Year 12 Chemistry Test ***SOLUTIONS***

Topic 1: Monitoring the Environment

1.

(a) Carbon dioxide is a greenhouse gas, meaning its polar bonds are able to bend and stretch to absorb and re-emit infra-red radiation. Energy from the sun is absorbed by the Earth's surface and then re-emitted as infra-red radiation. The carbon dioxide therefore is reducing the rate at which this energy escapes the Earth's atmosphere, keeping it at a steady temperature.

(b) Anthropogenic increases in carbon dioxide will disrupt the thermal balance by causing infra-red radiation to escape Earth's atmosphere more slowly. Over a period of time this will increase the global average temperature.

This will cause climate change which affects water collection and crops disrupting the human population.

-OR- This will cause polar ice caps to melt, causing coastal flooding which disrupts the human population

(c) An increase of carbon dioxide in the atmosphere will cause an increase in carbon dioxide absorbed by the oceans, creating carbonic acid: $CO_2 + H_2O \rightarrow H_2CO_3$

Carbonic acid partially ionises, increasing the concentration of hydrogen ions. This increases the rate of dissolution of skeletons and shells of many marine organisms, decreasing their populations.
$2H^+ + CaCO_3 \rightarrow H_2O + Ca^{2+} + CO_2$

(d) $\text{pH} = -\log\left[H^+\right]$

$= -\log\left(2.0\times10^{-8}\right)$

$= 7.7$

2.

(a) Furnaces

(b) $N_2 + O_2 \xrightarrow{\text{heat}} 2NO$

(c) N_2 contains a strong triple covalent bond, and the heat provides the energy required for the reaction to occur.

(d) Substance released into environment which has harmful effect.

(e) Catalytic converters catalyse the reactions that convert NO and NO_2 into N_2.

(f) The NO released by the plants reacts with O_2 to form NO_2. This is then broken down by UV into NO and atomic oxygen. The atomic oxygen reacts with O_2 to form ozone. Therefore if the number of plants were to be increased or decreased, the concentration of ozone in the area would increase or decrease respectively.

An increased concentration of ozone could lead to (only two required):

Health problems in animals (adverse effects on respiratory system)

Reduction of photosynthesis in plants (yellowing of leaves)

Cracking and perishing of rubber and plastics

Contributes to enhanced greenhouse effect/global warming

3. *Must emphasise the links between science and society (people). Example points (four expected):*

A group of aviation experts came together to collaborate and share their findings.

They were able to collaborate to utilise findings from the documented research of experts from many fields in science, engineering, and technology leading to greater perspectives and evidence.

The experts needed to communicate their understanding of these findings to justify alternative firefighting chemicals.

This was a benefit to society as the replacement chemicals were considered in terms of their environmental impact, ease and cost of production, and safety in use and disposal.

This will result in chemicals that are safer for those working in the industry to produce, safer for firefighters to use, more economical for the industries producing them, and contribute less to the environment in terms of residuals and greenhouse gas emissions.

Residuals in ground water can lead to issues for human consumption and increased greenhouse gas emissions lead to the undesirable consequences of climate change such as erratic weather patterns, including drought and floods.

4.

(a) (*each of* i *to* iv *has one mark allocated for the answer being to* 4 s.f.)

(i) $n_{MnO_4^-} = C_{MnO_4^-} V_{MnO_4^-} = 0.02123 \times 0.02763 = 5.866 \times 10^{-4}$ mol

(ii) $n_{MnO_4^-} : n_{H_2O_2} = 2:5$

$\therefore n_{H_2O_2} = \frac{5}{2} \times 5.866 \times 10^{-4} = 1.466 \times 10^{-3}$ mol

(iii) In diluted solution: $C_{H_2O_2} = \frac{n_{H_2O_2}}{V_{H_2O_2}} = \frac{1.466 \times 10^{-3}}{0.02000} = 0.07332$ mol L^{-1}

Now to calculate commercial solution (using dilution formula):

$C_1 = ?$ $C_2 = 0.07332$ mol L^{-1} $V_1 = 0.02500$ L $V_2 = 0.2500$ L

$C_1V_1 = C_2V_2$

$\therefore C_1 = \frac{C_2V_2}{V_1} = \frac{0.07332 \times 0.2500}{0.02500} = 0.7332$ mol L^{-1}

(iv) $M_{H_2O_2} = 34.016$ g mol^{-1}

$\therefore 0.7332 \times 34.016 = 24.94$ g L^{-1}

$= 2.494$ %w/v

(b) Distilled water. This allows the number of moles of hydrogen peroxide to be accurately known (rinsing with hydrogen peroxide would mean there was extra, unmeasured hydrogen peroxide present).

(c) It would be greater if rinsed with distilled water (reason is not required but it is because the permanganate is more dilute so more of it is needed to completely react with the permanganate)

5.

(a) $\frac{4}{10} = 0.4$ (must show working for both marks)

(b) **X** is more polar. It has moved the least distance meaning it is the most attracted to the polar stationary phase and more polar substances attract more polar substances.

6.

(a) $\left[H^+\right] = 10^{-pH}$

$= 10^{-8.1}$

$= 7.9 \times 10^{-9}$ mol L^{-1}

(b) The hemoglobin being collected from the column means it is was less attracted to the surface of the resin and therefore more easily displaced by positive ions flowing through in solution. The cytochrome C must have been more highly positively charged and therefore not effectively exchanged with the ions flowing through the solution.

(c) Less effective (reason is not required but it is because the cytochrome C is no longer positively charged therefore will not bind to the resin)

7.

(a) 2.4 min (anything from 2.35 to 2.45 would be accepted. also this is approx. 2 min 24 sec)

(b) The imitation perfume has no peak where component **D** would be. There is a different peak instead, and since every compound has a unique retention time this means a different compound has been used in the imitation perfume.

8.

(a)

(i) 0.225 (anything from 0.21 to 0.23 would be accepted)

(ii) 3.5 ppb $\therefore$ 3.5 μg L^{-1} (since 3.5 g per billion mL or 3.5 g per million L)

$\therefore$ 0.035 μg in 10.0 mL $(3.5 \div 100$ since there are 100 lots of 10.0 mL in 1 L$)$

(iii) 0.035 µg in 0.45 g

$\therefore$ 7.78×10^{-2} µg per g (divided 0.035 by 0.45)

$\therefore$ 7.78×10^{-8} g per g (multiplied 7.78×10^{-2} by 10^{-6})

$\therefore$ 77.8 ppb (multiplied 7.78×10^{-8} by 10^{9} to get g per billion g)

(b) During AAS, a wavelength is chosen for analysis (for measurement of absorbance) that is unique to arsenic. The elements in sulfuric acid would have different energy levels than arsenic and therefore would not be able to absorb the wavelength chosen for analysis.

(c) Has non zero absorbance for zero concentration of arsenic.

(d)

(i) One of the 3p electrons has been excited into 4s subshell. The energy released by the atom as this electron returns to 3p will be in the form of light.

(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$