Write your name here

Surname	Other names

Pearson BTEC Level 3 Diploma

Centre Number

Learner Registration Number

Applied Science

Unit 5: Principles and Applications of Science II

Chemistry

PROPERTIES AND USES OF SUBSTANCES

Tuesday 5 June 2018 – Afternoon

Time: 50 minutes

Paper Reference

31627H/1C

You must have:
A calculator and ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The exam is comprised of three papers worth 40 marks each.
  Section A: Organs and systems (Biology).
  Section B: Properties and uses of substances (Chemistry).
  Section C: Thermal physics, materials and fluids (Physics).
- The total mark for this exam is 120.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- The periodic table of elements and formulae sheet can be found at the back of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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1/1/1/1/1

P 6 1 0 7 5 A 0 1 1 6

Pearson

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Understanding the structure of organic compounds is important in the pharmaceutical industry.

(a) Methane has the formula CH_4.

Which is the correct bond angle in methane?

(1)

☒ **A** 90.0°

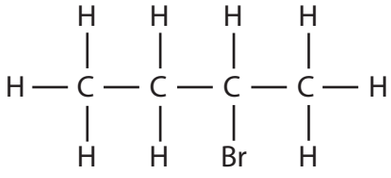
☒ **B** 104.5°

☒ **C** 107.0°

☒ **D** 109.5°

(b) Identify the IUPAC name for the compound in the diagram.

(1)



☒ **A** 2-bromobutane

☒ **B** 3-bromobutane

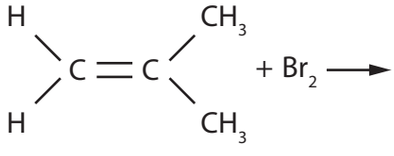
☒ **C** 2–bromopentane

☒ **D** 3-bromopentane

(c) Methylpropene reacts with bromine.

(i) Complete the equation to show the structural formula of the product formed in this reaction.

(2)



(ii) Name the type of reaction in (c)(i).

(2)

.....

(iii) Which row in Table 1 shows the correct number of σ (sigma) and π (pi) bonds in the C=C bond?

(1)

	σ (sigma)	**π (pi)**
A	2	0
B	0	2
C	1	1
D	1	2

Table 1

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) Explain how the carbon to carbon bond strength in ethane is different to ethene.

(3)

.....

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(Total for Question 1 = 10 marks)

2 Electrolysis of brine can be carried out in a membrane cell.

Figure 1 shows a membrane cell.

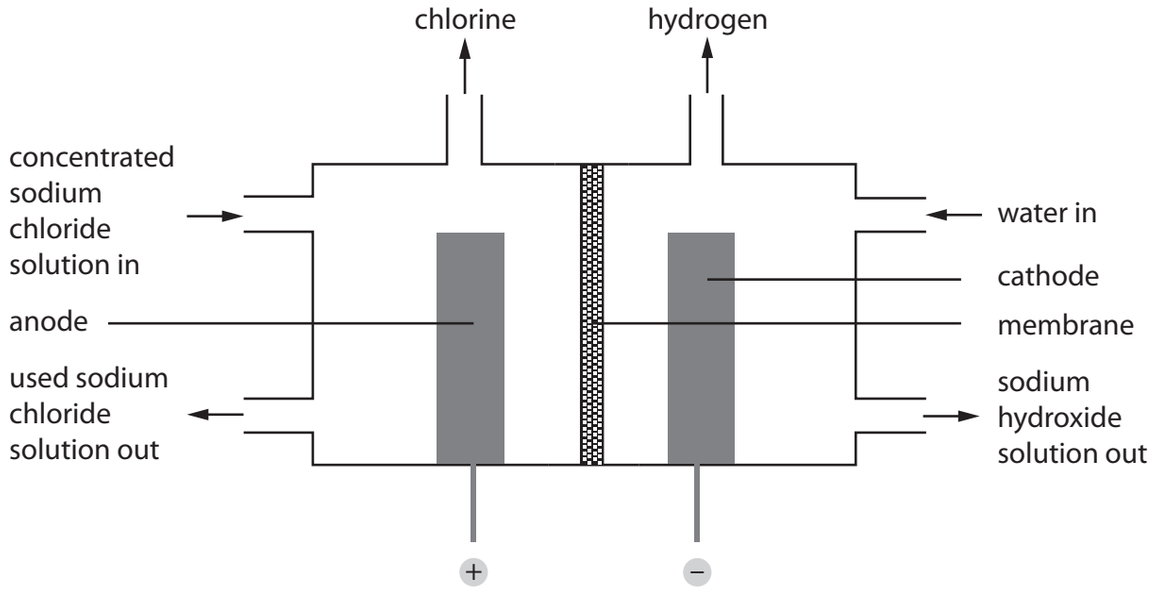


Figure 1

(a) At the cathode, hydrogen ions gain electrons to produce hydrogen gas.

The half-equation for the production of hydrogen is:

$$2H^+ + 2e^- \longrightarrow H_2$$

At the anode, chloride ions lose electrons to produce chlorine gas.

Write a balanced half-equation for the production of chlorine at the anode.

(2)

(b) Explain the function of the membrane in the cell shown in Figure 1.

(4)

(Total for Question 2 = 6 marks)

3 (a) Transition metals are often used as catalysts.

Explain how a transition metal works as a catalyst.

(3)

(b) Vanadium (III) complexes can be used as catalysts.

Figure 2 shows a vanadium (III) complex ion, where 6 water molecules are bonded to a central vanadium (III) ion.

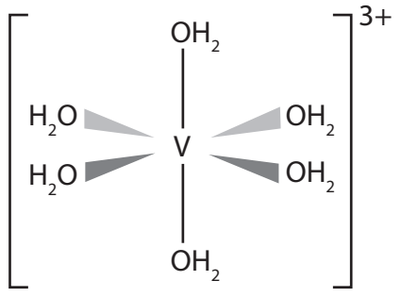


Figure 2

Describe how the water molecules are bonded to the vanadium (III) ion.

(2)

(Total for Question 3 = 5 marks)

4 Propane is an alkane and has the formula C_3H_8.

(a) Give the general formula of an alkane.

(1)

.....

.....

(b) Write a balanced equation for the cracking of propane to produce ethene and **one** other product.

(2)

.....

(c) A catalyst can be used instead of steam in the cracking process.

Steam produces a higher yield of alkenes than using a catalyst.

State **two** benefits of using a catalyst to crack hydrocarbons.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 4 = 5 marks)

5 (a) The reaction shows an example of enthalpy change of combustion.

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

State what is meant by the term **standard enthalpy change of combustion**.

(2)

.....

.....

.....

.....

(b) (i) The standard enthalpy change of formation is measured under conditions of 1 atm and 298 K.

Give the temperature of 298 K in °C.

(1)

..... °C

(ii) The standard enthalpy change of formation (ΔH^{θ}_f) for butane (C_4H_{10}) cannot be measured directly but can be calculated from standard enthalpy of combustion (ΔH^{θ}_c) data.

Table 2 shows the standard enthalpy changes of combustion for butane, carbon and hydrogen.

substance	standard enthalpy change of combustion (kJ mol^{-1})
carbon	-393.7
hydrogen	-285.8
butane	-2876.5

Table 2

Figure 3 shows a Hess energy change cycle for the standard enthalpy change of formation of butane.

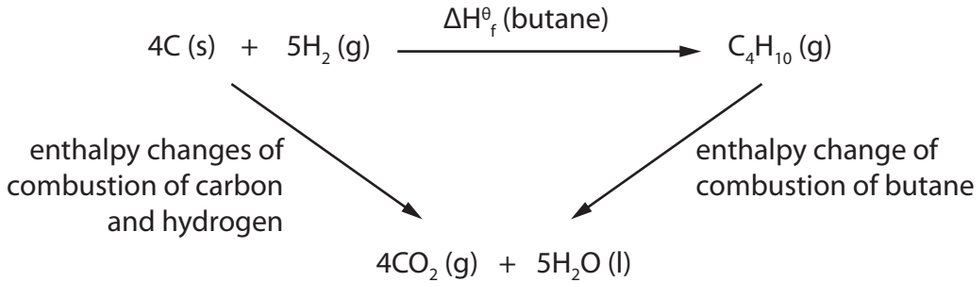


Figure 3

Calculate the ΔH^{θ}_{f} for butane, using the standard enthalpy of combustion values in Table 2.

Show your working, using the Hess energy cycle or any other method.

(5)

ΔH^{θ}_{f} (standard enthalpy change of formation) for butane = ... kJ mol^{-1}

(c) Figure 4 shows the enthalpy profiles for two different reactions.

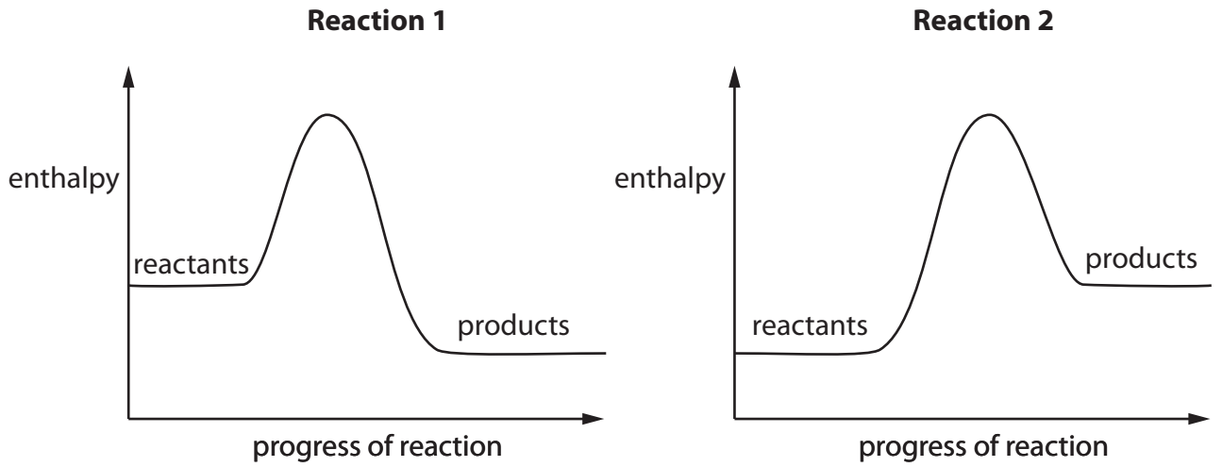


Figure 4

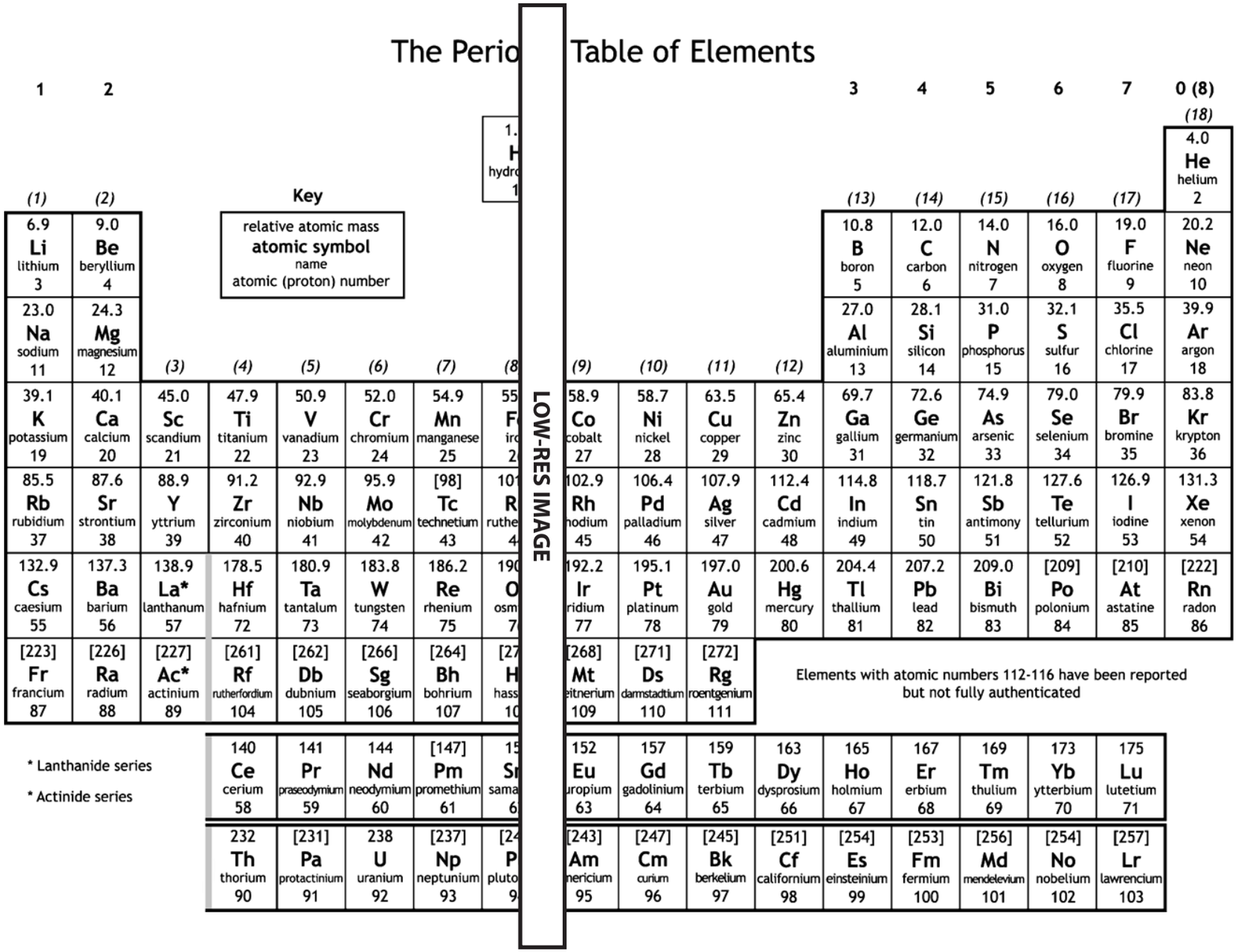
Explain the differences between Reaction 1 and 2, using the enthalpy profiles.

(6)

(Total for Question 5 = 14 marks)

TOTAL FOR PAPER = 40 MARKS

The Perio Table of Elements



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