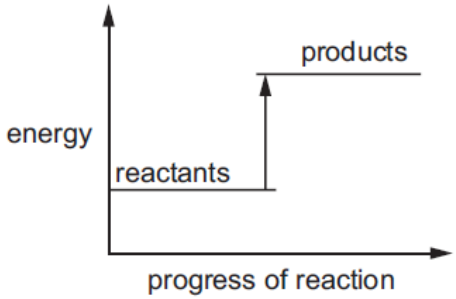
Chemical Energetics – 2023 IGCSE Chemistry 0620

1. Nov/2023/Paper_0620/11/No.11

The reaction pathway diagram for a reaction is shown.



Which statements are correct?

1 The reaction is exothermic.

2 The reaction is endothermic.

3 The temperature of the surroundings increases.

4 The temperature of the surroundings decreases.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

2. Nov/2023/Paper_0620/11/No.12

Which process involves a chemical change?

A adding sodium to water

B boiling water

C dissolving sodium chloride in water

D producing water from aqueous sodium chloride

3. Nov/2023/Paper_0620/12/No.13

The initial and final temperatures of four different reactions are measured.

Which reaction is the **least** exothermic?

	initial temperature / °C	final temperature / °C
A	19	25
B	21	18
C	22	17
D	22	26

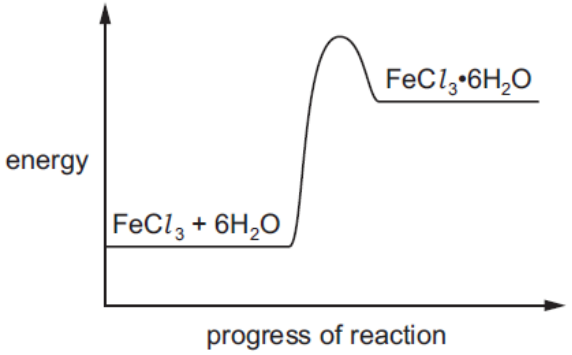
4. Nov/2023/Paper_0620/13/No.13

When water is added to anhydrous iron(III) chloride, $FeCl_3$, hydrated iron(III) chloride, $FeCl_3 \cdot 6H_2O$, is formed and energy is given out.

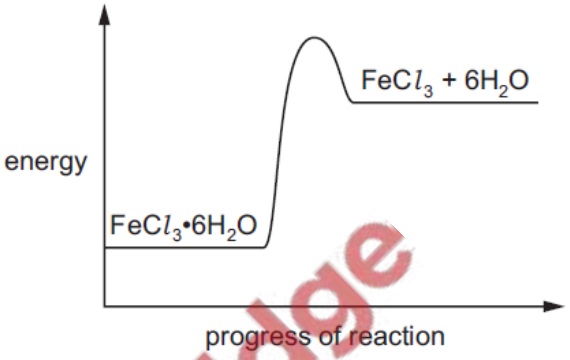
$$FeCl_3 + 6H_2O \rightleftharpoons FeCl_3 \cdot 6H_2O$$

Which reaction pathway diagram represents the formation of anhydrous iron(III) chloride in the **reverse** reaction?

A



B



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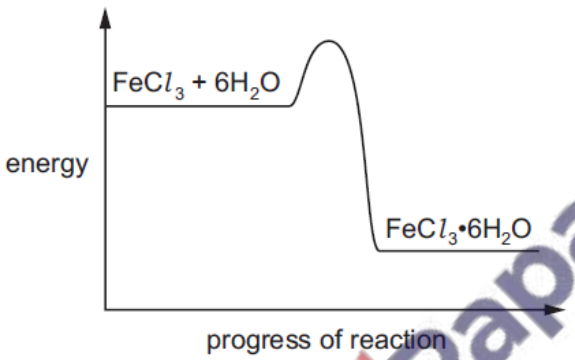
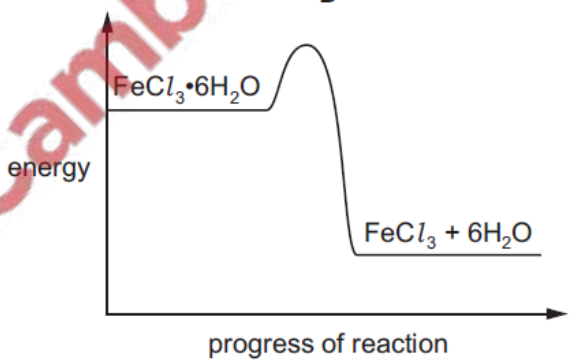


D



5. Nov/2023/Paper_0620/13/No.14

Which process is a chemical change?

A burning carbon in air

B dissolving copper(II) sulfate crystals in water

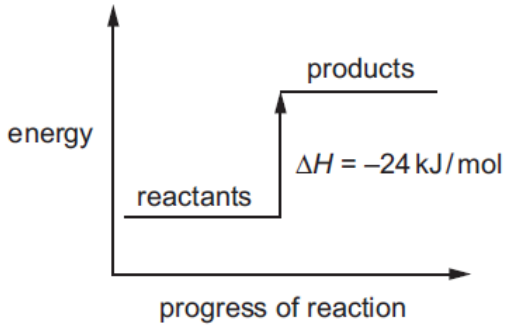
C evaporating ethanol

D freezing water

6. Nov/2023/Paper_0620/21/No.10

Which reaction pathway diagram represents an endothermic reaction?

A



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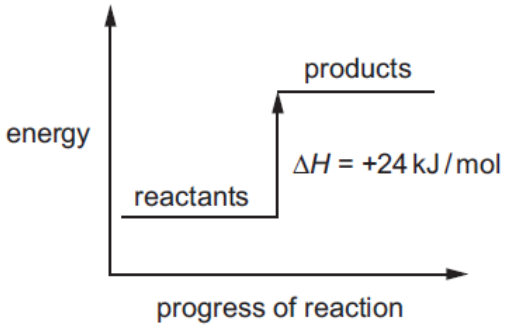

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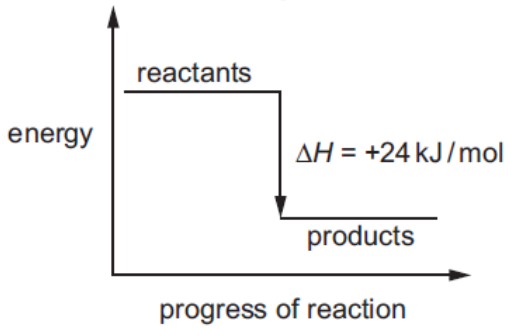

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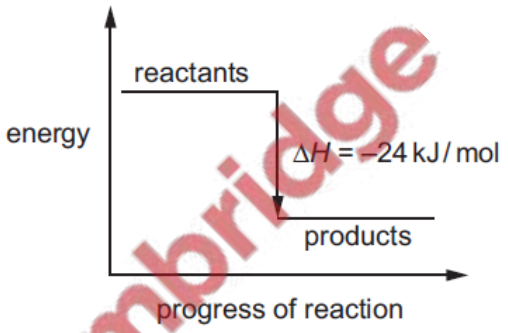


7. Nov/2023/Paper_0620/21/No.11

Hydrogen burns in oxygen.

The equation for the reaction is shown.

$$2H_2 + O_2 \rightarrow 2H_2O$$

The table shows the bond energies involved.

bond	bond energy in kJ / mol
H–H	436
O=O	498
O–H	464

What is the energy given out during the reaction?

A –3226 kJ / mol

B –884 kJ / mol

C –486 kJ / mol

D –442 kJ / mol

8. Nov/2023/Paper_0620/21/No.12

Which process involves a chemical change?

A adding sodium to water

B boiling water

C dissolving sodium chloride in water

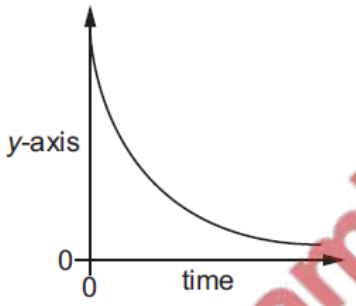
D producing water from aqueous sodium chloride

9. Nov/2023/Paper_0620/21/No.13

An experiment is carried out to find the rate of reaction between hydrochloric acid and zinc.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The results of the experiment are shown.



What is the label on the *y*-axis?

A amount of $ZnCl_2$ produced

B concentration of HCl

C mass of Zn reacted

D volume of H_2 produced

10. Nov/2023/Paper_0620/21/No.14

Hydrogen peroxide, H_2O_2, decomposes to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Manganese(IV) oxide catalyses the decomposition reaction.

The reaction is investigated in four experiments.

experiment	volume and concentration of hydrogen peroxide	conditions
1	12.5 cm^3 of 1.0 mol/dm^3	25 °C with manganese(IV) oxide powder added
2	12.5 cm^3 of 2.0 mol/dm^3	40 °C with manganese(IV) oxide powder added
3	25 cm^3 of 1.0 mol/dm^3	40 °C without manganese(IV) oxide powder
4	25 cm^3 of 1.0 mol/dm^3	40 °C with manganese(IV) oxide powder added

All reactions go to completion and all measurements of gas volumes are at room temperature and pressure.

Which statement is correct?

A Experiment 1 produces less gas than experiment 4, but at the same rate.

B Experiment 2 produces more gas than experiment 1, but at the same rate.

C Experiment 2 and experiment 4 each produce the same volume of gas, but at different rates.

D Experiment 3 and experiment 4 each produce the same volume of gas and at the same rate.

11. Nov/2023/Paper_0620/22/No.12

The initial and final temperatures of four different reactions are measured.

Which reaction is the **least** exothermic?

	initial temperature /°C	final temperature /°C
A	19	25
B	21	18
C	22	17
D	22	26

12. Nov/2023/Paper_0620/22/No.13

Which equation represents an endothermic reaction?

A $Cl_2(g) \rightarrow 2Cl(g)$

B $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

C $H(g) + H(g) \rightarrow H_2(g)$

D $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$

13. Nov/2023/Paper_0620/22/No.14

Methane burns in oxygen to form carbon dioxide and water.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

The bond energies are shown.

bond	bond energy in kJ/mol
C–H	410
C–O	360
C=O	805
O–H	460
O–O	146
O=O	496

What is the energy change for this reaction?

A –818 kJ/mol **B** –102 kJ/mol **C** +102 kJ/mol **D** +818 kJ/mol

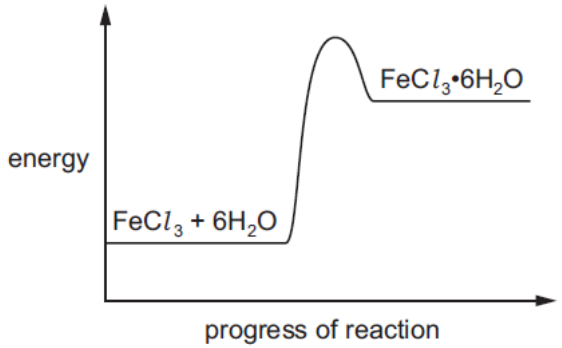
14. Nov/2023/Paper_0620/23/No.13

When water is added to anhydrous iron(III) chloride, $FeCl_3$, hydrated iron(III) chloride, $FeCl_3 \cdot 6H_2O$, is formed and energy is given out.

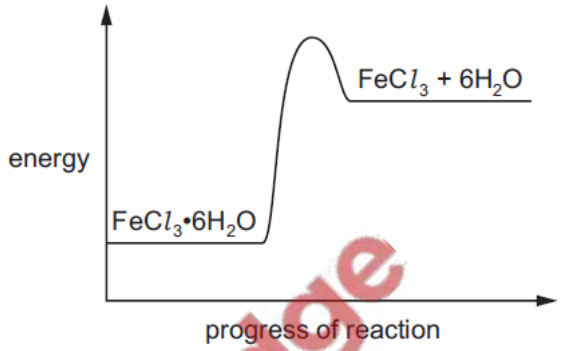
$$FeCl_3 + 6H_2O \rightleftharpoons FeCl_3 \cdot 6H_2O$$

Which reaction pathway diagram represents the formation of anhydrous iron(III) chloride in the **reverse** reaction?

A



B



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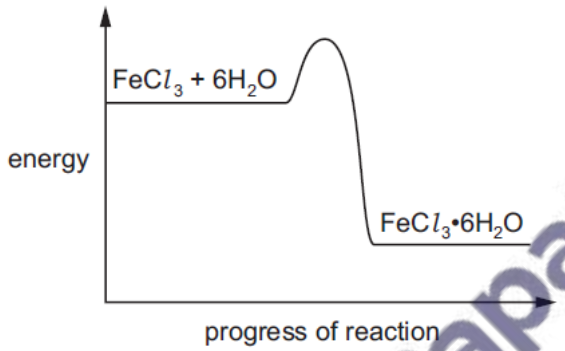

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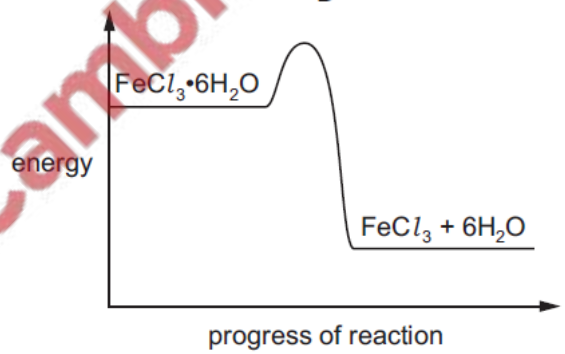

15. Nov/2023/Paper_0620/23/No.14

Ethene reacts with hydrogen. The equation is shown.

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

The bond energies are shown.

bond	bond energy in kJ/mol
C–C	+350
C=C	+610
C–H	+410
H–H	+436

What is the energy change for the reaction?

A –560 kJ/mol **B** –124 kJ/mol **C** +486 kJ/mol **D** +5496 kJ/mol

16. Nov/2023/Paper_0620/32/No.3(b)

(a) Table 3.1 shows the average concentrations, in ng / 1000 cm^3, of air pollutants in four different years.

Table 3.1

year	concentration of air pollutant in ng / 1000 cm^3				
	carbon monoxide	hydrocarbons	oxides of nitrogen	particulates	sulfur dioxide
2019	2.5	12.0	19.6	28.0	30.0
2020	2.0	13.5	21.8	30.1	21.7
2021	1.8	14.8	18.5	27.5	23.8
2022	1.6	16.0	22.7	26.2	25.0

(b) (i) State **one** adverse effect of particulates on health.

..... [1]

(ii) Particulates are formed by the incomplete combustion of hydrocarbons.

State the meaning of the term incomplete combustion.

.....

..... [1]

17. Nov/2023/Paper_0620/42/No.5

Chemical reactions can involve transfer of thermal energy.

(a) State the term used for the transfer of thermal energy during a reaction.

..... [1]

(b) Tetrachloromethane gas, $CCl_4(g)$, reacts with steam as shown.

$$CCl_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4HCl(g)$$

The reaction is reversible. The forward reaction is exothermic.

(i) State what happens, if anything, to the rate of the forward reaction if the concentration of CCl_4 is increased.
Explain your answer in terms of collision theory.

.....

.....

.....

..... [3]

(ii) State what happens to the position of equilibrium, if anything, when the pressure is increased.
Explain your answer.

.....

..... [2]

(iii) Fig. 5.1 shows an incomplete reaction pathway diagram for the forward reaction.

$$CCl_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4HCl(g)$$

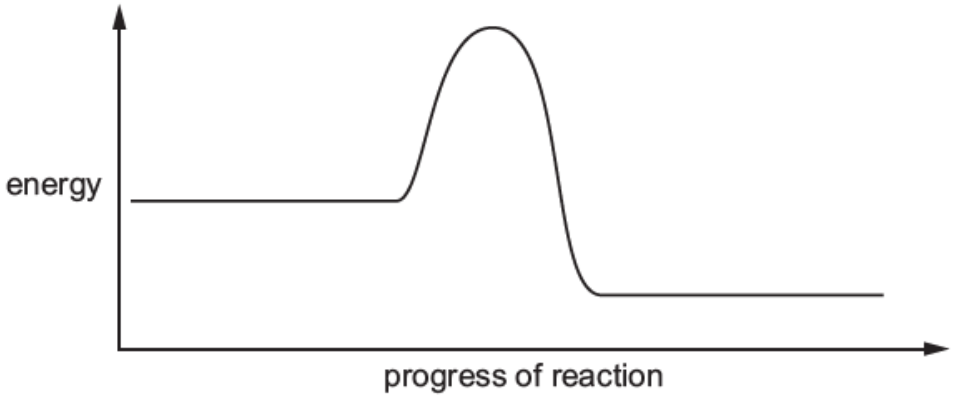

Fig. 5.1

On Fig. 5.1:

- insert the formulae of the reactants and products
- draw an arrow, labelled E_a, to show the activation energy
- draw an arrow, labelled ΔH, to show the transfer of energy in the reaction.

[3]

(iv) Define the term activation energy.

.....

..... [2]

(v) State **one** way in which the activation energy of a reaction can be changed.

..... [1]

(c) The equation for the reaction between tetrachloromethane gas and steam can be represented as shown in Fig. 5.2.

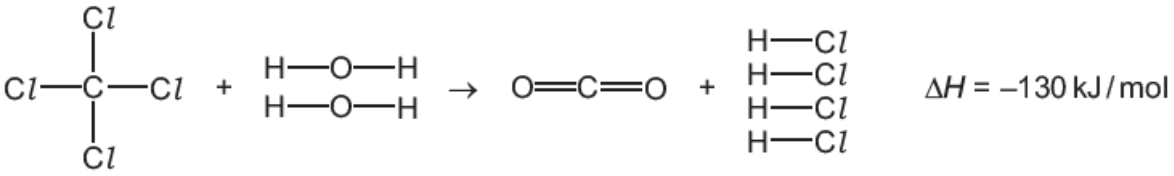

Fig. 5.2

Table 5.1 shows some bond energies.

Table 5.1

bond	C–C*l*	H–O	C=O
bond energy in kJ / mol	340	460	805

Use the bond energies in Table 5.1 and the ΔH value for the reaction to calculate the H–C*l* bond energy using the following steps.

- Calculate the energy needed to break the bonds in the reactants.

..... kJ

- Calculate the energy released when the bonds in carbon dioxide form.

..... kJ

- Calculate the H–C*l* bond energy.

..... kJ / mol
[4]

[Total: 16]

18. Nov/2023/Paper_0620/43/No.1(e)

A list of substances is shown.

barium nitrate
carbon monoxide
hydrated cobalt(II) chloride
copper(II) oxide
anhydrous copper(II) sulfate
ethane
potassium iodide
propene
sodium bromide
sulfur dioxide
zinc oxide

Answer the following questions using only the substances from the list.
Each substance may be used once, more than once or not at all.

(e) is a product of incomplete combustion of fossil fuels

..... [1]