Pearson Edexcel

Additional Assessment Materials
Summer 2021

Pearson Edexcel GCSE in Chemistry (1CH0)
Higher

Resource Set Topic I: Transition metals, alloys & corrosion, equilibria, and chemical cells
(H tier only, Chemistry Only)

Questions

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1 Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

(a) Which row of the table shows the typical properties of a transition metal?

(1)

	used as a catalyst	density	colour of metal chloride
☒ **A**	yes	high	colourless
☒ **B**	no	low	colourless
☒ **C**	yes	high	coloured
☒ **D**	no	low	coloured

(b) Figure 1 shows the chain on a bicycle.

Figure 1

Explain how lubricating the chain with oil prevents corrosion of the steel chain.

(2)

The oil provides a physical barrier between the steel chain and air and water, which are required in rusting.

(c) Iron fences can be galvanised by coating them with a layer of zinc.
When the layer of zinc is scratched exposing the iron to the weather, the iron does not rust.

Explain why the exposed iron does not rust.

(2)

Zinc provides sacrificial protection for the iron so the zinc reacts with water and oxygen instead.

7

*(d) The reaction to produce sulfur trioxide reaches an equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.
The rate of attainment of equilibrium and the equilibrium yield of sulfur trioxide are affected by pressure and temperature.

A manufacturer considered two sets of conditions, A and B, for this reaction.
In each case sulfur dioxide is mixed with excess oxygen.
The manufacturer changed the temperature and the pressure and only used a catalyst in B.
The sets of conditions A and B are shown in Figure 7.

set of conditions	pressure in atm	temperature in °C	catalyst
A	2	680	no catalyst used
B	4	425	catalyst used

Figure 7

The manufacturer chooses set of conditions B rather than set of conditions A.

Explain, by considering the effect of changing the conditions on the rate of attainment of equilibrium and on the equilibrium yield of sulfur trioxide, why the manufacturer chooses the set of conditions B rather than the set of conditions A.

(6)

At higher pressure, equilibrium is reached faster as the particles collide more frequently. The forward reaction is favoured as there are fewer moles on the right, so yield of SO_3 is higher. At lower temperature, although equilibrium is reached slower as particles have less kinetic energy, move slower and collide less frequently, the equilibrium shifts to the right as the forward reaction is exothermic, so yield is higher. Catalyst is used so that equilibrium can be reached faster. It has no effect on the yield.

1 In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

(a) The overall reaction occurring in this fuel cell is a reaction of hydrogen with oxygen.

Write the balanced equation for this reaction.

(2)

$2H_2 + O_2 \rightarrow 2H_2O$

(b) The electrodes of a fuel cell are in contact with water and air.
The electrodes are made of platinum rather than iron.

(i) State why iron is not a suitable metal for the electrodes of the cell.

(1)

Iron is no inert and will react with water and iron.

(ii) Platinum acts as a catalyst.

State, in terms of its position in the periodic table, why you would expect platinum to act as a catalyst.

(1)

Platinum is in the d block of the periodic table so it is a transition metal.

(c) Some metal objects are electroplated.

State **two** reasons for electroplating a metal object.

(2)

1 to give a shiny surface

2 to prevent the object from rusting

7 Many metals corrode.

(a) When a metal corrodes

(1)

☒ **A** the metal reacts with nitrogen

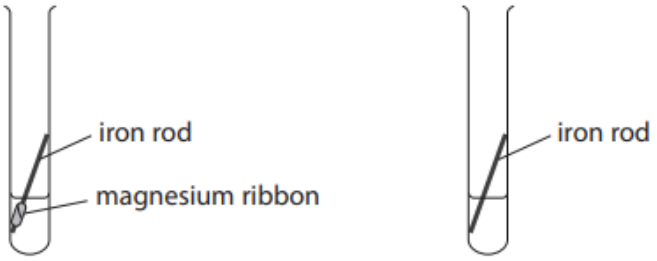
☒ **B** the metal reacts with another metal

☒ **C** the metal element decomposes

☒ **D** the metal is oxidised

(b) An experiment is carried out to see if magnesium ribbon wrapped around a piece of iron rod has an effect on the rate at which the iron rod rusts.

The apparatus is shown in Figure 4.



boiling tube **A** boiling tube **B**

Figure 4

The method used is

- an iron rod, with magnesium ribbon wrapped around it, is placed in a boiling tube labelled **A**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube
- an identical rod but with no magnesium ribbon wrapped around it is placed in a second boiling tube labelled **B**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube.

Both boiling tubes are left for a few days.

(i) Explain why iron rod rather than stainless steel rod is used in this experiment.

(2)

Iron will react with oxygen in air and water to rust, but a stainless steel rod does not rust.

(ii) State why it is not necessary to use a pipette to measure out 10 cm^3 water in this experiment.

(1)

water is in excess in the reaction

(iii) After a few days the two boiling tubes were examined.

The results are shown in Figure 5.

boiling tube A	the appearance of the iron rod is unchanged the magnesium has started to disappear
boiling tube B	a small amount of brown deposit has formed around the rod

Figure 5

Explain the results of this experiment.

(2)

In boiling tube A, the magnesium provides sacrificial protection so iron does not rust. In boiling tube B, iron has reacted with water and oxygen in air so it has rusted.

(c) Hydrazine, N_2H_4, reacts with oxygen.

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

A metal in water corrodes faster than an identical piece of metal in the same volume of water containing dissolved hydrazine.

Use the information to explain how hydrazine slows corrosion.

(2)

Hydrazine reacts with oxygen in air. Rusting requires both oxygen and water, so if there is less oxygen available rusting slows down.

(d) Ammonia is used to make hydrazine.

In the industrial process to manufacture ammonia, nitrogen and hydrogen are combined in the presence of an iron catalyst.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) State the name of the industrial process to manufacture ammonia.

(1)

Haber process

(ii) Predict the effect that adding the catalyst has on the rate of attainment of equilibrium.

(1)

equilibrium is reached faster

(iii) Predict the effect that adding the catalyst has on the equilibrium yield of ammonia.

(1)

Adding catalyst does not affect the equilibrium yield.

10 (a) Nitric acid can be titrated with a solution of ammonia.

(i) State the type of reaction occurring when nitric acid reacts with ammonia.

(1)

neutralisation

(ii) What salt is formed in this reaction?

(1)

- ☒ **A** ammonia nitric
- ☒ **B** ammonia nitrate
- ☒ **C** ammonium nitric
- ☒ **D** ammonium nitrate

*(c) In another stage in the production of nitric acid, ammonia is reacted with oxygen to form nitrogen oxide and water.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

Heat energy is given out when ammonia reacts with oxygen.

The conditions chosen for the reaction are
- excess air, rather than just the right amount
- a pressure of 10 atm, rather than atmospheric pressure
- a temperature of 900 °C, rather than room temperature.

Explain the effect of the conditions chosen on the equilibrium yield of nitrogen oxide and on the rate of attainment of equilibrium.

(6)

contains excess O_2 which

Excess air will shift the equilibrium to the right as there are more reactants on the left hand side. The rate of attainment of equilibrium is faster as there are more frequent collisions between reacting particles. A higher pressure will shift equilibrium to the left so yield of NO decreases. This is because there are fewer moles of the left hand side. The rate of attainment of equilibrium is faster as particles collide more often. At 900°C, equilibrium shifts to the left as forward reaction is exothermic, so yield of NO is lower. Rate of attainment of equilibrium is higher as particles gain more kinetic energy at high temperature and move faster, so there are more collisions.

1 Alloys of gold are often used to make jewellery.
The purity of gold is measured in carats.
Different alloys of gold have different carats.

(a) Figure 1 shows the percentage of different metals in two samples of gold.

	percentage of metal		
	gold	**silver**	**copper**
18 carat gold	75.0	15.0	10.0
24 carat gold	100.0	0.0	0.0

Figure 1

Explain why 18 carat gold is stronger than 24 carat gold.

You may use diagrams to help your answer.

(2)

18 carat gold is an alloy made from gold, silver and copper. Metal ions of different sizes form layers which do not slide past each other so 18 carat gold is strong. 24 carat gold is made of pure gold so the layers of metal ions can slide past each other since the ions have the same size.

(b) Figure 2 shows the relationship between the purity of gold in carats and the percentage of gold in the alloy.

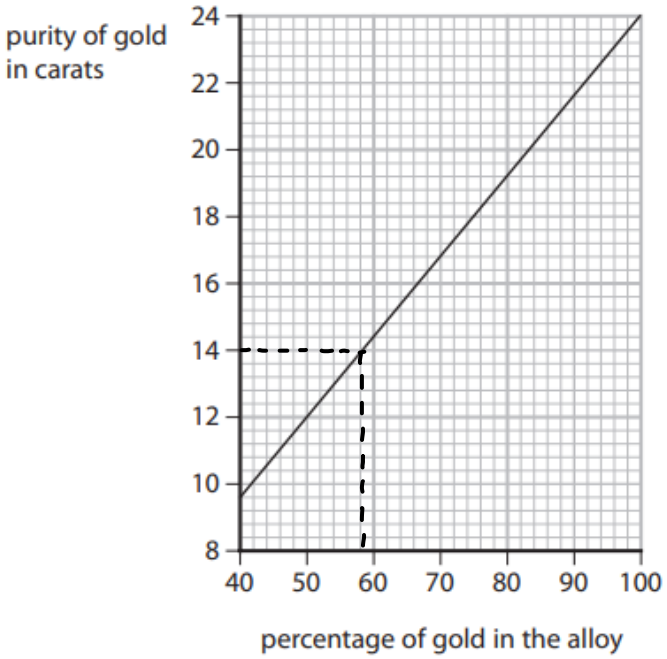


Figure 2

A necklace with a mass of 5.0 g was found to contain 2.9 g of gold.

Determine the purity of the gold necklace in carats.
Show your working.

(3)

percentage of gold in alloy $= \frac{2.9}{5.0} \times 100$

$= 58\%$

purity of the gold necklace = 14 carats

7 (a) Methane reacts with steam to form hydrogen and carbon dioxide.

The reaction takes place in two stages.

stage 1: $CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$

stage 2: $CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g)$

(i) Stage 1 takes in heat energy, it is endothermic.

Explain the effect of increasing the temperature on the yield of the products of stage 1.

(2)

Equilibrium shifts to the right so yield of product increases

(ii) The overall equation for the process is

$$CH_4(g) + 2H_2O(g) \rightarrow 4H_2(g) + CO_2(g)$$

0.40 g of methane were fully reacted with steam to form carbon dioxide and hydrogen.

Calculate the maximum volume of hydrogen in dm^3, measured at room temperature and pressure, that could be made in this reaction.

(relative formula mass: $CH_4 = 16$,
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)

moles of methane : $\frac{0.40}{16} = 0.025$ mol

moles of H_2 : $4(0.025) = 0.1$ mol

volume of H_2 : $0.1 \times 24 = 2.4\ dm^3$

maximum volume of hydrogen = 2.4 dm^3

*(b) Hydrogen-oxygen fuel cells can be used to provide electrical energy in a spacecraft.

The reaction that takes place in the fuel cell is

$$\text{hydrogen} + \text{oxygen} \rightarrow \text{water}$$

Evaluate the advantages and disadvantages of providing electrical energy in a spacecraft using hydrogen-oxygen fuel cells rather than chemical cells.

(6)

Hydrogen - oxygen fuel cells are suitable for space crafts as there are no moving parts to maintain and they are small but produce a significant amount of electrical energy. The only other product is water so there is no pollution, as the water produced can be used for drinking. However, they require a constant supply of hydrogen, which is difficult to store and flammable. Fuel cells stop producing electrical energy once one of the reactants run out.

10 (a) Ammonia is manufactured by the Haber process.

The equation for the reaction is

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction is reversible and can reach equilibrium.

(i) An iron catalyst can be used in the reaction.

Which row of the table shows how adding the iron catalyst affects the rate of attainment of equilibrium and the equilibrium yield of ammonia?

(1)

	rate of attainment of equilibrium	equilibrium yield of ammonia
☒ **A**	increases	increases
☒ **B**	decreases	does not change
☒ **C**	decreases	increases
☒ **D**	increases	does not change

(ii) Which of the following statements is correct when the reaction reaches equilibrium?

(1)

☒ **A** the reverse reaction starts to take place

☒ **B** the amounts of nitrogen, hydrogen and ammonia are equal

☒ **C** the amounts of nitrogen, hydrogen and ammonia become constant

☒ **D** the reaction stops

(iii) The reaction is carried out at a pressure of 200 atmospheres.

Explain what effect a pressure higher than 200 atmospheres would have on the rate of attainment of equilibrium and on the equilibrium yield of ammonia.

(4)

Rate of attainment of equilibrium will be higher as particles collide more often. Equilibrium shifts to the right as there are fewer moles on the right, so yield of ammonia increases.

(b) Ammonium sulfate and ammonium nitrate are used as fertilisers as they both contain nitrogen, which will increase the yield of crops.

(i) Suggest **one** other reason for using solid ammonium sulfate and solid ammonium nitrate as nitrogenous fertilisers.

(1)

solid fertilisers are not easily washed away by rain

(ii) Ammonium nitrate can be made by the reaction of ammonia with nitric acid.

Write the balanced equation for this reaction.

(2)

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

(iii) Describe **one** similarity and **one** difference between the industrial production of ammonium sulfate and the laboratory preparation of ammonium sulfate.

(2)

similarity ammonia and sulfuric acid react to form ammonium sulfate

difference there is only one step in laboratory preparation but many steps in industrial production.

TOTAL FOR PAPER IS 63 MARKS