8.3 Acid Deposition

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Course	DP IB Chemistry
Section	8. Acids & Bases
Topic	8.3 Acid Deposition
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry SL
Students of other boards may also find this useful

1

The correct answer is **B** because:

- Rainwater is naturally acidic due to carbon dioxide dissolving in the water and forming carbonic acid, which is weakly acidic

A is incorrect as	methane is insoluble in water, so it does not affect the pH of rainwater
C is incorrect as	nitrogen oxides (which come from vehicle exhausts) would make the rainwater very acidic and below pH 5.5
D is incorrect as	sulfur dioxide (which comes from the combustion of fossil fuels) would make the rainwater very acidic and below pH 5.5

2

The correct answer is **D** because:

- There are two competing equilibria here
- Increasing levels of CO_2 will drive the first equilibrium to the right, also increasing the concentration of HCO_3^- and H^+
- At the same time the pH will fall as the concentration of H^+ increases
- The increased concentration of H^+ will drive the second equilibrium to the left reducing the concentration of CO_3^{2-} (aq)
- Not only does it reduce the concentration of dissolved CO_3^{2-} but shells containing $CaCO_3$ will slowly begin to dissolve and become thinner over time

A, **B** & **C** are incorrect as	these are all true statements

3

The correct answer is **B** because:

- The high temperatures inside the internal combustion engine are capable of oxisiding nitrogen to nitrogen oxides, chiefly NO and NO_2
- These oxides dissolve in water to form a mixture of nitrous and nitric acid
- NO is unstable and readily oxidises to NO_2
- The result is that, of the two oxoacids, HNO_3 is the major nitrogen based acid produced and the second major acidic component in acid rain

A is incorrect as	this is a major component of acid rain, but it does not originate in car engines
C is incorrect as	this is not produced in car engines and is an oxide, not acid
D is incorrect as	this is not the acid itself, but the oxide which goes on to further react and produce nitric acid

4

The correct answer is **B** because:

- Marble is calcium carbonate which readily reacts with acids, so a marble statue would be corroded by acid rain
- Acid rain falling on soil releases metal ions such as Al^{3+} from rocks which are leached out of the soil

A, C & D are incorrect as	ozone levels are not affected by acid rain

5

The correct answer is **B** because:

- The mass of sulfur in 125 g of coal is

$$\text{mass of S} = \frac{125 \times 3}{100}$$

- The amount of sulfur in moles is:

$$n(\text{S}) = \frac{mass}{Ar} = \frac{125 \times 3}{100 \times 32.07}$$

- Assuming complete combustion, the same amount of sulfur dioxide is produced:

$$\text{S (s)} + \text{O}_2\text{ (g)} \rightarrow \text{SO}_2\text{ (g)}$$

- The mass of sulfur dioxide is

$$\text{mass SO}_2 = \text{moles} \times M = \frac{125 \times 3 \times 64.07}{100 \times 32.07}$$

A, **C** & **D** are incorrect as	they are the wrong workings

6

The correct answer is **D** because:

- Acid rain can fall on soils and release important minerals such as magnesium, calcium and potassium which are leached (washed out) from soils and are therefore unavailable to plants
- Aluminium ions released from rocks are toxic to many plants and damage their roots
- Acid particulates can block stomata (plant pores) and prevent gaseous exchange

7

The correct answer is **C** because:

- Acid rain is too dilute to cause any direct impact on the skin
- Acidic particulates in the air can increase the risk of respiratory diseases such as bronchitis, asthma and emphysema
- When acid rain comes into contact with metal pipes there is an increased risk that toxic metal ions will be released into the drinking water supply such as copper, lead and aluminium

8

The correct answer is **D** because:

- The balanced equation is:
  $2CO(g) + 2NO(g) \rightarrow 2CO_2(aq) + N_2(g)$
  Sum of the coefficients = 2 + 2 + 2 + 1 = 7

A, **B** & **C** are incorrect as	they do not give the right coefficients

9

The correct answer is **A** because:

- Catalytic converters change NO_x into N_2
- Recirculating exhaust gases lowers the combustion temperature and reduces NO_x emissions
- Blended gasoline-alcohol fuel is used to reduce the amount of petroleum consumed, but does not change the high temperature of combustion which produces NO_x

10

The correct answer is **A** because:

- The oxidation state of iron increases so it loses electrons and is a reducing agent

$$Fe\,(s) \rightarrow Fe^{2+} + 2e^-$$

$$0 \qquad +2$$

- The oxidation state of sulfur increases so it loses electrons and is a reducing agent

$$SO_2\,(g) \rightarrow SO_4^{2-}\,(s) + 2e^-$$

$+4$ ($2O = -4$) $\qquad +6$ ($O_4 = -8$, charge is -2)

- (this is not a balanced equation – it just shows the redox change)

B, **C** & **D** are incorrect as	the enthalpy change cannot be ΔH_f as it is defined as the formation of a compound from its *elements* and here SO_2 is one of the reactants