Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary

Unit 1: The Core Principles of Chemistry

Thursday 14 January 2010 – Morning
Time: 1 hour 30 minutes

Paper Reference
6CH01/01

Candidates may use 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 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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

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

Turn over ▶

N35131A

7/7/5/3/

N 3 5 1 3 1 A 0 1 2 4

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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 The isotopes of magnesium, $^{24}_{12}Mg$ and $^{25}_{12}Mg$, both form ions with charge 2+. Which of the following statements about these ions is true?

☒ **A** Both ions have electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2$.

☒ **B** $^{25}_{12}Mg^{2+}$ has more protons than $^{24}_{12}Mg^{2+}$.

☒ **C** The ions have the same number of electrons but different numbers of neutrons.

☒ **D** The ions have the same number of neutrons but different numbers of protons.

(Total for Question 1 = 1 mark)

2 Chlorine has two isotopes with relative isotopic mass 35 and 37. Four *m/z* values are given below. Which will occur in a mass spectrum of chlorine gas, Cl_2, from an ion with a single positive charge?

☒ **A** 35.5

☒ **B** 36

☒ **C** 71

☒ **D** 72

(Total for Question 2 = 1 mark)

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

3 The human body contains around 0.025 g of iodine molecules, I_2. Which of the following shows the number of iodine **atoms** in 0.025 g of I_2?

The Avogadro constant is $6.02 \times 10^{23}\,mol^{-1}$.

☒ **A** $\frac{0.025}{126.9} \times 6.02 \times 10^{23}$

☒ **B** $\frac{0.025}{253.8} \times 6.02 \times 10^{23}$

☒ **C** $\frac{253.8}{0.025} \times 6.02 \times 10^{23}$

☒ **D** $\frac{126.9}{0.025} \times 6.02 \times 10^{23}$

(Total for Question 3 = 1 mark)

---

4 Which equation represents the reaction for which the enthalpy change is the standard enthalpy change of formation, $\Delta H_f^{\ominus}$, of sodium nitrate, $NaNO_3$?

☒ **A** $2Na(s) + N_2(g) + 3O_2(g) \rightarrow 2NaNO_3(s)$

☒ **B** $Na(s) + ½N_2(g) + 1½O_2(g) \rightarrow NaNO_3(s)$

☒ **C** $Na(s) + N(g) + 3O(g) \rightarrow NaNO_3(s)$

☒ **D** $Na(g) + ½N_2(g) + 1½O_2(g) \rightarrow NaNO_3(g)$

(Total for Question 4 = 1 mark)

---

5 Which equation represents the reaction for which the enthalpy change, ΔH, is the mean bond enthalpy of the C–H bond?

☒ **A** $¼CH_4(g) \rightarrow ¼C(g) + H(g)$

☒ **B** $CH_4(g) \rightarrow C(s) + 2H_2(g)$

☒ **C** $CH_4(g) \rightarrow C(g) + 4H(g)$

☒ **D** $CH_4(g) \rightarrow C(g) + 2H_2(g)$

(Total for Question 5 = 1 mark)

6 The first ionization energies, in kJ mol^{-1}, of four elements with consecutive atomic numbers are shown below.

A 1680

B 2080

C 496

D 738

(a) Which element could be an inert gas?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which element could be X in a covalent compound with formula HX?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which element could be Y in an ionic compound with formula YH_2?

(1)

☒ **A**

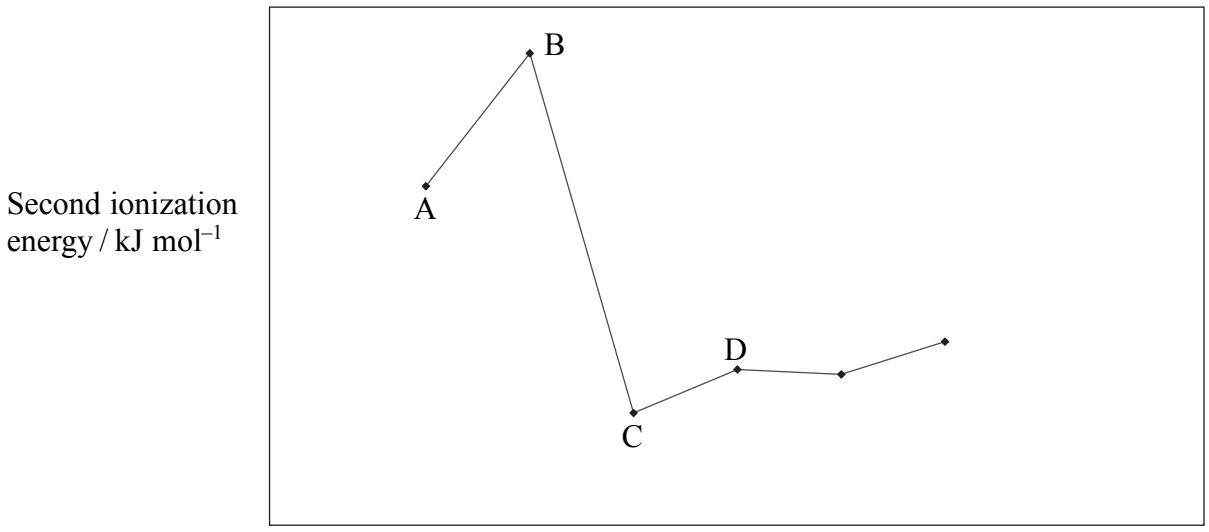
☒ **B**

☒ **C**

☒ **D**

(Total for Question 6 = 3 marks)

7 The graph below shows the **second** ionization energy of a series of elements with consecutive atomic numbers.



Which element could be lithium?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 1 mark)

8 The first five ionization energies, in kJ mol^{-1}, of aluminium are

578 1817 2745 11 578 14 831

The orbitals from which the first five electrons are removed during ionization, starting with the first electron, are

☒ **A** 1s 2s 2p 3s 3p

☒ **B** 1s 1s 2s 2s 2p

☒ **C** 3p 3s 2p 2s 1s

☒ **D** 3p 3s 3s 2p 2p

(Total for Question 8 = 1 mark)

9 Going across the Periodic Table from sodium to aluminium,

☒ **A** the melting temperature increases.

☒ **B** the radius of the atom increases.

☒ **C** the radius of the metal ion increases.

☒ **D** the bonding in the element changes from metallic to covalent.

(Total for Question 9 = 1 mark)

10 Going down Group 1 from lithium to rubidium

☒ **A** the radius of the atom decreases.

☒ **B** the radius of the ion decreases.

☒ **C** the first ionization energy decreases.

☒ **D** the polarizing power of the ion increases.

(Total for Question 10 = 1 mark)

11 A drop of concentrated nickel(II) sulfate solution, which is green, is placed on moist filter paper on a microscope slide and the ends of the slide are connected to a 24 V DC power supply. After ten minutes,

☒ **A** a blue colour has moved towards the negative terminal and a yellow colour towards the positive terminal.

☒ **B** a blue colour has moved towards the positive terminal and a yellow colour towards the negative terminal.

☒ **C** a green colour has moved towards the negative terminal but there is no other visible change.

☒ **D** a green colour has moved towards the positive terminal but there is no other visible change.

(Total for Question 11 = 1 mark)

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

12 The bonding in magnesium oxide, MgO, is

☒ **A** ionic.

☒ **B** metallic and ionic.

☒ **C** ionic and covalent.

☒ **D** metallic and covalent.

(Total for Question 12 = 1 mark)

13 Which of the following mixtures could **not** form when octane, C_8H_{18}, is cracked?

☒ **A** propane + pentene

☒ **B** butane + butene

☒ **C** pentane + propene

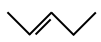
☒ **D** heptane + ethene

(Total for Question 13 = 1 mark)

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

14 This question is about the organic compounds with skeletal formulae as shown:

A 

B 

C 

D 

(a) Which compound is 2-methylpropane?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which compound has the molecular formula C_5H_{12}?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which compounds are isomers?

(1)

☒ **A** compound **A** and compound **C**

☒ **B** compound **B** and compound **C**

☒ **C** compound **B** and compound **D**

☒ **D** compound **C** and compound **D**

(d) Which compound reacts with acidified potassium manganate(VII) to form a diol?

(1)

☒ **A**

☒ **B**

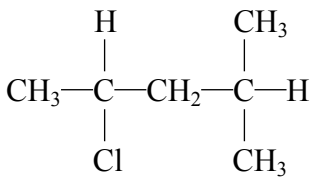
☒ **C**

☒ **D**

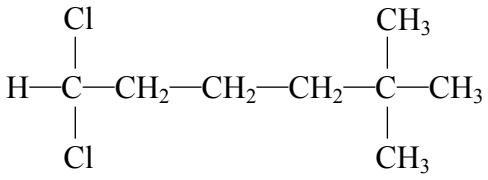
(Total for Question 14 = 4 marks)

15 The structural formula of 5-chloro-2,2-dimethylhexane is

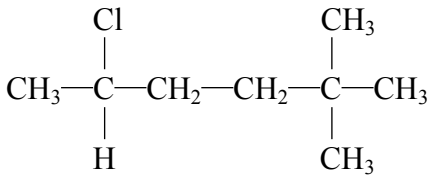
☒ **A**



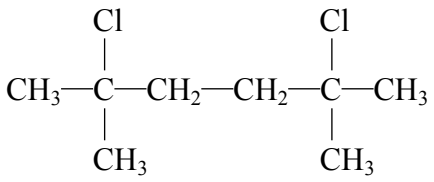
☒ **B**



☒ **C**



☒ **D**



(Total for Question 15 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

16 Magnesium chloride can be made by reacting solid magnesium carbonate, $MgCO_3$, with dilute hydrochloric acid.

(a) Write an equation for the reaction, including state symbols.

(2)

(b) Give TWO observations you would make when the reaction is taking place.

(2)

(c) In an experiment to make crystals of hydrated magnesium chloride, $MgCl_2.6H_2O$, magnesium carbonate was added to 25 cm^3 of hydrochloric acid with concentration 2.0 mol dm^{-3}. The molar mass of magnesium carbonate is 84.3 g mol^{-1}.

(i) How many moles of acid are used in the reaction?

(1)

(ii) What mass of magnesium carbonate, in grams, reacts with this amount of acid?

(1)

(iii) Suggest why slightly more than this mass of magnesium carbonate is used in practice.

(1)

(iv) How would you separate the magnesium chloride solution from the reaction mixture in (iii)?

(1)

(v) The magnesium chloride solution was left to crystallise. The crystals were separated and dried carefully. A sample of 3.75 g of hydrated crystals, $MgCl_2.6H_2O$, which have molar mass 203.3 g mol^{-1}, was obtained. Calculate the percentage yield of this reaction.

(2)

(vi) Give ONE reason why the yield of crystals is less than 100%, even when pure compounds are used in the preparation.

(1)

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.....

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(d) Lattice energies can be measured using the Born-Haber cycle, or calculated from electrostatic theory. Lattice energies of magnesium chloride and magnesium iodide are shown below.

Salt	Lattice energy from Born-Haber cycle using experimental data / kJ mol^{-1}	Lattice energy from electrostatic theory / kJ mol^{-1}
$MgCl_2$	–2526	–2326
MgI_2	–2327	–1944

(i) What does this data indicate about the bonding in magnesium chloride?

(1)

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*(ii) Explain why there is a greater difference between the experimental (Born-Haber) and theoretical lattice energies for magnesium iodide, MgI_2, compared with magnesium chloride.

(2)

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(e) Blood plasma typically contains 20 parts per million (ppm) of magnesium, by mass.

(i) Calculate the mass of magnesium, in grams, present in 100 g of plasma.

(1)

(ii) Magnesium chloride can be used as a supplement in the diet to treat patients with low amounts of magnesium in the blood. Suggest ONE property which makes it more suitable for this purpose than magnesium carbonate.

(1)

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.....

(Total for Question 16 = 16 marks)

17 Sulfamic acid is a white solid used by plumbers as a limescale remover.

(a) Sulfamic acid contains 14.42% by mass of nitrogen, 3.09% hydrogen and 33.06% sulfur. The remainder is oxygen.

(i) Calculate the empirical formula of sulfamic acid.

(3)

(ii) The molar mass of sulfamic acid is 97.1 g mol^{-1}. Use this information to deduce the molecular formula of sulfamic acid.

(1)

(b) A solution of sulfamic acid contains hydrogen ions. The hydrogen ions react with magnesium to produce hydrogen gas. In an experiment, a solution containing 5.5×10^{-3} moles of sulfamic acid was reacted with excess magnesium. The volume of hydrogen produced was 66 cm^3, measured at room temperature and pressure.

(i) Draw a labelled diagram of the apparatus you would use to carry out this experiment, showing how you would collect the hydrogen produced and measure its volume.

(2)

(ii) Calculate the number of moles of hydrogen, H_2, produced in this reaction.

[The molar volume of a gas is 24 $dm^3 mol^{-1}$ at room temperature and pressure]

(1)

(iii) Show that the data confirms that each mole of sulfamic acid produces one mole of hydrogen ions in solution.

(2)

(c) Plumbers use sulfamic acid powder for descaling large items such as boilers. Sulfamic acid acts as a descaler because the hydrogen ions react with carbonate ions in limescale.

(i) Write an ionic equation for the reaction of hydrogen ions with carbonate ions. State symbols are **not** required.

(1)

(ii) Suggest ONE reason why sulfamic acid is considered less hazardous than hydrochloric acid as a descaler.

(1)

(Total for Question 17 = 11 marks)

18 This question is about hexane, C_6H_{14}, and hex-1-ene, C_6H_{12}.

(a) What test would you use to distinguish between hexane and hex-1-ene? Give the results of the test for each substance.

(2)

Test: .....

.....

Result with hexane: .....

.....

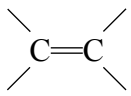
Result with hex-1-ene: .....

.....

(b) Hex-1-ene has a number of isomers, including two stereoisomers of hex-2-ene.

(i) Complete the formula to show the structure of *E*-hex-2-ene.

(1)



*(ii) Explain why stereoisomerism can occur in alkenes, and why hex-2-ene has stereoisomers but hex-1-ene does not.

(2)

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(c) The enthalpy change of combustion of hexane was measured using a spirit burner to heat a known mass of water in a calorimeter. The temperature rise of the water was measured. The results of the experiment are shown below.

Mass of hexane burnt	0.32 g
Mass of water in calorimeter	50 g
Initial temperature of water	22 °C
Final temperature of water	68 °C

The specific heat capacity of water is 4.18 J g^{-1} °C^{-1}.

(i) Calculate the energy in joules produced by burning the hexane. Use the expression

energy transferred = mass × specific heat capacity × temperature change.

(1)

(ii) Calculate the enthalpy change of combustion of hexane. The mass of 1 mole of hexane is 86 g.

Give your answer to TWO significant figures. Include a sign and units in your answer.

(3)

(iii) The value for the enthalpy change of combustion in this experiment is different from the value given in data books. Suggest TWO reasons for this difference.

(2)

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.....

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.....

(iv) A student suggested that the results would be more accurate if a thermometer which read to 0.1°C was used. Explain why this would **not** improve the accuracy of the result. A calculation is **not** required.

(1)

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.....

(d) Hex-1-ene can be converted to hexane in the following reaction.

$$C_6H_{12}(l) + H_2(g) \rightarrow C_6H_{14}(l)$$

(i) What catalyst is used in this reaction?

(1)

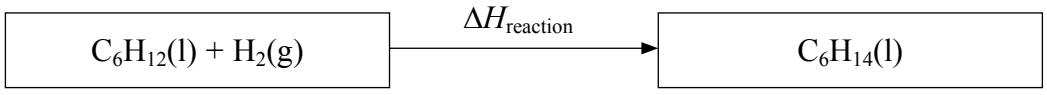
.....

(ii) The enthalpy change of this reaction $\Delta H_{reaction}$ can be calculated from the following enthalpy changes of combustion.

Substance	Enthalpy change of combustion /kJ mol^{-1}
Hex-1-ene, C_6H_{12}	–4003
Hydrogen, H_2	–286
Hexane, C_6H_{14}	–4163

Complete the Hess cycle by adding labelled arrows. Use your cycle to calculate the enthalpy change $\Delta H_{reaction}$.

(3)



$\Delta H_{reaction}$ = ... kJ mol^{-1}

(iii) The enthalpy change for the reaction of some other alkenes with hydrogen is shown below.

Reaction	Standard enthalpy change / kJ mol^{-1}
$C_3H_6 + H_2 \rightarrow C_3H_8$	–125
$C_4H_8 + H_2 \rightarrow C_4H_{10}$	–126
$C_5H_{10} + H_2 \rightarrow C_5H_{12}$	–126

Explain why the values are so similar.

(1)

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.....

.....

(Total for Question 18 = 17 marks)

19 Chloroethane, C_2H_5Cl, can be made from either ethane or ethene.

(a) (i) What reagent and condition would be used to make chloroethane from **ethane**?

(2)

Reagent.....

Condition.....

(ii) State the type of reaction and mechanism by which this reaction occurs.

(2)

.....

.....

(b) (i) What reagent would be used to make chloroethane from **ethene**?

(1)

.....

(ii) Show, in full, the mechanism for this reaction in which **ethene** is converted to chloroethane.

(3)

(c) Which method of making chloroethane has

(3)

- a higher atom economy? .....
- a higher percentage yield? .....

Explain your answers.

Higher atom economy .....

.....

.....

Higher percentage yield .....

.....

(d) The compound chloroethene, $CH_2{=}CHCl$, forms an addition polymer.

(i) Draw a diagram, using dots or crosses, to show the arrangement of electrons in chloroethene. Only the outer shell electrons need be shown.

(2)

(ii) Chloroethene can form an addition polymer. Write the displayed formula of poly(chloroethene) showing two repeat units.

(1)

*(iii) Poly(chloroethene) is commonly known as PVC. Almost a quarter of the PVC which is manufactured is used to make water pipes, which were formerly made of metal.

Give TWO factors which have to be considered when deciding which material, PVC or metal, contributes to more sustainable uses of resources in the long term.

(2)

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(Total for Question 19 = 16 marks)

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

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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

* Lanthanide 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
* Actinide series	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