HL Paper 3

Nitrogen dioxide and sulfur dioxide are two air pollutants.

Both of these air pollutants also contribute to acid deposition. Outline mechanisms for the formation of $\mathrm{HNO_3}$ and $\mathrm{SO_3}$.

Markscheme

*For **[1 max]***

specific effect on certain diseases *e.g*. relieves nausea in cancer patients to gain mass/weight / relieves glaucoma/Parkinson's disease symptoms / increases appetite in AIDs patients;

personal freedom argument / frees police to deal with other/more serious crimes / more taxes / *OWTTE*;

No mark for comment such as: cannabis is no more harmful than other legal drugs so why should cannabis be different.

*Against **[1 max]***

increased risk of lung cancer / respiratory ailments / may suppress body's immune system;

may lead to use of harder drugs;

Examiners report

The argument for and against the legalization of cannabis often produced general answers that were rather journalistic in nature with little specific

detail provided to score the marks. Usually the last marking point for argument against was scored.

Acid deposition is a consequence of industrial processes.

a. State what is meant by the term acid deposition. [1]

b. Describe, using equations, the mechanism of acid deposition caused by the oxides of nitrogen, including their initial formation. [3]

c. All shellfish have a calcium carbonate shell. Discuss, including a balanced equation, the long-term effect of acid deposition on these organisms. [2]

Balanced equation:

Markscheme

a. process by which acidic (substances) leave atmosphere/return to Earth / *OWTTE*;

Do not allow acid rain.

b. *Formation:*

$N_2(g) + O_2(g) \rightarrow 2NO(g) / 2NO(g) + O_2(g) \rightarrow 2NO_2(g)$;

*Acid deposition: Award **[2 max]** for any two of the following.*

$H_2O(g) + O_3(g) \rightarrow 2HO \bullet (g) + O_2(aq) / H_2O(g) + O \bullet (g) \rightarrow 2HO \bullet (g)$;

$HO \bullet (g) + NO_2(g) \rightarrow HNO_3(aq)$;

$HO \bullet (g) + NO(g) \rightarrow HNO_2(aq)$;

$2NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + HNO_2(aq) / 2H_2O(l) + 4NO_2(g) + O_2(g) \rightarrow 4HNO_3(aq)$;

Allow radicals represented without dot (if consistent throughout), but penalize inconsistency once only in 17 (b)(ii) and 18 (b).

Ignore state symbols.

*Award **[2 max]** if no free radical used in describing mechanism.*

c. shells become thinner as some of the calcium carbonate shell reacts / *OWTTE*;

Accept "dissolving of marine carbonate shells".

$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca\ (NO_3)_2(aq) + H_2O(l) + CO_2(g) /$

$CO_3^{2-}(s) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l) /$

$CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + H_2O(l) /$

$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(aq) + CO_2(g) + H_2O(l)$;

Ignore state symbols.

Allow equations with H_2SO_3 and HNO_2.

Do not accept H_2CO_3 instead of H_2O and CO_2.

Examiners report

a. Candidates confused acid rain with acid deposition in Q18 and the mechanism of acid deposition was patchy. The effect on the carbonate shell of shellfish was understood and most candidates illustrated the reaction with sulfuric acid.

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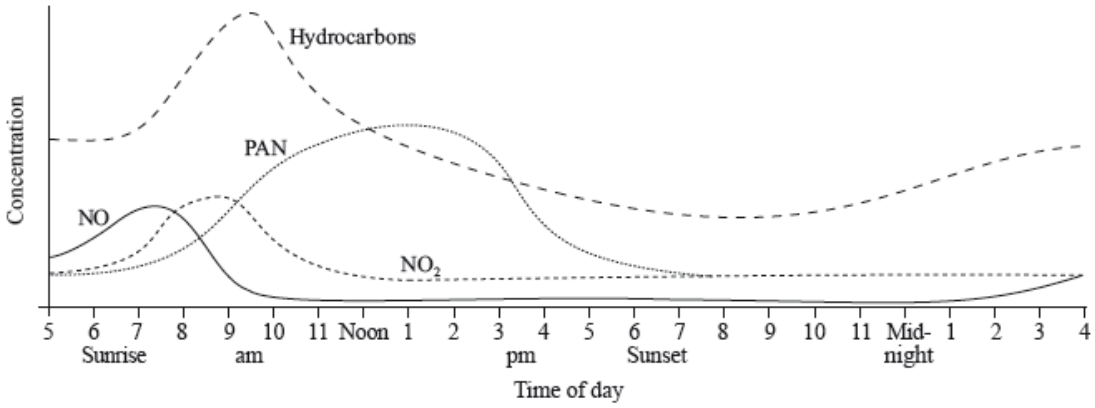
The concentration of some pollutants in a city was measured over a 24 hour period. The results are shown below.



Outline the cause of the increase in NO levels between 5 and 8 am.

Markscheme

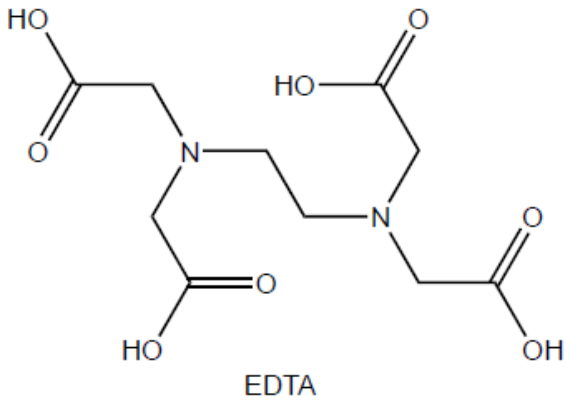
NO produced from cars engines increases during morning rush hour;

NO produced by high temperature combination of nitrogen and oxygen (in engine);

Examiners report

In (a), most candidates scored M1, but reference to high temperature was often omitted.

EDTA is produced by reacting ethane-1,2-diamine with chloroethanoic acid, $ClCH_2COOH$.



EDTA

a. Identify the other product formed. [1]

b. Explain why EDTA, a chelating agent, is more effective in removing heavy metal ions from solution than monodentate ligands. [3]

Markscheme

a. HCl/hydrogen chloride

Accept “hydrochloric acid”.

[1 mark]

b. forms four/six/several/multiple coordinate/coordination bonds «to a central metal ion»

OR

is a polydentate/tetradentate/hexadentate ligand

forms more stable complex/stronger bonds with central metal ion
OR
increases entropy/*S* by releasing smaller «monodentate ligand» molecules previously complexed

complex ions are much larger «and can be removed easily due to large size of chelate complexes»
OR
heavy metal ions trapped inside the ligand/become «biologically» inactive/nontoxic/harmless

Accept “dative «covalent»” for “coordinate/coordination”.

*Do **not** accept just “chelates”.*

[3 marks]

Examiners report

a. [N/A]
b. [N/A]