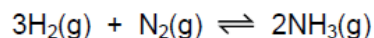


## Nitrogen and Compounds – 2022 IGCSE

### 1. June/2022/Paper\_21/No.30

The equation for the manufacture of ammonia in the Haber process is shown.



The forward reaction is exothermic.

Which row describes the effect of the stated change on the reaction rate and the yield of ammonia?

	change	effect on reaction rate	effect on yield of ammonia
A	decrease pressure	increases	decreases
B	decrease temperature	decreases	increases
C	increase pressure	increases	decreases
D	increase temperature	increases	increases

### 2. June/2022/Paper\_23/No.29

Nitrogen oxide, NO, is formed in the engine of petrol-powered cars.

One constituent of petrol is octane,  $\text{C}_8\text{H}_{18}$ .

Nitrogen oxide is removed from exhaust fumes by catalytic converters.

Which row identifies the reactants that produce nitrogen oxide and a reaction that removes it in a catalytic converter?

	reactants that produce NO	reaction that removes NO
A	octane + one gas found in air	$2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$
B	octane + one gas found in air	$\text{NO} + \text{CO}_2 \rightarrow \text{NO}_2 + \text{CO}$
C	two gases found in air	$2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$
D	two gases found in air	$\text{NO} + \text{CO}_2 \rightarrow \text{NO}_2 + \text{CO}$

This question is about nitrogen and compounds of nitrogen.

(a) Nitrogen molecules have the formula  $N_2$ .

Some properties of nitrogen are shown:

- melting point of  $-210^\circ\text{C}$
- boiling point of  $-196^\circ\text{C}$
- non-conductor of electricity when solid
- insoluble in water.

(i) Name the type of bonding between the atoms in an  $N_2$  molecule.

..... [1]

(ii) Explain, in terms of attractive forces between particles, why nitrogen has a low melting point.

.....  
 ..... [1]

(iii) Explain why nitrogen does **not** conduct electricity.

.....  
 ..... [1]

(b) Nitrogen reacts with hydrogen to form ammonia,  $NH_3$ , in the Haber process.

State the essential conditions in the Haber process. Write an equation for the chemical reaction.

.....  
 .....  
 .....  
 .....  
 ..... [4]

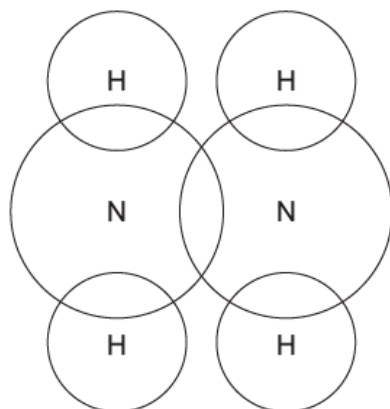
(c) Ammonia is made in the laboratory by heating ammonium chloride with calcium hydroxide.

Balance the chemical equation for the reaction.



(d) Hydrazine,  $\text{N}_2\text{H}_4$ , is another compound that contains nitrogen and hydrogen.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrazine. Show outer electrons only.



[2]

(e) Ammonia and hydrazine are weak bases.

The chemical equation for the reaction between one molecule of ammonia and one molecule of water is shown.



(i) State the meaning of the term *base*.

..... [1]

(ii) Write a chemical equation for the reaction between one molecule of hydrazine,  $\text{N}_2\text{H}_4$ , and one molecule of water.

..... [1]

[Total: 12]

Nitrogen dioxide,  $\text{NO}_2$ , is an atmospheric pollutant and is formed in car engines.

(a) Explain how nitrogen dioxide is formed in car engines.

.....  
 ..... [2]

(b) Nitrogen dioxide causes respiratory problems.

State one **other** adverse effect of nitrogen dioxide.

..... [1]

(c) Nitrogen dioxide emissions can be reduced by adding an aqueous solution of urea,  $(\text{NH}_2)_2\text{CO}$ , to car exhaust gases.

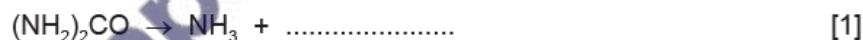
The heat of the exhaust gases breaks down the urea into simpler substances.

(i) Name the type of reaction which occurs when a substance is heated and breaks down into simpler substances.

..... [1]

(ii) One molecule of urea breaks down to form one molecule of ammonia and one other molecule.

Complete the chemical equation to show the formula of the other molecule formed in this reaction.



(iii) State the test for ammonia.

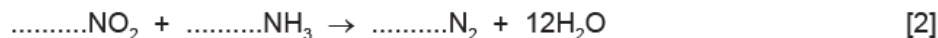
test .....

observations .....

[2]

(d) The ammonia formed reacts with nitrogen dioxide to form nitrogen and water.

(i) Balance the equation for this reaction.



(ii) State how the equation shows that the nitrogen in nitrogen dioxide is reduced.

..... [1]

(iii) This reaction is a redox reaction.

State the meaning of the term *redox*.

..... [1]

(e) 135 moles of urea,  $(\text{NH}_2)_2\text{CO}$ , is stored in the tank of a car.

Calculate the mass, in kg, of the stored  $(\text{NH}_2)_2\text{CO}$ .

mass of  $(\text{NH}_2)_2\text{CO}$  = ..... kg  
[2]

(f) Another oxide of nitrogen formed in car engines is nitrogen monoxide, NO. A catalytic converter removes NO by reacting it with a gas formed by incomplete combustion of the fuel. Two non-toxic gases are formed.

(i) Name the gas formed by incomplete combustion of the fuel.

..... [1]

(ii) Name the **two** non-toxic gases formed.

..... and ..... [1]

[Total: 15]

