IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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M06/4/CHEMI/HP3/ENG/TZ0/XX/M+

MARKSCHEME

May 2006

CHEMISTRY

Higher Level

Paper 3

22 pages

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;
Cr^{3+} / 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]***

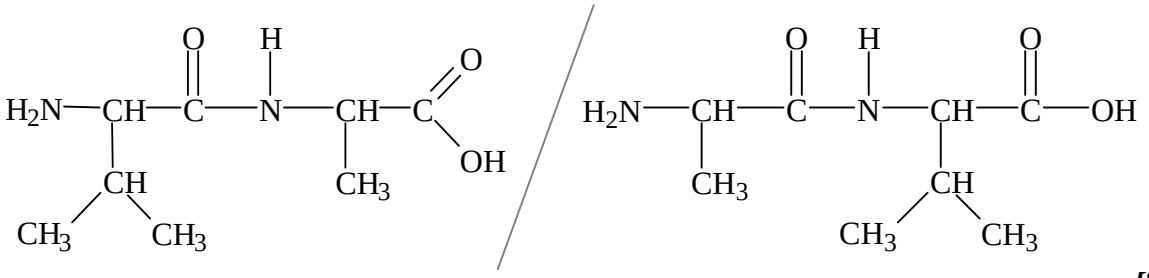
(b) (i) (0.8+0.3+0.1=)1.2 atm; ***[1]***

(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 enantioner 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]***

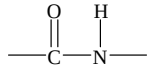
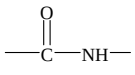
Option C – Human biochemistry

C1. (a) (i)



[2]

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

Accept  *or*  *for the peptide bond.*

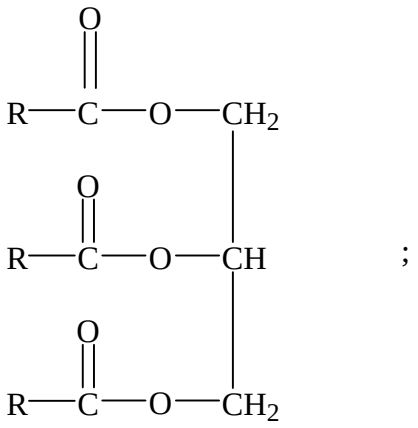
(ii) condensation;
H_2O / water; ***[2]***

(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]***

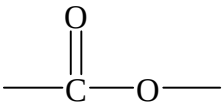
(ii) α-helix = intramolecular/spiral/*OWTTE*;
β-sheet = attraction between chains (accept intermolecular) / *OWTTE*; ***[2]***
Accept suitable diagrams.

C2. (a)



;

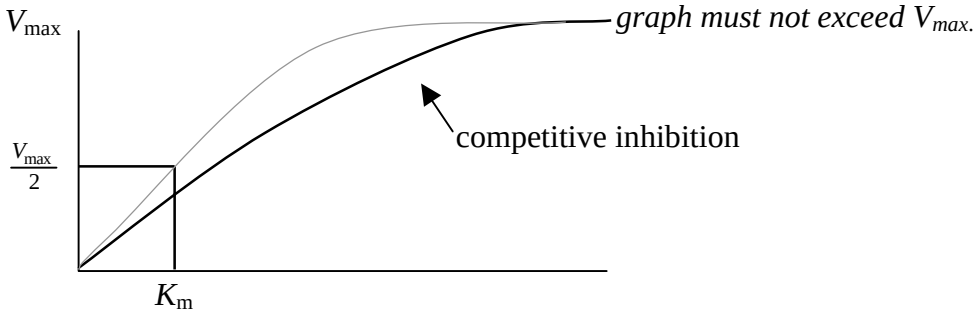
[1]

Accept —COO— *in place of* 

(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; ***[3]***
Accept London / dispersion forces / vdW but not intermolecular.

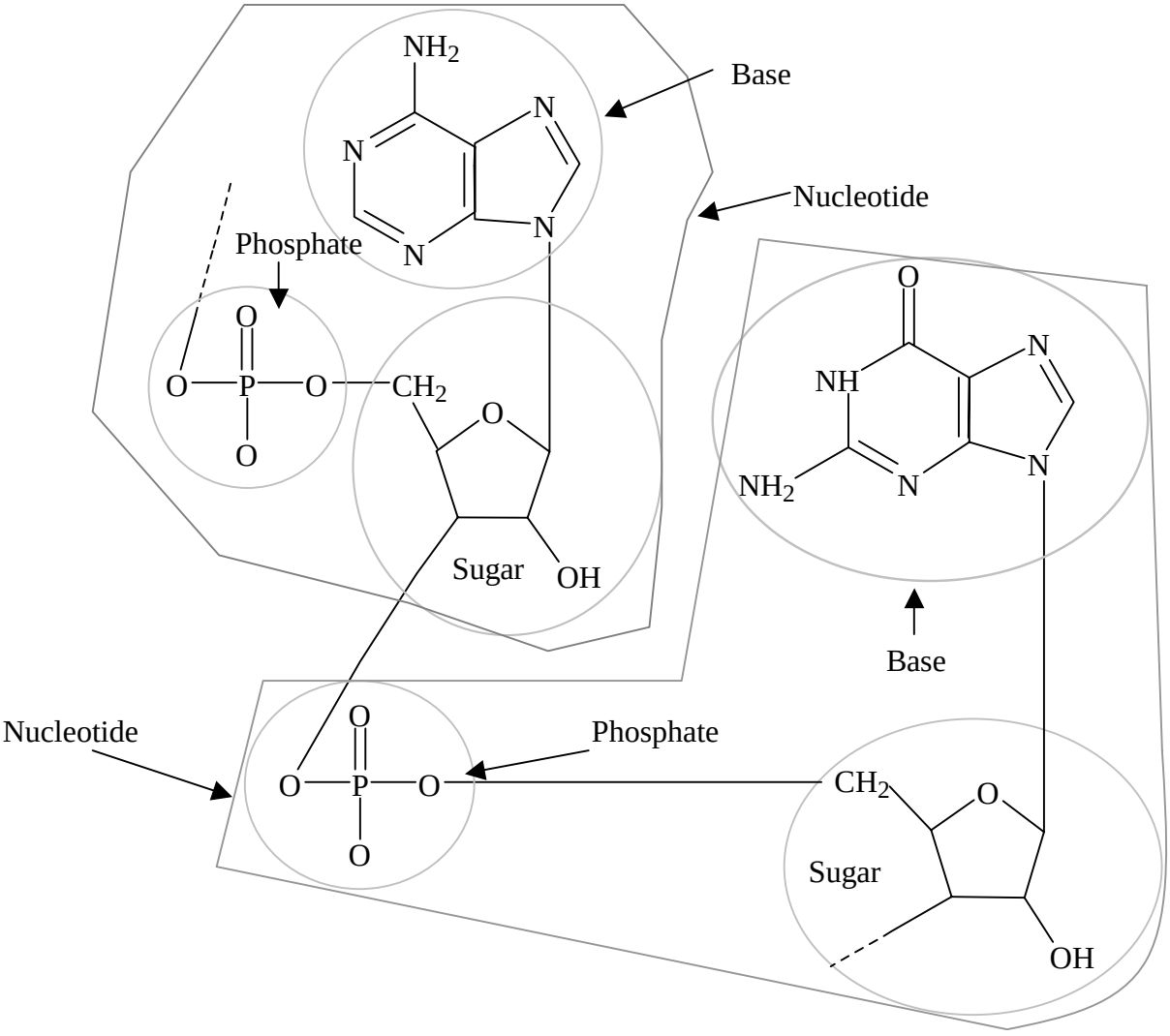
C3. (a) reaction slows down;
V_{max} unchanged;
K_m increased;
inhibitors occupy active sites;
substrate molecules prevented from binding to enzyme; ***[4 max]***
*Any four for **[1]** each*.

(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; ***[3]***
*If the same nucleotide is used award **[2]** max.*



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;
glaciers; ***[2]***
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^-;
$H^+ + OH^- \rightarrow H_2O$; ***[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;
D; ***[2]***

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;
$C + O_2 \rightarrow CO_2$ / $2C + O_2 \rightarrow 2CO$ / $P_4 + 5O_2 \rightarrow P_4O_{10}$ / $Si + O_2 \rightarrow SiO_2$; ***[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
$2H_2O + 2e^- \rightarrow H_2 + 2OH^- / 2H^+ + 2e^- \rightarrow H_2$;

positive electrode
$2Cl^- \rightarrow Cl_2 + 2e^-$; ***[2]***

Accept e instead of e^-.
Award ***[1]*** *for two correct equations at the wrong electrode*s.

(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;
$Cr_2O_3 + 3C \rightarrow 2Cr + 3CO$; ***[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/ PbO_2 /lead dioxide; ***[1]***

(b) $PbO_2 + 4H^+ + SO_4^{2-} + 2e \rightarrow PbSO_4 + 2H_2O$ /
$PbO_2 + 2H^+ + H_2SO_4 + 2e \rightarrow PbSO_4 + 2H_2O$;
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; ***[6 max]***
*Award **[1]** each for any two.*

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; ***[2 max]***
*Award **[1]** each for any two.*

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

$t = \frac{1n\frac{100}{10}}{k} = 1.3 \times 10^6$ 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; *Accept Mass spectroscopy*.
Functional groups present in an organic compound	Infrared spectroscopy;
Concentration of Fe^{3+} ions in industrial waste waters	Visible spectroscopy/flame spectroscopy / colorimetry; *Accept UV / visible but not UV on its own.*

[3]

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

(ii) produces one frequency/wavelength; ***[1]***
Accept narrow range.

(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; ***[2]***
*Award **[2]** max*.

(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

$$R_f = \frac{\text{distance travelled by the spot}}{\text{distance travelled by the solvent front}};$$ ***[1 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; ***[3 max]***
*Award **[1]** for any three.*

Option H – Further organic chemistry

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

(b) Throughout accept radical with or without •
initiation reaction(s):
$Cl_2 \rightarrow 2\ Cl\bullet$; ***[1]***

propagation reactions:

$Cl\bullet + CH_3CH_3 \rightarrow CH_3CH_2\bullet + HCl$;
$CH_3CH_2\bullet + Cl_2 \rightarrow CH_3CH_2Cl + Cl\bullet$; ***[2]***

termination reactions:

$CH_3CH_2\bullet + Cl\bullet \rightarrow CH_3CH_2Cl$;
$2Cl\bullet \rightarrow Cl_2$;
$2CH_3CH_2\bullet \rightarrow CH_3CH_2CH_2CH_3$; ***[1 max]***
*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 $Cl\bullet$ radicals;
$Cl\bullet$ 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.*

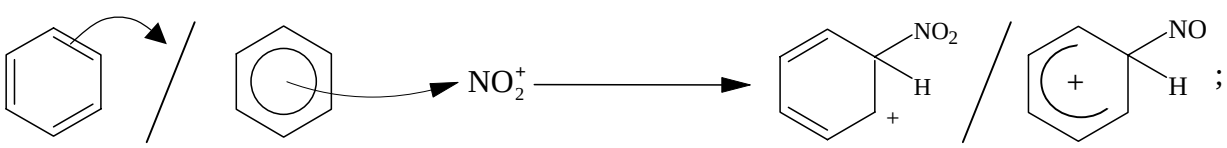
H2. (a) concentrated HNO_3;
concentrated H_2SO_4; ***[2]***
No penalty for omitting one "concentrated".
*Award **[1]** for both reagents correct but no "concentrated".*

(b) $HNO_3 + H_2SO_4 \rightarrow H_2NO_3^+ + HSO_4^-$ **and** $H_2NO_3^+ \rightarrow H_2O + NO_2^+$;

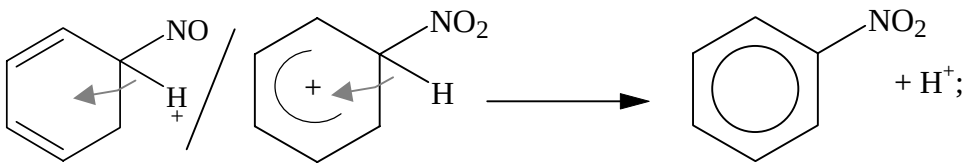
Or

$HNO_3 + H_2SO_4 \rightarrow H_2O + NO_2^+ + HSO_4^- / HNO_3 + 2H_2SO_4 \rightarrow H_3O^+ + NO_2^+ + 2HSO_4^-$; ***[1 max]***

(c)



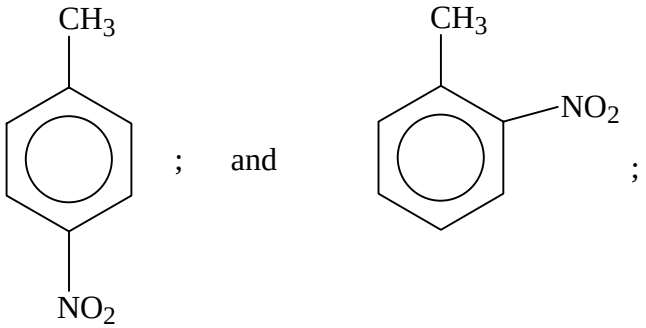
Award mark for curly arrow shown correctly.



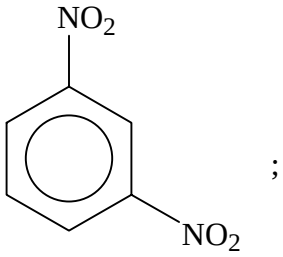
[2]

Award mark for curly arrow shown correctly.

(d)



Accept correct names.
*Award **[1]** for each.*



[3]

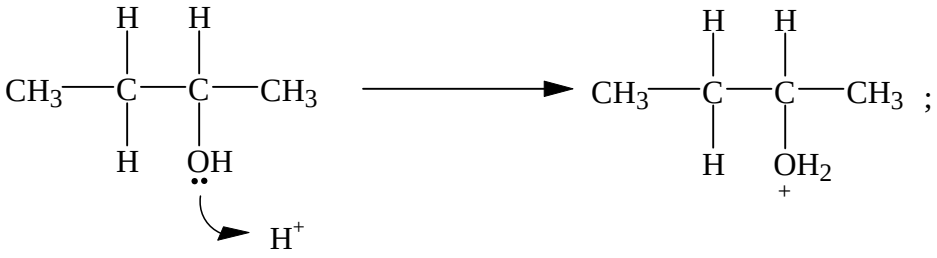
Accept 1,3-dinitrobenzene.

(e) CH_3- is electron-releasing / has positive inductive effect;
increase attraction between ring and NO_2^+ / *OWTTE*; ***[2]***

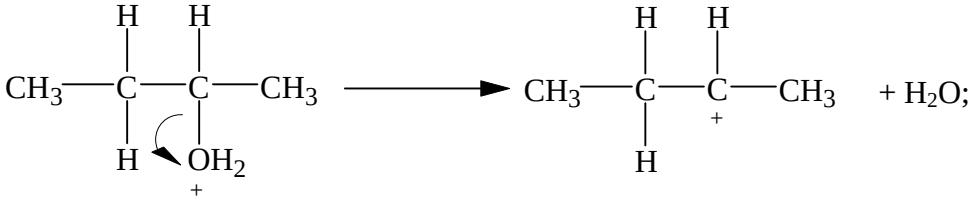
(f) chloromethane / CH_3Cl;
Accept CH_3Br *or* CH_3I
aluminium chloride / $AlCl_3$ / Fe / $FeCl_3$; ***[2]***

H3. (a) concentrated H_3PO_4 / H_2SO_4;
elimination / dehydration; ***[2]***

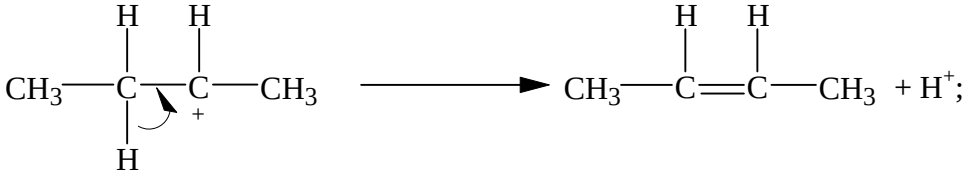
(b)



Award mark for structure of protonated alcohol.



Award mark for curly arrow shown correctly.



[3]

Award mark for curly arrow shown correctly ***and*** *structure of alkene.*
For second and third step accept single step mechanism.