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<h1>Applied Science</h1> <p>Unit 5: Principles and Applications of Science II Chemistry PROPERTIES AND USES OF SUBSTANCES</p>										
Tuesday 5 June 2018 – Afternoon						Paper Reference				
Time: 50 minutes						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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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 .

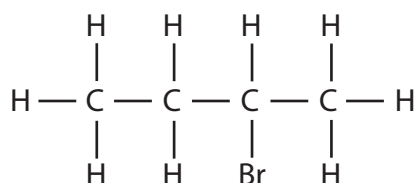
Which is the correct bond angle in methane?

(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)

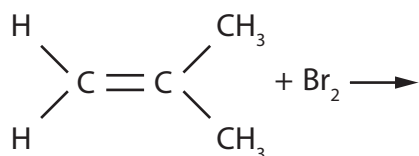


- A 2-bromobutane
 B 3-bromobutane
 C 2-bromopentane
 D 3-bromopentane

(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)

(Total for Question 1 = 10 marks)



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

Figure 1 shows a membrane cell.

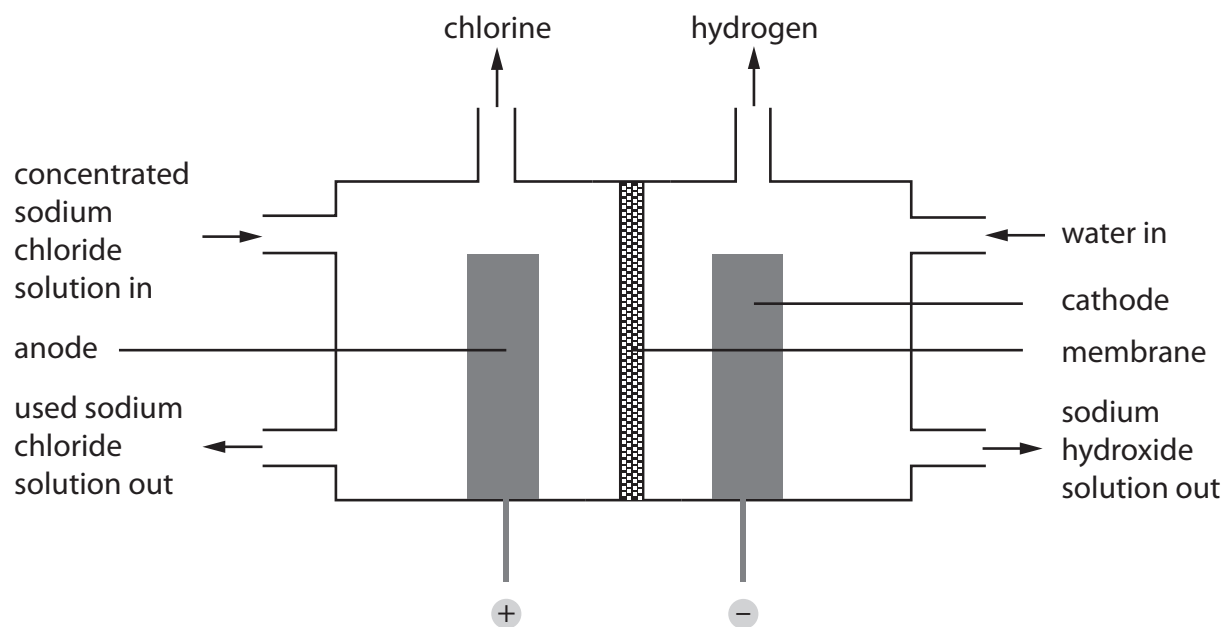
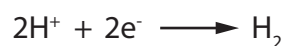


Figure 1

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

The half-equation for the production of hydrogen is:



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)

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

(4)

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(Total for Question 2 = 6 marks)

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

Explain how a transition metal works as a catalyst.

(3)

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(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.

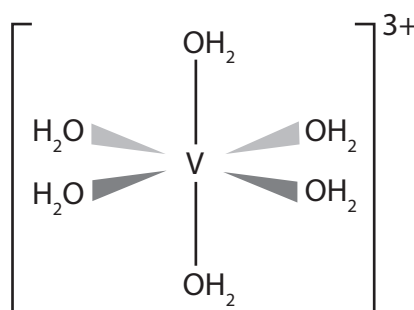


Figure 2

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

(2)

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(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)

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

(2)

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(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)

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(Total for Question 4 = 5 marks)

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



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

(2)

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(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_f^\ominus) for butane (C_4H_{10}) cannot be measured directly but can be calculated from standard enthalpy of combustion (ΔH_c^\ominus) 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

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

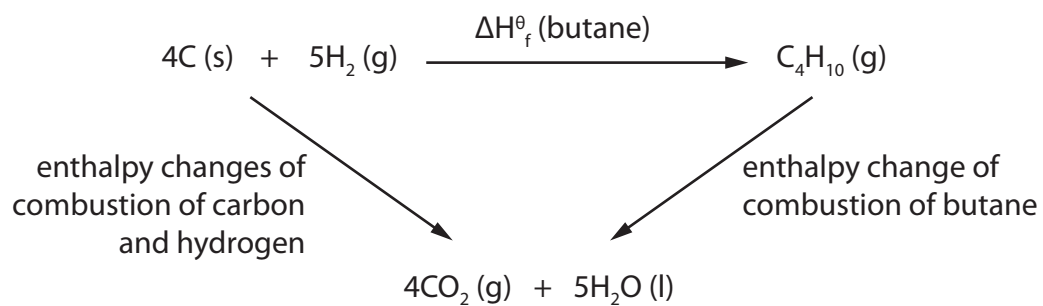


Figure 3

Calculate the ΔH_f^\ominus 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_f^\ominus (standard enthalpy change of formation) for butane = kJ mol^{-1}



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

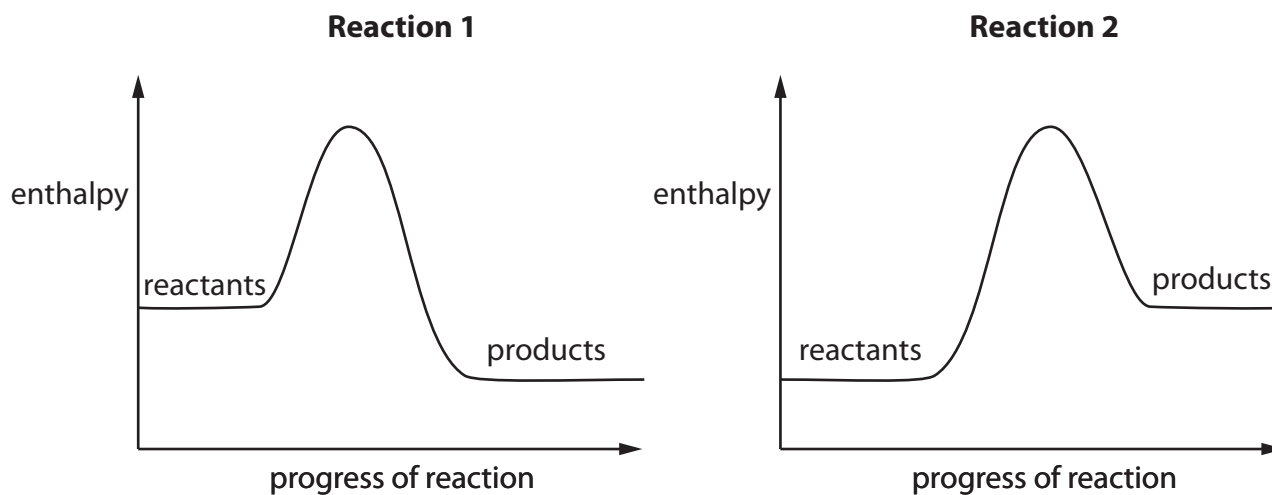


Figure 4

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

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Handwriting practice area with 20 horizontal dotted lines.

(Total for Question 5 = 14 marks)

TOTAL FOR PAPER = 40 MARKS





The Periodic Table

1	2	LOW-RES IMAGE										3	4	5	6	7	0 (8)																																																												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)																																																												
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6.9 Li lithium 3	9.0 Be beryllium 4	23.0 Na sodium 11	24.3 Mg magnesium 12	39.1 K potassium 19	40.1 Ca calcium 20	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	98.9 Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	126.9 I iodine 53	131.3 Xe xenon 54	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	126.9 I iodine 53	131.3 Xe xenon 54	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	210 Po polonium 84	210 At astatine 85	222 Rn radon 86	152 Eu europium 63	157 Gd gadolinium 64	162 Tb terbium 65	167 Dy dysprosium 66	173 Ho holmium 67	175 Er erbium 68	177 Tm thulium 69	178 Yb ytterbium 70	173 Lu lutetium 71	232 Th thorium 90	231 Pa protactinium 91	238 U uranium 92	237 Np neptunium 93	244 Pu plutonium 94	244 Am americium 95	247 Cm curium 96	251 Bk berkelium 97	252 Cf californium 98	257 Es einsteinium 99	261 Fm fermium 100	265 Mendelevium 101	269 Nobelium 102	270 Lr lawrencium 103	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	147 Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	162 Tb terbium 65	167 Dy dysprosium 66	173 Ho holmium 67	175 Er erbium 68	177 Tm thulium 69	178 Yb ytterbium 70	173 Lu lutetium 71

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series
* Actinide series

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