higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(Second Paper)
NQF LEVEL 3

(10021003)

13 March 2018 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 9 pages, 1 data sheet, 1 periodic table and 1 graph paper.

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TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write your EXAMINATION NUMBER (and CENTRE NUMBER if applicable) in the space provided in the ANSWER BOOK.
5. Cross out any work that you do NOT want to be marked.
6. Write with blue or black ink only.
7. ALL final answers must be accurately approximated to TWO decimal places.
8. Write neatly and legibly.

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SECTION A

QUESTION 1

Give ONE term for each of the following descriptions. Write only the term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 A chemical mist made up of water vapour and pollutants which leads to acid rain

1.2 A type of chemical reaction in which a compound splits or breaks apart into two or more substances

1.3 The minimum energy needed by the reactants in order to transform into products

1.4 An intermolecular force that accounts for the liquid phase of helium

1.5 The law that states that the deformation of a material is directly proportional to the force applied on it until the material exceeds its elastic limit

(5 × 1) **[5]**

QUESTION 2

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–J) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Type of chemical bond formed between a metal and a nonmetal	A	metallic bond
		B	Charles' law
2.2	Type of bond found between atoms in sodium	C	CO_2
2.3	Change of state without change in temperature	D	intermolecular forces
		E	covalent bond
2.4	Gas from the air that dissolves in rainwater to form carbonic acid	F	latent heat
2.5	At constant pressure, the volume of a gas is directly proportional to the absolute temperature of the gas	G	N_2
		H	viscosity heat
		I	ionic bond
		J	Boyle's law

(5 × 1) **[5]**

QUESTION 3

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1–3.5) in the ANSWER BOOK.

3.1 The boiling point of a liquid is the temperature at which the vapour pressure of the liquid is less than the external pressure.

3.2 The ammonia molecule has a linear shape.

3.3 28 g of nitrogen gas contains 2 moles of nitrogen atoms.

3.4 The nitrogen gas used in the Haber process is very unreactive, unless high temperatures or high pressures are applied.

3.5 The enthalpy change (ΔH) of a reaction is equal to the difference between the potential energy of the products and the potential energy of the reactants.

(5 × 2) **[10]**

QUESTION 4

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (4.1–4.5) in the ANSWER BOOK.

4.1 Which ONE of the following industrial gases is a highly flammable, clean fuel and the main component of natural gas:

A NH_3
B SO_2
C CH_4
D SO_2

4.2 A change in temperature of 30 ˚C is exactly the same as . . .

A (273 + 30) K.
B (273 – 30) K.
C 30 K.
D (30 – 273) K.

4.3 When snow forms, liquid water at 0 ˚C is converted into solid water crystals at 0 ˚C.

During this process …

A the potential energy of the water molecules increases.
B the potential energy of the water molecules decreases.
C the kinetic energy of the water molecules increases.
D the kinetic energy of the water molecules decreases.

4.4 When a catalyst is added in a chemical reaction, it speeds up the rate of the reaction by …

A increasing the potential energy of the reactants.
B decreasing the kinetic energy of the reactants.
C increasing the activation energy.
D reducing the activation energy.

4.5 Which ONE of the following is a combination reaction:

A $S + O_2 \longrightarrow SO_2$
B $C\ell_2 + NaI \longrightarrow NaC\ell + I_2$
C $Zn + 2HC\ell \longrightarrow ZnC\ell_2 + H_2$
D $Zn + CuSO_4 \longrightarrow Cu + ZnSO_4$

(3 × 5) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5

5.1 Define the following terms:

5.1.1 Deformation

5.1.2 Hardness

(2 × 2) (4)

5.2 Calculate the oxidation state of iron (Fe) in the following compounds:

5.2.1 FeO

5.2.2 Fe_2O_3

(2 × 2) (4)

5.3 The valence electron structures of elements P, Q, R and T are shown below.

P : $2s^1$
Q : $2s^2\ 2p^5$
R : $3s^2\ 3p^4$
T : $2s^2\ 2p^3$

Use the symbols P, Q, R and T to answer the following questions:

5.3.1 Which element is a halogen? (2)

5.3.2 Which element belongs to period 3? (2)

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5.3.3 Which element is most likely to form a cation? (2)

5.3.4 How many electrons are there in a neutral atom of T? (2)

5.3.5 What type of chemical bond occurs between atoms of Q? (2)

5.3.6 Write down the formula of the compound formed when P combines with R. (2)

[20]

QUESTION 6

6.1 Study the table below and answer the questions.

COMPOUND	MELTING POINT (˚C)	BOILING POINT (˚C)
Methane	-200	-160
Candle wax	40	80
Water	0	100

From the table above, choose the compound that:

6.1.1 Has the strongest intermolecular forces between its molecules

6.1.2 Has the highest vapour pressure

6.1.3 Has the weakest intermolecular forces

6.1.4 Is in the solid phase at 30 ˚C

(4 × 2) (8)

6.2 Tabulate TWO differences between *evaporation* and *boiling*. (2 + 2) (4)

6.3 A chemist conducts an investigation to establish the relationship between the pressure and volume of an enclosed mass of gas. The following set of results were obtained:

READING NO	PRESSURE (kPa)	VOLUME (cm^3)	PV
1	60	24,00	144 000
2	65	22,15	
3	70	20,15	
4	75	x	

6.3.1 From the results obtained, what is the relationship between pressure and volume? Give a reason for the answer. (3)

6.3.2 Name ONE factor that must be kept constant in this investigation. (2)

6.3.3 Calculate the unknown volume x in cm^3. (3)

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6.4 A learner studies the behaviour of nitrogen gas under different conditions. She finds that if the temperature of 300 cm^3 of nitrogen gas (N_2), increases from 27 ˚C to 100 ˚C then pressure increases from 100 kPa to 150 kPa.

What will the volume of the gas be at 100 ˚C and 150 kPa? (5)

[25]

QUESTION 7

7.1 When ethanol burns, the following combustion reaction takes place:

6,9 g ethanol reacts completely in excess oxygen

$C_2H_6O + 3O_2 \longrightarrow 2CO_2 + 3H_2O$

7.1.1 State the law of conservation of mass. (2)

7.1.2 Calculate the volume of CO_2 produced at STP. (5)

7.1.3 Calculate the maximum mass of H_2O than can be produced. (3)

7.2 A student performs the following chemical reaction:

$BaC\ell_{2(aq)} + Na_2SO_{4(aq)} \longrightarrow \downarrow BaSO_4 + 2NaC\ell$

7.2.1 Write down the names of the reactants. (2)

7.2.2 Write down the names of the products. (2)

7.2.3 What type of a reaction is this? Choose from combination, decomposition or single displacement. (2)

7.3 Write down the chemical formula of the product or products in the following reactions:

7.3.1 $Ca + O_2 \longrightarrow$

7.3.2 $S + O_2 \longrightarrow$

7.3.3 $H_2O_2 \longrightarrow$

(3 × 2) (6)

7.4 12,7 g zinc reacts with 7,3 g $HC\ell$ according to the following balanced chemical equation:

$$Zn + 2HC\ell \longrightarrow ZnC\ell_2 + H_2$$

Determine which substance is in excess and by how many mole. (6)

[28]

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QUESTION 8

8.1 Indicate whether the following reactions are exothermic or endothermic:

8.1.1 $3H_2 + N_2 \longrightarrow 2NH_3$ + heat

8.1.2 $2SO_2 + O_2 \longrightarrow 2SO_3 \quad \Delta H < 0$

(2 × 2) (4)

8.2 The following hypothetical reaction that has an activation energy of 70 kJ.mol^{-1} and enthalpy of -50 kJ.mol^{-1}:

$A_2 + B_2 \longrightarrow 2AB \quad \Delta H = -50$ kJ.mol^{-1}

Assume that the potential energy of the reactants is 0 kJ.mol^{-1}.

8.2.1 Sketch a graph showing the potential energy changes during the course of the reaction.

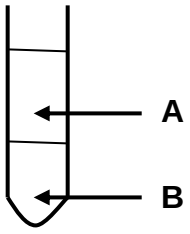
- Label the axes.
- Indicate the potential energy of the reactants, activated complex and products. (5)

8.2.2 What is the activation energy for the reverse reaction? (2)

8.3 A student added chlorine water to a test tube containing a solution of potassium iodide. She observed a colour change.

She then added carbon tetra chloride to the contents of the test tube.

She shook the test tube and observed two separate layers. One layer was coloured and the other layer was clear.



8.3.1 Write a balanced equation for the chemical reaction that takes place. (3)

8.3.2 What colour change occurred? (2)

8.3.3 Carbon tetrachloride has a higher density than water.

Which layer, A or B, represents carbon tetrachloride? (2)

8.3.4 Which layer, A or B, has ions dissolved in it? (2)

8.3.5 Explain in terms of polarity and types of intermolecular forces why there are two liquid layers in the test tube. (5)

[25]

QUESTION 9

9.1 Define the term *air pollution*. (2)

9.2 Use chemical equations to explain how the burning of sulphur contributes to the formation of acid rain. (3)

9.3 Identify any TWO industrial gases that contribute to air pollution. (2)

9.4 Give TWO uses for each of the following industrial gases:

9.4.1 Methane

9.4.2 Hydrochloride

9.4.3 Carbon dioxide

(3 × 2) (6)

9.5 Ozone is an allotrope of oxygen and is found in the upper atmosphere. Its main purpose in the atmosphere is to filter harmful ultraviolet radiation from reaching the earth's surface.

9.5.1 What is an allotrope? (2)

9.5.2 Write the formula of ozone. (2)

[17]

TOTAL SECTION B: 115
GRAND TOTAL: 150

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DATA SHEET

TABLE 1: PHYSICAL CONSTANTS

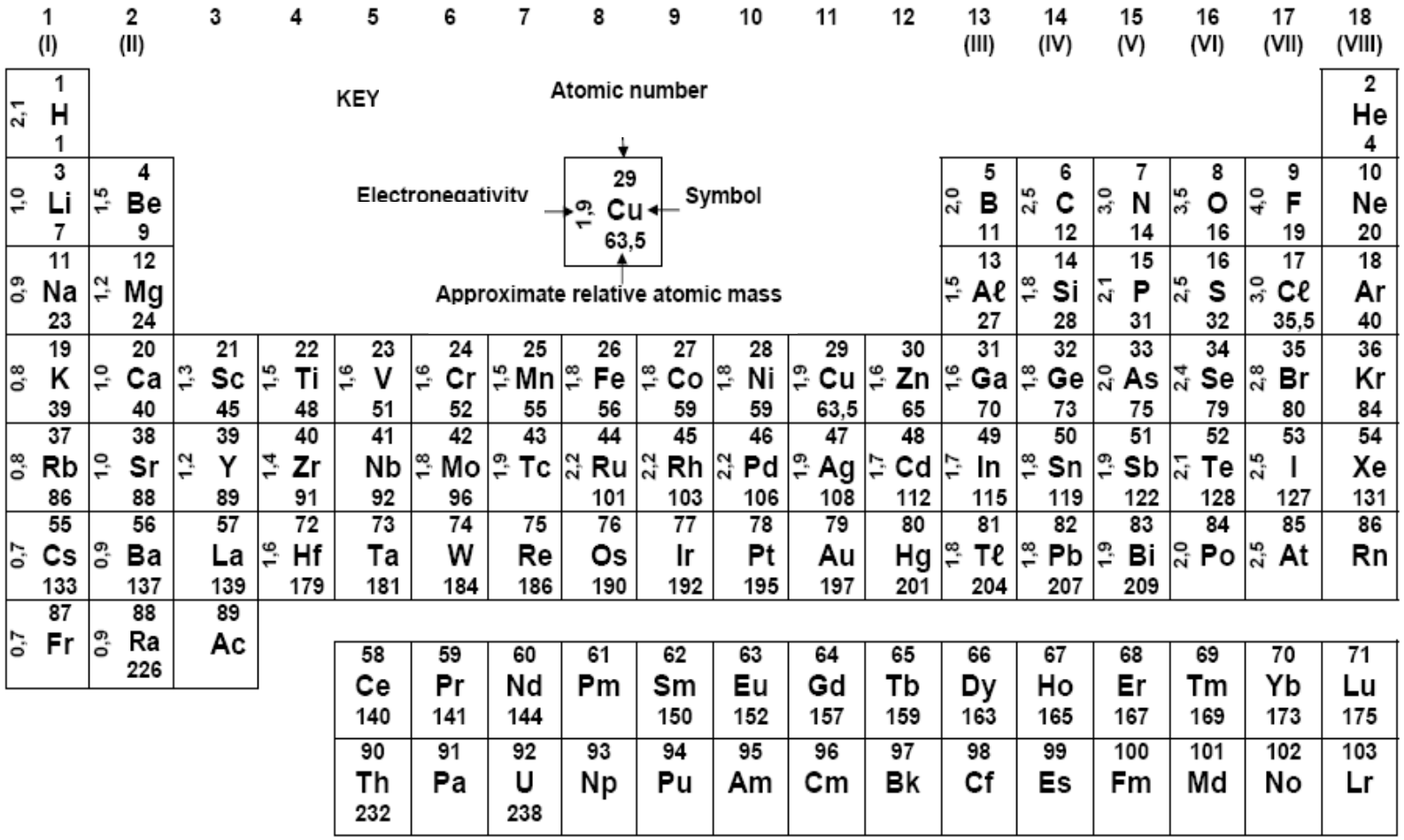
NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas volume at STP	V_m	$22{,}4\ dm^3.mol^{-1}$
Standard pressure	p^θ	$1{,}013 \times 10^5\ Pa$
Standard temperature	T^θ	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}\ C$
Molar gas constant	R	$8{,}31\ J.K^{-1}.mol^{-1}$

TABLE 2: FORMULAE

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$\frac{n_a}{n_b} = \frac{c_aV_a}{c_bV_b}$ $\quad I \quad$ $\frac{n_s}{n_b} = \frac{c_sV_s}{c_bV_b}$

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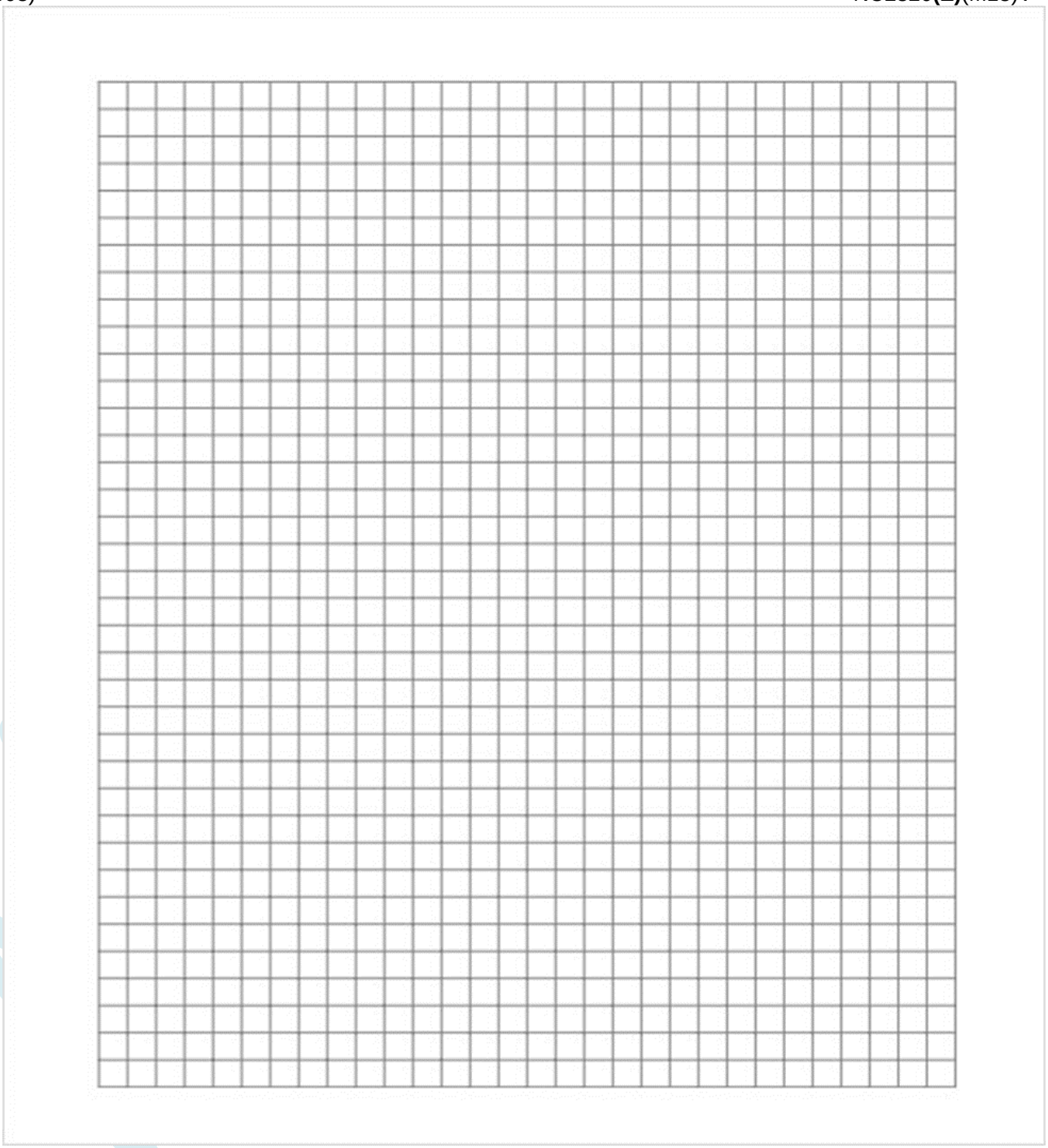
THE PERIODIC TABLE OF ELEMENTS



1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc 43	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

												58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152
												64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169
												70 Yb 173	71 Lu 175				
												90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am
												96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md
												102 No	103 Lr				

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