

Topic 1: Elemental and Environmental

1.

- (a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$
 (b) p
 (c) high
 (d)
 (i) $\text{SeO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SeO}_3 + \text{H}_2\text{O}$
 (ii) non-metallic
 (iii) It can share all its $4p^4$ electrons with a more electronegative element.
 (iv) +2

2.

- (a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
 (b) $\text{As}_2\text{O}_3 + 3\text{H}_2\text{O} \rightarrow 2\text{H}_3\text{AsO}_3$
 (c) HAsO_4^{2-} will be more effectively removed. The 2- charge will be more strongly attracted than the 1- charge to the 3+ charge.
 (d) Amphoteric

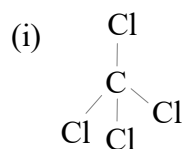
3.

- (a) SO_2 reacts with O_2 in the air to produce SO_3 . Both SO_2 and SO_3 are acidic oxides, they react with rain water to produce oxyacids, for example: $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$. These oxyacids then ionise to form hydrogen ions, lowering the pH of the rain water, for example: $\text{H}_2\text{SO}_4 \rightarrow \text{H}^+ + \text{SO}_4^{2-}$.
 (b) Carbon dioxide is a weak acid, it only partially ionises into hydrogen ions. It is therefore unlikely to lower pH below 5.6.
 (c) Any of:
 Damages structures by corroding metals and carbonates.
 Causes mobilisation in the soil (leaching) of toxic cations which disrupt defense mechanisms in plants / damage necessary bacteria / lead to suffocation of fish / enter human drinking water and cause disease or death
 Reduces the pH in lakes and rivers, harming fish populations.
 (d) $[\text{H}^+] = 10^{-\text{pH}} = 10^{-4.5} = 3.2 \times 10^{-5} \text{ mol/L}$

4.

- (a) Ti is a metal (low electronegativity) and O is a nonmetal (high electronegativity), so the bonding is ionic. The attraction between oppositely charged ions (Ti^{4+} and O^{2-}) is very strong.
 (b) $\text{TiO}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{OH}^- + \text{Ti}^{4+}$
 (c) $\text{pOH} = -\log([\text{OH}^-])$
 $= -\log(3.2 \times 10^{-6})$
 $= 5.5$
 $\text{pH} = 14 - \text{pOH}$
 $= 14 - 5.5$
 $= 8.5$

(d)



(ii) tetrahedral

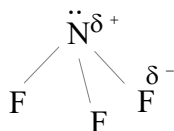
5.

- (a) Energy from the sun is absorbed by the Earth's surface and then re-emitted as infra-red radiation. Greenhouse gases bend and stretch to absorb and re-emit infra-red, reducing the rate at which this energy escapes the Earth's atmosphere. Higher concentration of greenhouse gases will lead to less infra-red escaping the atmosphere, therefore increasing the average temperature.
 (b) Enhanced greenhouse effect
 (c) (i) It will cause climate change which affects water collection and crops disrupting the human population.
 -OR- It will cause polar ice caps to melt, causing coastal flooding which disrupts the human population
 (d)
 (i) The electronegativity difference between carbon and oxygen causes electrons to be unequally shared.
 (ii) Carbon dioxide has a linear shape so the bond dipoles do not share a common direction (they cancel out).

6.

(a) It has polar bonds

(b)



(c) The pairs of bonding and non-bonding electrons repels each other to be as far apart as possible (in three dimensions).

(d) +3

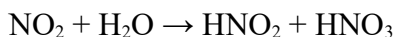
(e) covalent

(f) covalent bonds are stronger than the interactions between molecules of NF_3 .

7.

(a) N_2 is not soluble in water and therefore is not able to be absorbed through plant roots.

(b) Nitrogen oxides react with rain water to form oxyacids, for example:



These oxyacids ionise, forming nitrate and nitrite ions which are soluble in water.

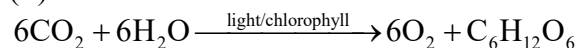
(c) Anaerobic

(d) PO_4^{3-}

(e)

(i) Photosynthesis

(ii)



8.

(a) $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$

(b) The heat in the engine provides energy to break the triple covalent bond in N_2 , allowing it to react with O_2 to form NO .

(c) Increased concentration of NO in the will result in increased concentration of NO_2 . UV light and NO_2 lead to formation of O_3 , so increased NO_2 causes increased O_3 .

(d)

(i) secondary

(ii) NO_2 / unburnt hydrocarbons

9.

(a) The highly charged Al^{3+} ions attract to the negative surface charge of the suspended clay particles. This forms clumps (floc) which are too heavy to remain in suspension.

(b) Decreases turbidity / Less cloudiness / Clearer water

(c) $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$

(d) HClO is an oxidising agent so it kills harmful bacteria.

(e) Keep separate from acids.

-or-

Conduct experiment in a fume hood.