hard to control;
- (ii) *Tidal energy:*
 not every place has great tidal changes / needs energy storage facilities / OWTTE; **[2]**
- F2.** *advantages*
 no pollution;
 no moving parts / no maintenance;
 no need for refueling / sunlight is free/unlimited;
 produce less noise;
 does not use non-renewable source of energy / conserves petroleum for other uses / OWTTE;**[3 max]**
Award [1] each for any three.
- disadvantages*
 low power output / not very efficient / need a large surface area;
 battery/storage facilities (needed in absence of light);
 high capital cost;
 easily damaged; **[3 max]**
Award [1] each for any three.
- F3.** (a) Lead/Pb **and** lead(IV) oxide/PbO₂/lead dioxide; **[1]**
- (b) $\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e} \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$ /
 $\text{PbO}_2 + 2\text{H}^+ + \text{H}_2\text{SO}_4 + 2\text{e} \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$;
 positive because reduction occurs / electron gained; **[2]**

F4. *outline*

surplus energy used to pump water from low to high level;
electricity generated when water flows from high to low level;

advantages

uses cheap/off peak electricity;
rapid response to demand;
produces no pollution;
avoids building power plants that would be used rarely;

Award [1] each for any two.

disadvantages

impact on the environment;
high capital cost;
few locations suitable;
energy lost in pumping water;

Award [1] each for any two.

[6 max]

F5. (a) high activity / gives out much radiation;

stays radioactive for a long time / (contains isotopes with) long half-lives;

[2]

(b) under water / in cooling ponds;

vitrified / made into glass;
buried underground/in granite/in deep mines;

Award [1] each for any two.

[2 max]

(c) $k = \frac{0.693}{3.8 \times 10^5} = 1.82 \times 10^{-6} \text{ (year}^{-1}\text{)};$

$t = \frac{\ln \frac{100}{10}}{k} = 1.3 \times 10^6 \text{ years};$

[2]

Unit needed for second mark.

Accept value in range 1.25×10^6 and 1.30×10^6 .

Option G – Modern analytical chemistry

G1. (a)

Information	Analytical technique
Isotopic composition of an element	Mass spectrometry; <i>Accept Mass spectroscopy.</i>
Functional groups present in an organic compound	Infrared spectroscopy;
Concentration of Fe ³⁺ ions in industrial waste waters	Visible spectroscopy/flame spectroscopy / colorimetry; <i>Accept UV / visible but not UV on its own.</i>

[3]

G2. (a) (i) A: beam splitter / (rotating) mirror;
 B: sample;
 C: control / reference / solvent;
Accept B and C to be in inverted order
Award [2] for three correct, [1] for any two.

[2]

(ii) produces one frequency/wavelength;
Accept narrow range.

[1]

(iii) to convert radiation to an electronic signal;
 to compare (the intensities of) sample and control/reference beams;
 to determine the absorption (at particular frequencies);

[2 max]

(b) vibrations excited to higher energy levels;
 the bonds bend/stretch;
 the dipole moment/polarity of the molecule changes;
Award [2] max.

[2]

(c) I corresponds to A;
 II corresponds to C;
 III corresponds to B;

[2 max]

Award [1] for identifying each of two matches (the third one is automatically determined).

I=O–H;
 II=C=O;
 III=C=C;

[3]

(d) A;
 higher wavenumbers imply higher energies;

[2]

- G3.** (a) mass spectrometry; [1]
- (b) (i) LC can handle larger amounts than GLC; [1]
- (ii) HPLC;
Sugars would decompose at the high temperature used in GLC / sugars not volatile; [2]
- (c) (i) the ratio between the distance travelled by the spot/stain and the distance travelled by the solvent front;

Or

$$R_f = \frac{\text{distance travelled by the spot}}{\text{distance travelled by the solvent front}}; \quad [1 \text{ max}]$$

- (ii) Y is a pure substance, X is a mixture;

Sample X

contains a substance different from A,B,C and D;
(probably) contains alkaloid A;

Sample Y

(probably) contains alkaloid B;
Award [1] for any three.

[3 max]

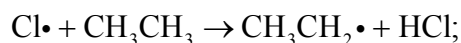
Option H – Further organic chemistry

H1. (a) UV light / sunlight (present); [1]

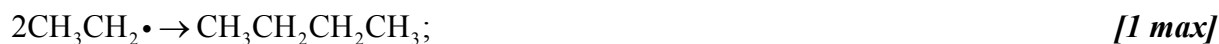
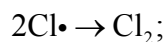
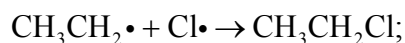
(b) Throughout accept radical with or without •
initiation reaction(s):



propagation reactions:



termination reactions:



Award [1] for any termination reaction.

If initiation, propagation, termination not labelled or incorrectly labelled award [3] max.

(c) CFCs/chlorofluoroalkanes reach the upper atmosphere because they are normally unreactive;

UV light breaks the C-Cl bond releasing Cl• radicals;

Cl• radicals react with ozone (molecules);

a (comparatively) small number of radicals can decompose a large number of ozone molecules /OWTTE; [3 max]

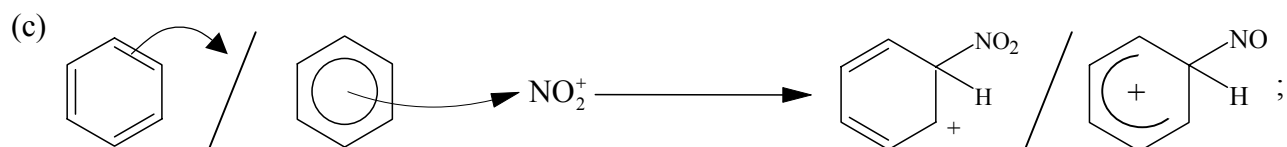
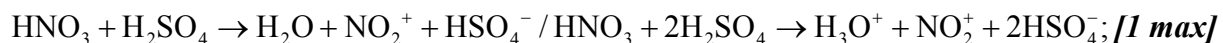
Accept suitable equations.

Award [1] for any three.

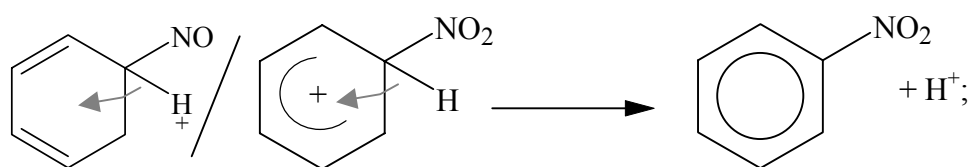
- H2. (a) concentrated HNO₃;
 concentrated H₂SO₄; [2]
No penalty for omitting one "concentrated".
Award [1] for both reagents correct but no "concentrated".



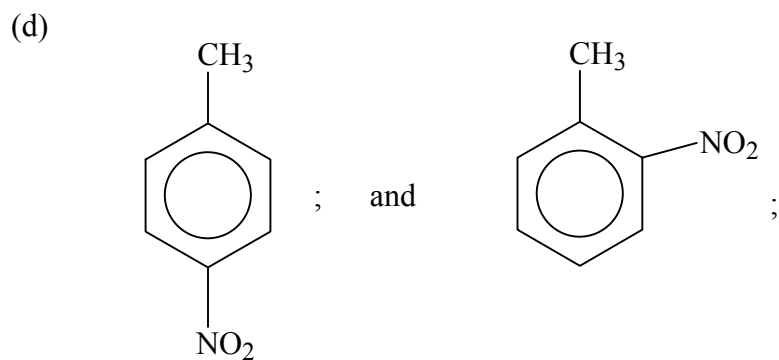
Or



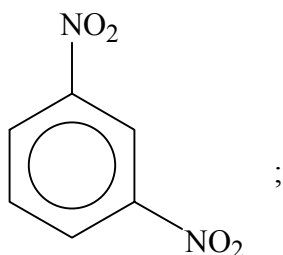
Award mark for curly arrow shown correctly.



Award mark for curly arrow shown correctly.



Accept correct names.
Award [1] for each.



Accept 1,3-dinitrobenzene.

[3]

- (e) CH_3^- is electron-releasing / has positive inductive effect;
increase attraction between ring and NO_2^+ / *OWTTE*; [2]
- (f) chloromethane / CH_3Cl ;
Accept CH_3Br or CH_3I
aluminium chloride / AlCl_3 / Fe / FeCl_3 ; [2]

