

Please check the examination details below before entering your candidate information

Candidate surname					Other names				
Centre Number					Candidate Number				

Pearson Edexcel International Advanced Level

Thursday 9 October 2025

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WCH11/01**

Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

You must have:
Scientific calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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SECTION A

Answer ALL the questions in this section.

You should aim to spend no more than 20 minutes on this section.

For each question, select one answer from A to D and put a cross in the box ☐. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☐.

1 Atomic numbers and mass numbers are used to identify isotopes.

(a) What is the mass number of the isotope $^{84}_{36}\text{Kr}$?

(1)

- ☐ A 36
☐ B 48
☐ C 84
☐ D 120

(b) Which element has the atomic number 15 and mass number 31?

(1)

- ☐ A Ga
☐ B P
☐ C Pd
☐ D S

(c) What is the number of electrons in the selenide ion $^{80}_{34}\text{Se}^{2-}$?

(1)

- ☐ A 34
☐ B 36
☐ C 80
☐ D 82

(Total for Question 1 = 3 marks)

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2 Mass spectrometry is used to analyse samples of elements and molecules.

(a) What is used to accelerate ions in a mass spectrometer?

(1)

- ☐ A beam of electrons
- ☐ B electric field
- ☐ C magnetic field
- ☐ D vaporisation

(b) A sample of boron contains 20.6% ^{10}B and 79.4% ^{11}B .

What is the relative atomic mass of this sample of boron?

(1)

- ☐ A 10.21
- ☐ B 10.50
- ☐ C 10.79
- ☐ D 10.80

(c) Bromine only has the two isotopes, ^{79}Br and ^{81}Br .

A pure sample of elemental bromine, Br_2 , was analysed in a mass spectrometer.

Why did the mass spectrum have a small peak with $m/z = 80$?

(1)

- ☐ A an isotope with a mass of 80 was formed in the spectrometer
- ☐ B there was contamination in the spectrometer
- ☐ C ions can form with a 2+ charge
- ☐ D this is the mean value of the two isotopic masses

(Total for Question 2 = 3 marks)

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- 3 An organic compound contains 53.3% carbon, 11.1% hydrogen and 35.6% oxygen by mass. The molar mass of this compound is 90.0 g mol^{-1} .

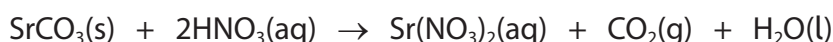
[Data: A_r H = 1.0 C = 12.0 O = 16.0]

What is the **empirical** formula of the compound?

- ☐ A $\text{C}_4\text{H}_{10}\text{O}$
- ☐ B $\text{C}_4\text{H}_{10}\text{O}_2$
- ☐ C $\text{C}_4\text{H}_5\text{O}_2$
- ☐ D $\text{C}_2\text{H}_5\text{O}$

(Total for Question 3 = 1 mark)

- 4 Strontium nitrate, $\text{Sr}(\text{NO}_3)_2$, can be prepared by the reaction of strontium carbonate with dilute nitric acid. The equation is shown.



- (a) Which is the **ionic** equation for this reaction?

(1)

- ☐ A $\text{Sr}^{2+}(\text{s}) + 2\text{NO}_3^-(\text{aq}) \rightarrow \text{Sr}(\text{NO}_3)_2(\text{aq})$
- ☐ B $\text{CO}_3^{2-}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- ☐ C $\text{SrCO}_3(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Sr}^{2+}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- ☐ D $\text{SrCO}_3(\text{s}) + 2\text{HNO}_3(\text{aq}) \rightarrow \text{Sr}^{2+}(\text{aq}) + 2\text{NO}_3^- + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$

- (b) What is the percentage atom economy, by mass, for this preparation of strontium nitrate?

[Data: A_r H = 1.0 C = 12.0 N = 14.0 O = 16.0 Sr = 87.6]

(1)

- ☐ A 22.7
- ☐ B 70.7
- ☐ C 77.3
- ☐ D 82.8

(Total for Question 4 = 2 marks)

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5 Which isoelectronic ion has the largest radius?

- ☐ A Ca^{2+}
- ☐ B Cl^-
- ☐ C K^+
- ☐ D S^{2-}

(Total for Question 5 = 1 mark)

6 0.100 mol of sodium nitrate dissolves in deionised water to form 250 cm^3 of solution.

What is the solution concentration, in g dm^{-3} ?

[Data: NaNO_3 molar mass = 85.0 g mol^{-1}]

- ☐ A 0.034
- ☐ B 0.400
- ☐ C 8.50
- ☐ D 34.0

(Total for Question 6 = 1 mark)

7 Which of the giant lattices of carbon atoms contain flat hexagonal rings?

- ☐ A diamond only
- ☐ B graphene only
- ☐ C graphite only
- ☐ D graphene and graphite only

(Total for Question 7 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



8 The first ionisation energy for hydrogen is 1312 kJ mol^{-1} .

What is the ionisation energy, in **joules**, that is needed per atom of hydrogen?

[Data: Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$]

- ☐ A 1.09×10^{-18}
- ☐ B 2.18×10^{-18}
- ☐ C 1.09×10^{-21}
- ☐ D 2.18×10^{-21}

(Total for Question 8 = 1 mark)

9 Which molecule is polar?

- ☐ A BeCl_2
- ☐ B NCl_3
- ☐ C CCl_4
- ☐ D PCl_5

(Total for Question 9 = 1 mark)

10 Zinc has electrons in s, p and d orbitals.

How many electrons **in total** does zinc have in p orbitals?

- ☐ A 12
- ☐ B 10
- ☐ C 8
- ☐ D 6

(Total for Question 10 = 1 mark)

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11 A sample of 6.300 g of cerium reacted completely with 1.439 g of oxygen gas.

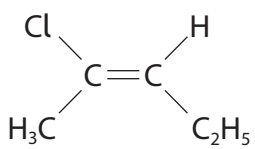
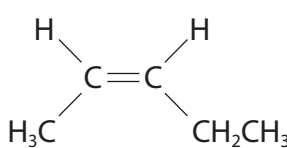
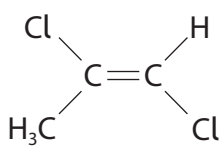
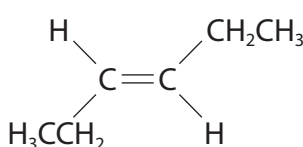
What is the formula of the oxide formed in this reaction?

[Data: A_r Ce = 140.1 O = 16.0]

- ☐ A CeO_4
- ☐ B Ce_2O_3
- ☐ C CeO_2
- ☐ D Ce_3O_4

(Total for Question 11 = 1 mark)

12 Which compound can only be named using the *E-Z* naming system and **not** using the *cis-* and *trans-* naming system?

- ☐ A 
- ☐ B 
- ☐ C 
- ☐ D 

(Total for Question 12 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

13 Free radical substitution is the mechanism of the reaction between methane and chlorine.

(a) Which drawing of curly half-arrows shows initiation?

(1)



(b) Which equation is **not** a possible propagation step in the reaction?

(1)



(c) What differentiates a termination step from a propagation step?

(1)

- ☐ **A** covalent bonds are formed
- ☐ **B** heterolytic fission occurs
- ☐ **C** no free radicals are formed
- ☐ **D** ultraviolet radiation is not needed

(Total for Question 13 = 3 marks)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

- 14 Ionisation energies provide information about the orbitals in the electronic structures of atoms.

(a) State what is meant by the term 'orbital'.

(2)

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(b) Explain the trend in first ionisation energies down Group 1.

(4)

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- (c) Explain how the changes in the first four successive ionisation energies of calcium indicate the group to which it belongs.

(2)

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- (d) Write the equation for the **second** ionisation energy of fluorine. Include state symbols.

(2)

- (e) The **first** ionisation energy of nitrogen is $+1402 \text{ kJ mol}^{-1}$.

Predict an approximate value for the first ionisation energy of oxygen. Justify your answer.

(3)

Value kJ mol^{-1}

Justification

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(f) The first ionisation energy of magnesium and of aluminium are shown.

Element	First ionisation energy / kJ mol^{-1}
Magnesium	+738
Aluminium	+578

Explain why the first ionisation energy of aluminium is less than that of magnesium.

(2)

(Total for Question 14 = 15 marks)

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15 Propane and butane are used as fuels in portable heaters. They are stored under pressure in cylinders as liquids. When the cylinder valve is opened, the decrease in pressure causes the liquid fuel to change into a gas.

(a) A gas cylinder contains 18.4 dm^3 of liquid propane, C_3H_8 .

Calculate the volume of propane gas that would be produced from this quantity of liquid propane at 101 kPa and 25°C .

Include units in your answer. You **must** show your working.

Use the ideal gas equation, $pV = nRT$.

[Data: $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ Density of liquid propane = 0.585 g cm^{-3}]

(4)

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(b) Gas cylinders are made of metal.

Explain, with reference to structure and bonding, why these gas cylinders can withstand the high pressures.

(2)

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(c) Complete combustion of butane produces more carbon dioxide than the complete combustion of propane, per mole of fuel.

- (i) Write an equation for the complete combustion of propane.
State symbols are not required.

(1)

- (ii) Determine the increase in volume, in **dm³**, of carbon dioxide gas produced per mole of butane compared to per mole of propane on complete combustion.

Use $24 \text{ dm}^3 \text{ mol}^{-1}$ for the molar volume of carbon dioxide gas.

(1)

- (iii) State an environmental problem which arises from the use of propane and butane as fuels.

(1)

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- (d) Incomplete combustion of propane produces carbon monoxide, which is a serious health hazard. The UK's Health and Safety Executive has imposed a maximum workplace exposure limit. This limit is 20 ppm of carbon monoxide, by volume, during an 8-hour period.

- (i) A small workroom has a volume of 50.2 m^3 .

Calculate the **maximum** number of carbon monoxide molecules allowed in the workroom if a person is present for 8 hours.

[Data: Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$
Molar gas volume = $24 \text{ dm}^3 \text{ mol}^{-1}$]

(3)

- (ii) Suggest **two** steps a person could take to reduce the risk associated with the hazardous carbon monoxide whilst working in this room.

(2)

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(Total for Question 15 = 14 marks)



- (d) Both pent-1-ene and pent-2-ene react with steam in the presence of an acid catalyst to produce alcohols.

Explain, by referring to the addition of steam, how both alkenes can produce the same alcohol but can also produce different alcohols.
Include names and structures of all three alcohols.

(5)

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- (e) Draw **two** repeat units of poly(pent-2-ene).

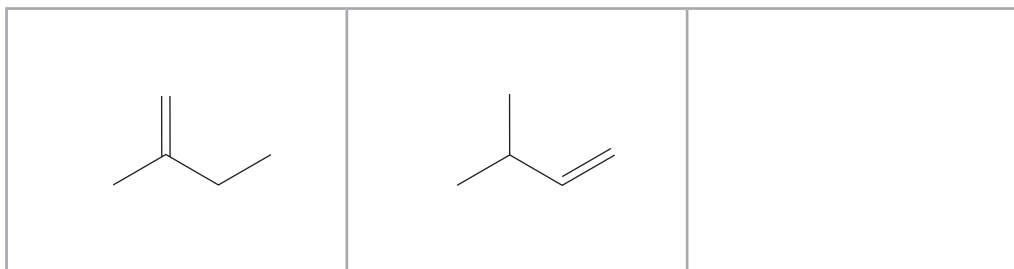
(1)



- (f) There are three branched alkenes with the molecular formula C_5H_{10} .
The skeletal formulae of two of these are shown.

Draw the **skeletal** formula of the other branched alkene of C_5H_{10} .

(1)



- (g) Five cycloalkane molecules have the molecular formula C_5H_{10} .

(i) Describe the result when bromine is added to cyclopentane in the dark.

(1)

- (ii) Draw the structure of **three** of the other cycloalkane isomers of C_5H_{10} .
Do **not** draw cyclopentane.

(2)

(Total for Question 16 = 16 marks)

17 This question is about the salts ammonium sulfate and copper(II) sulfate.

(a) Ammonium sulfate has the formula $(\text{NH}_4)_2\text{SO}_4$.

Ammonium salts contain the ammonium ion NH_4^+ . This ion is formed when ammonia forms a dative covalent bond with a proton.

Explain, using electron-pair repulsion theory, how the ammonia molecule and the ammonium ion have different bond angles and shapes.

(4)

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(b) Copper(II) sulfate is an ionic compound.

- (i) Describe an experiment which would demonstrate the movement of the copper(II) ions in an aqueous solution of this salt.

(3)

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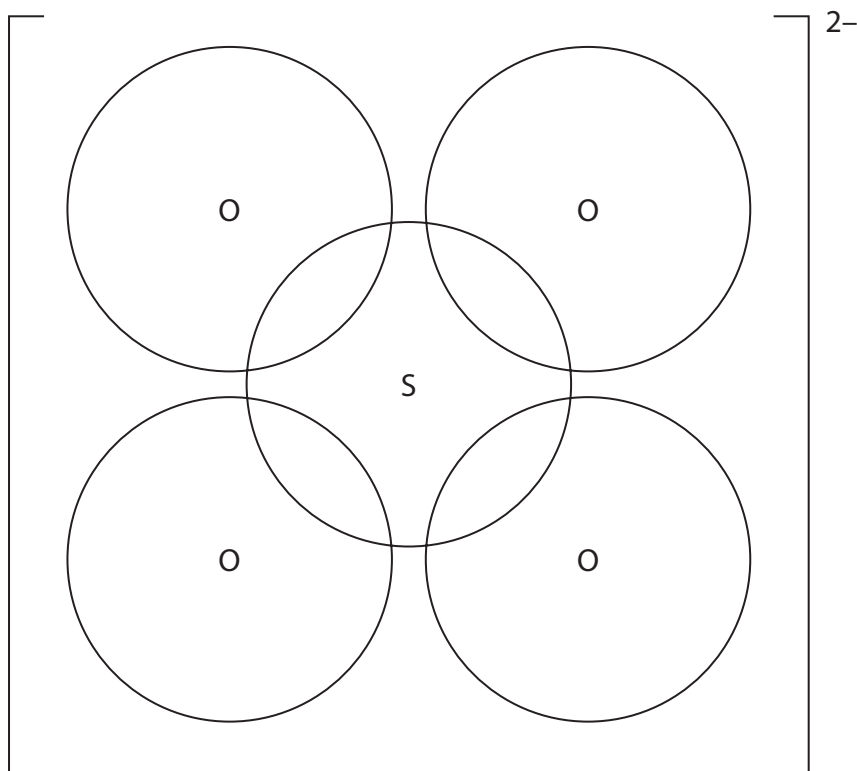
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- (ii) Complete the dot-and-cross diagram of the sulfate ion.
Use dots (•) for the sulfur electrons, crosses (×) for the oxygen electrons and triangles (▲) for the extra electrons.

(2)



- (c) The double salt, $(\text{NH}_4)_2\text{Cu}(\text{SO}_4)_2$, can be made by adding ammonium sulfate solution to aqueous copper(II) sulfate. The equation for this preparation is shown.



The double salt was prepared by:

- dissolving 3.35 g of ammonium sulfate in 25 cm^3 of deionised water
- dissolving 3.96 g of copper(II) sulfate in 25 cm^3 of deionised water
- adding the two solutions together, heating and then leaving to crystallise

- (i) Calculate which of the salts was in excess.

(3)



- (ii) The crystalline salt prepared is hydrated and has the formula $(\text{NH}_4)_2\text{Cu}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. The mass collected was 9.52 g.

Calculate the percentage yield of the double salt from this preparation.

(3)

(Total for Question 17 = 15 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

1.0

H

hydrogen

1

10.8

B

boron

5

27.0

Al

aluminium

13

69.7

Ga

gallium

31

114.8

In

indium

49

204.4

Tl

thallium

81

12.0

C

carbon

6

28.1

Si

silicon

14

72.6

Ge

germanium

32

118.7

Sn

tin

50

207.2

Pb

lead

82

14.0

N

nitrogen

7

31.0

P

phosphorus

15

74.9

As

arsenic

33

121.8

Sb

antimony

51

209.0

Bi

bismuth

83

16.0

O

oxygen

8

32.1

S

sulfur

16

79.0

Se

selenium

34

127.6

Te

tellurium

52

209.0

Po

polonium

84

19.0

F

fluorine

9

35.5

Cl

chlorine

17

79.9

Br

bromine

35

126.9

I

iodine

53

210.0

At

astatine

85

20.2

Ne

neon

10

39.9

Ar

argon

18

83.8

Kr

krypton

36

131.3

Xe

xenon

54

222.0

Rn

radon

86

4.0

He

helium

2

18.0

138.9

Cs

caesium

55

223.0

Fr

francium

87

137.3

Ba

barium

56

226.0

Ra

radium

88

138.9

La*

lanthanum

57

227.0

Ac*

actinium

89

88.9

Y

yttrium

39

87.6

Sr

strontium

38

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

68.0

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

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

127.6

Te

tellurium

52

131.3

Xe

xenon

54

137.3

Cs

caesium

55

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

209.0

Po

polonium

84

210.0

At

astatine

85

222.0

Rn

radon

86

223.0

Fr

francium

87

226.0

Ra

radium

88

227.0

Ac*

actinium

89

228.0

Th

thorium

90

232.0

Pa

protactinium

91

238.0

U

uranium

92

238.0

Np

neptunium

93

242.0

Pu

plutonium

94

244.0

Am

americium

95

247.0

Cm

curium

96

247.0

Bk

berkelium

97

251.0

Cf

californium

98

252.0

Es

einsteinium

99

257.0

Fm

fermium

100

259.0

Md

mendelevium

101

261.0

No

nobelium

102

265.0

Lr

lawrencium

103

267.0

Rf

rutherfordium

104

269.0

Db

dubnium

105

271.0

Sg

seaborgium

106

272.0

Bh

bohrium

107

277.0

Hs

hassium

108

285.0

Mt

meitnerium

109

289.0

Ds

darmstadtium

110

290.0

Rg

roentgenium

111

294.0

Uu

unbinilium

112

295.0

Uub

unbibium

113

299.0

Uut

unbistrium

114

301.0

Uuq

unbihexium

115

304.0

Uubk

unbihexium

116

307.0

Uuh

unbohrium

117

310.0

Uus

unsextium

118

315.0

Uuhc

unhassium

119

318.0

Uuqk

unquincium

120

321.0

Uuhf

unheptium

121

324.0

Uuqk

unquincium

122

327.0

Uuhg

unhassium

123

330.0

Uuqk

unquincium

124

333.0

Uuhh

unhassium

125

336.0

Uuqk

unquincium

126

339.0

Uuh

unbohrium

127

343.0

Uuqk

unquincium

128

346.0

Uuh

unbohrium

129

350.0

Uuqk

unquincium

130

353.0

Uuh

unbohrium

131

357.0

Uuqk

unquincium

132

360.0

Uuh

unbohrium

133

364.0

Uuqk

unquincium

134

367.0

Uuh

unbohrium

135

371.0

Uuqk

unquincium

136

374.0

Uuh

unbohrium

137

378.0

Uuqk

unquincium

138

381.0

Uuh

unbohrium

139

385.0

Uuqk

unquincium

140

388.0

Uuh

unbohrium

141

392.0

Uuqk

unquincium

142

395.0

Uuh

unbohrium

143

399.0

Uuqk

unquincium

144

402.0

Uuh

unbohrium

145

406.0

Uuqk

unquincium

146

409.0

Uuh

unbohrium

147

413.0

Uuqk

unquincium

148

416.0

Uuh

unbohrium

149

420.0

Uuqk

unquincium

150

423.0

Uuh

unbohrium

151

427.0

Uuqk

unquincium

152

430.0

Uuh

unbohrium

153

434.0

Uuqk

unquincium

154

437.0

Uuh

unbohrium

155

441.0

Uuqk

unquincium

156

444.0

Uuh

unbohrium

157

448.0

Uuqk

unquincium

158

451.0

Uuh

unbohrium

159

455.0

Uuqk

unquincium

160

458.0

Uuh

unbohrium

161

462.0

Uuqk

unquincium

162

465.0

Uuh

unbohrium

163

469.0

Uuqk

unquincium

164

472.0

Uuh

unbohrium

165

476.0

Uuqk

unquincium

166

479.0

Uuh

unbohrium

167

483.0

Uuqk

unquincium

168

486.0

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493.0

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497.0

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500.0

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504.0

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174

507.0

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511.0

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176

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612.0

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619.0

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623.0

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626.0

Uuh

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637.0

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700.0

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703.0

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707.0

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unquincium

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710.0

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714.0

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717.0

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724.0

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728.0

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731.0

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738.0

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unbohrium

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745.0

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752.0

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759.0

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763.0

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766.0

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770.0

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833.0

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840.0

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843.0

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847.0

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861.0

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864.0

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1004.0

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1008.0

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unquincium

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1011.0

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1015.0

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unquincium

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1018.0

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unbohrium

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1022.0

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1029.0

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1032.0

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1036.0

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326

1039.0

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327

1043.0

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unquincium

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1046.0

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unbohrium

32

DO NOT WRITE IN THIS AREA