Nitrogen and sulfur – 2021 AS

1. Nov/2021/Paper_12/No.34

When the liquid N_2F_4 is heated, it decomposes into a **single** product, X.

Which statements are correct?

1 N–F bonds are broken during this decomposition.

2 The enthalpy change when N_2F_4 decomposes into X is approximately $+160\,kJ\,mol^{-1}$.

3 Molecules of X are non-linear.

2. Nov/2021/Paper_13/No.19

The table describes two possible environmental consequences of adding too much ammonium nitrate fertiliser to the soil.

Which row is correct?

	increased plant growth in rivers	photochemical smog
A	✗	✗
B	✓	✗
C	✗	✓
D	✓	✓

3. Nov/2021/Paper_13/No.34

Which molecules contain at least one unpaired electron?

1 NO

2 NO_2

3 NH_3

4. Nov/2021/Paper_21/No.1

Sulfides are compounds that contain sulfur but not oxygen.

(a) Carbon disulfide, CS_2, is a volatile liquid at room temperature and pressure.

(i) State the meaning of *volatile*.

..... [1]

(ii) Draw a 'dot-and-cross' diagram of the CS_2 molecule.

[2]

(iii) Suggest the bond angle in a molecule of CS_2.

..... [1]

(iv) CS_2 is a liquid under room conditions, while CO_2 is a gas.

Explain what causes the difference in the physical properties between CS_2 and CO_2.

.....

.....

..... [2]

(b) The enthalpy change of combustion of $CS_2(l)$ is represented by the following equation.

$$CS_2(l) + 3O_2(g) \xrightarrow{\Delta H_c} CO_2(g) + 2SO_2(g)$$

(i) Define *enthalpy change of combustion*.

.....

.....

..... [2]

(ii) The table shows the enthalpy changes of formation of $CS_2(l)$, $CO_2(g)$ and $SO_2(g)$.

compound	enthalpy change of formation, ΔH_f / kJ mol^{-1}
$CS_2(l)$	+89.7
$CO_2(g)$	–394
$SO_2(g)$	–297

Use the data in the table to calculate the enthalpy change of combustion, ΔH_c, of $CS_2(l)$, in kJ mol^{-1}.

Show your working.

ΔH_c of $CS_2(l)$ = ... kJ mol^{-1}
[2]

(c) Hydrogen sulfide gas, $H_2S(g)$, is slightly soluble in water. It acts as a weak acid in aqueous solution.

(i) State the meaning of *weak acid*.

.....

..... [1]

(ii) Give the formula of the conjugate base of H_2S.

..... [1]

(iii) $H_2S(aq)$ reacts slowly with oxygen dissolved in water. The reaction is represented by the following equation.

$$H_2S(aq) + \tfrac{1}{2}O_2(aq) \rightarrow H_2O(l) + S(s)$$

Explain, with reference to oxidation numbers, why this reaction is a redox reaction.

.....

.....

.....

..... [2]

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(d) The compound As_2S_3 is a common mineral.

When As_2S_3 is heated strongly in air, it forms a mixture of products, as shown.

$$2As_2S_3(s) + 9O_2(g) \rightarrow As_4O_6(s) + 6SO_2(g)$$

(i) A sample containing 0.198 g As_2S_3 is placed in 0.100 dm^3 of pure oxygen, an excess, in a reaction chamber connected to a gas syringe at room temperature.

The reactants are heated until no further change is observed. The products are then allowed to cool to room temperature.

Calculate the volume, in dm^3, of gas present at the end of the experiment.

The molar volume of gas is 24.0 $dm^3 mol^{-1}$ under these conditions. Assume that the pressure is constant throughout the experiment.

Show your working.

volume of gas remaining = ... dm^3
[4]

(ii) State the environmental consequences of releasing $SO_2(g)$ into the atmosphere.

..... [1]

(iii) $SO_2(g)$ can be removed from the air by reacting it with NaOH(aq).

Construct an equation for the reaction of $SO_2(g)$ with NaOH(aq). Include state symbols.

..... [2]

[Total: 21]

5. Nov/2021/Paper_23/No.1

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6. March/2021/Paper_12/No.18

NO, NO_2, CO and unburnt hydrocarbons are present in the exhaust gases of internal combustion engines. When catalytic converters are used to remove these compounds from the exhaust gases, redox reactions occur.

What happens to each compound in the catalytic converter?

	NO	NO_2	CO	unburnt hydrocarbons
A	oxidised	oxidised	reduced	oxidised
B	oxidised	oxidised	oxidised	oxidised
C	reduced	reduced	oxidised	oxidised
D	reduced	reduced	reduced	reduced

7. March/2021/Paper_12/No.36

Nitrogen dioxide gas is produced when petrol is burned in car engines.

Which acids are made in the atmosphere as a result of this release of nitrogen dioxide into the air?

1 H_2SO_3

2 H_2SO_4

3 HNO_3

8. June/2021/Paper_11/No.18

Acid rain is a dilute solution of sulfuric acid.

Which pollutant also contributes to the formation of acid rain?

A carbon monoxide

B carbon dioxide

C nitrogen dioxide

D hydrocarbons

9. June/2021/Paper_12/No.18

What is an environmental consequence of the uncontrolled use of nitrate fertilisers?

A acid rain

B low oxygen levels in streams

C ozone depletion

D the greenhouse effect

10. June/2021/Paper_12/No.19

Ammonia gas, NH_3, and hydrogen sulfide gas, H_2S, react together to form the salt ammonium sulfide, $(NH_4)_2S$. Ammonium sulfide dissolves in water to produce an orange alkaline solution.

$$(NH_4)_2S(aq) \rightleftharpoons NH_3(aq) + NH_4SH(aq)$$

The addition of NaOH(aq) to this solution produces a gas, X.
The addition of HC*l*(aq) to a separate portion of this solution produces a gas, Y.

X and Y could represent different gases or identical gases.

What are the identities of X and Y?

	X	Y
A	H_2S	H_2S
B	H_2S	NH_3
C	NH_3	H_2S
D	NH_3	NH_3

11. June/2021/Paper_13/No.13

Ammonia exists as simple covalent molecules, NH_3. Ammonia can react with suitable reagents to form products containing ammonium ions, NH_4^+. Ammonia can also react with suitable reagents to form products containing amide ions, NH_2^-.

Which of these nitrogen-containing species are present in an aqueous solution of ammonia?

A ammonia molecules and amide ions

B ammonia molecules and ammonium ions

C ammonia molecules only

D ammonium ions only

12. June/2021/Paper_13/No.14

Which problem can result if too much NH_4NO_3 is applied to crops by farmers?

A Not all the NH_4NO_3 is used by plants and the excess makes the soil alkaline.

B Rain washes some of the NH_4NO_3 into rivers where it forms a precipitate.

C Some of the NH_4NO_3 dissolves in groundwater which may eventually be used for drinking.

D Ammonia is produced; this lowers the pH of the soil.