Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson BTEC Level 3 Nationals Diploma

Centre Number | | | | | | |

Learner Registration Number | | | | | | | | |

Monday 10 June 2019

Afternoon (Time: 50 minutes) | Paper Reference **31627H/1C**

Applied Science

Unit 5: Principles and Applications of Science II
Chemistry
SECTION B: PROPERTIES AND USES OF SUBSTANCES

You will need:
A calculator.

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 comprises 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 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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P 6 1 8 1 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 Titanium is a transition metal.

Figure 1 shows a human hip with a titanium replacement implant.

Titanium is suitable for this use because it is very strong.

Figure 1

(a) Give **one** other property that makes titanium suitable for this use.

(1)

.....

(b) Titanium can be extracted from its ore using the Kroll process.

The ore is first converted into titanium(IV) chloride.

It is then reduced to titanium in a furnace at temperatures of up to 1300 K.

(i) Identify the substance used to reduce titanium(IV) chloride to titanium.

(1)

☒ **A** carbon

☒ **B** chlorine

☒ **C** iron

☒ **D** magnesium

(ii) The reduction of titanium(IV) chloride to titanium cannot be carried out in air.

The air has to be replaced with argon gas.

Explain why air needs to be replaced with argon gas for this reaction.

(2)

.....

.....

.....

.....

(iii) Another method that could be used to extract titanium from its ore is electrolysis.

Two advantages of electrolysis are that it is quicker and can be run continuously.

Give **two** other reasons why electrolysis would be a more efficient method of extraction than the Kroll process.

(2)

.....

.....

.....

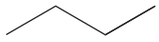
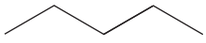
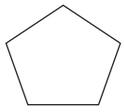
.....

(Total for Question 1 = 6 marks)

2 Pentane is an alkane that has the molecular formula C_5H_{12}.

(a) Identify the skeletal formula of pentane.

(1)

A 	**B** 
C 	**D** 

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Pentane burns in oxygen.

The process is exothermic.

(i) Name the type of reaction taking place when pentane burns in oxygen.

(1)

.....

(ii) Explain how exothermic processes affect their surroundings.

(2)

.....

.....

.....

.....

(iii) The enthalpy change (ΔH) for this reaction is –3509 kJ when one mole of pentane burns in oxygen.

The reaction is carried out at a pressure (p) of 100 kPa.

The change in volume (ΔV) is 0.21 m^3.

Calculate the change in internal energy (ΔU) for this reaction.

$$\Delta H = \Delta U + p\Delta V$$

Show your working.

(3)

ΔU = ... kJ

(Total for Question 2 = 7 marks)

3 The Contact process is used to make sulfur trioxide.

The equation for the Contact process is

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

(a) (i) This equation does not show the enthalpy change of formation of sulfur trioxide.

Give **one** reason why.

(1)

.....

.....

(ii) Identify the catalyst used in the Contact process.

(1)

☒ **A** aluminium oxide

☒ **B** iron(III) oxide

☒ **C** titanium(IV) oxide

☒ **D** vanadium(V) oxide

(b) Sulfuric acid, H_2SO_4, can be made by reacting sulfur trioxide with water.

Figure 2 shows a Hess energy cycle for the reaction of sulfur trioxide with water.

The values for the standard enthalpy change of formation ($kJ\,mol^{-1}$) for sulfur trioxide, water and sulfuric acid are shown in Figure 2.

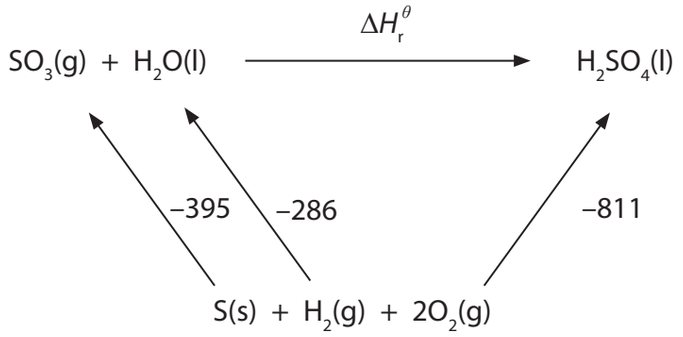


Figure 2

Calculate the value of ΔH_r^θ for the reaction of sulfur trioxide with water, using the standard enthalpy change values in Figure 2.

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

(3)

ΔH_r^θ = ... $kJ\,mol^{-1}$

(c) Sulfuric acid is often used in organic chemistry and reacts with ethene by electrophilic addition.

Figure 3 shows an incomplete diagram of the stages in the electrophilic addition mechanism between ethene and sulfuric acid.

The dipoles, charges, lone pairs of electrons and some of the curly arrows are not shown in Figure 3.

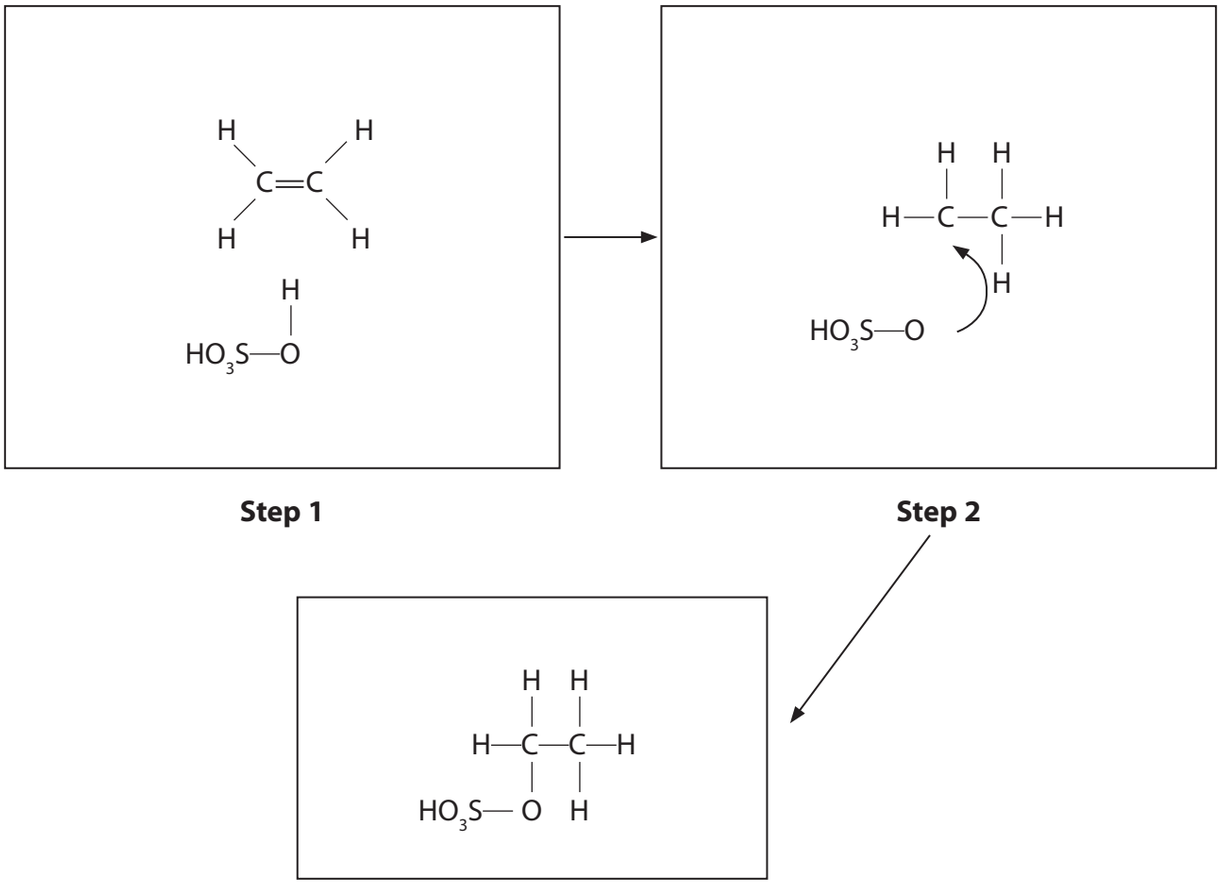


Figure 3

(i) Add the dipoles and curly arrows to the structures in Step 1 of Figure 3.

(2)

(ii) Add the charges and lone pair of electrons to Step 2 of Figure 3.

(2)

(d) Calcium hydroxide, $Ca(OH)_2$, can be used to neutralise sulfuric acid effluent from factories. The neutralisation reaction forms water, H_2O, and one other product.

Complete and balance the chemical equation for the reaction of calcium hydroxide with sulfuric acid.
(State symbols are not required.)

(2)

$Ca(OH)_2 + H_2SO_4 \rightarrow$ ..... + ...

(Total for Question 3 = 11 marks)

4 Benzene is a hydrocarbon.

It had been suggested that the structure of benzene consists of double and single carbon-carbon bonds.

A suggested skeletal formula for benzene is shown in Figure 4.

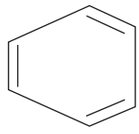


Figure 4

(a) Explain the difference in bond length between a carbon-carbon double bond and a carbon-carbon single bond.

(3)

(b) Benzene has the molecular formula C_6H_6.

Explain, in terms of the general formula for alkenes, why benzene can **not** be an alkene.

(2)

(c) Figure 5 shows the actual skeletal structure for benzene.

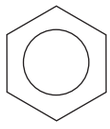


Figure 5

Identify the bond angle for benzene.

(1)

☒ **A** 109.5°

☒ **B** 120°

☒ **C** 180°

☒ **D** 270°

(d) When carbon atoms bond with one another, their atomic orbitals are hybridised.

Carbon atoms in benzene show sp^2 hybridisation.

Describe the process of sp^2 hybridisation for a carbon atom.

(4)

(Total for Question 4 = 10 marks)

5 Alumina is aluminium oxide.

It is extracted from its ore bauxite, but must be separated from impurities that are acidic (such as silica) and basic (such as iron(III) oxide).

Explain how alumina is extracted and purified from bauxite.

You may include equations in your answer.

(6)

(Total for Question 5 = 6 marks)

TOTAL FOR PAPER = 40 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	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] 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	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	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	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

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

* Lanthanide series

* Actinide series

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	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103