2020-DSE
CHEM
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2020

Candidate Number

CHEMISTRY PAPER 1

SECTION B : Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

(1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) This section consists of TWO parts, Parts I and II.

(4) Answer ALL questions in both Parts I and II. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) An asterisk (*) has been put next to the questions where one mark will be awarded for effective communication.

(6) Supplementary answer sheets will be provided on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string INSIDE this Question-Answer Book.

(7) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

* A 1 4 0 E 0 1 B *

PART I

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

1. The table below shows some information of elements **Y** and **Z**.

	Y	**Z**
Atomic number	35	53
Number of occupied electron shells in the atoms	4	5
Number of electrons in the outermost shell in the atoms	7	7

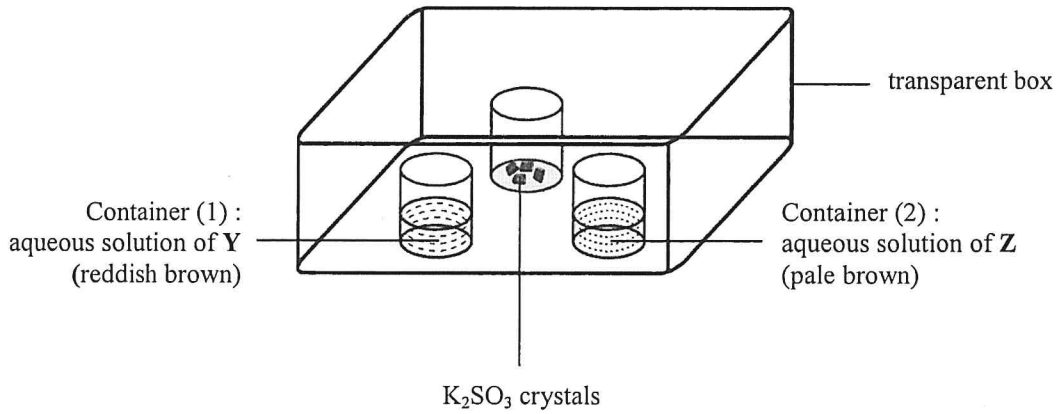
(a) State the electronic arrangement of an atom of **Y**.

(1 mark)

(b) Draw the electron diagram for a molecule of **Z**, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

(c) An experiment for **Y** and **Z** is performed as shown in the set-up below. Dilute hydrochloric acid is added to the K_2SO_3 crystals, then the whole set-up is covered with a lid.



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1. (c) (i) K_2SO_3 crystals react with dilute hydrochloric acid to give sulphur dioxide gas. Write a chemical equation for the reaction, showing all state symbols.

(ii) State the expected observation in Container (1) and write an ionic equation for the reaction involved.

(iii) It is expected that the observation in Container (2) is similar to that in Container (1). Suggest a reason for this expectation based on electronic arrangement.

(5 marks)

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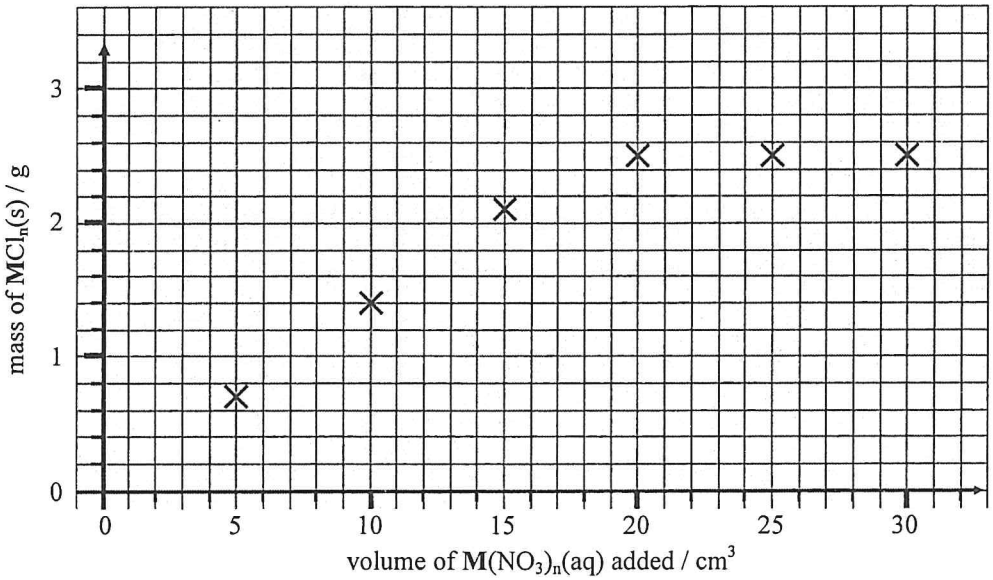
2. An experiment was performed to deduce the empirical formula of an insoluble chloride of a metal **M**. At room temperature, different volumes of a 0.50 mol dm^{-3} $\mathbf{M}(NO_3)_n(aq)$ were added to six beakers each containing 50 cm^3 of 0.36 mol dm^{-3} HCl(aq). The $\mathbf{MCl}_n(s)$ obtained in each beaker was filtered, washed, dried and weighed. The mass of $\mathbf{MCl}_n(s)$ obtained and the corresponding volume of $\mathbf{M}(NO_3)_n(aq)$ added were plotted on the graph below.



(a) Suggest why the masses of $\mathbf{MCl}_n(s)$ for the last three points in the graph are the same.

(1 mark)

(b) (i) By **sketching** on the graph above, deduce the volume of the $\mathbf{M}(NO_3)_n(aq)$ that can completely react with 50 cm^3 of 0.36 mol dm^{-3} HCl(aq).

Volume of $\mathbf{M}(NO_3)_n(aq)$ = _____ cm^3

(ii) Hence, calculate the number of moles of $\mathbf{M}(NO_3)_n(aq)$ that can completely react with the HCl(aq).

(3 marks)

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2. (c) Determine, by calculation, the empirical formula of the chloride of **M**. Hence, deduce whether **M** would be silver or lead.

(3 marks)

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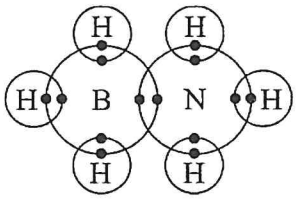
3. (a) Draw a three-dimensional diagram to represent the shape of each of the following molecules :

(i) NH_3

(ii) BH_3

(2 marks)

(b) H_3NBH_3 has a structure similar to that of ethane. Its electron diagram is shown below (showing electrons in the outermost shells only).



(i) Which of the H–B, B–N and N–H bonds would be dative covalent bond(s) ? Explain your answer.

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3. (b) (ii) Explain why H_3NBH_3 is a solid but ethane is a gas at room conditions.

(iii) Under suitable conditions, H_3NBH_3 can decompose into boron nitride and hydrogen. The structure of solid boron nitride is similar to that of graphite. Draw the structure of ONE LAYER of solid boron nitride (Note : B and N are in alternate positions).

(6 marks)

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4. Eggshells mainly contain calcium carbonate and a small amount of organic substances. The percentage by mass of calcium carbonate in a sample of eggshell was determined by the following steps :

Step (1) : The sample was ground into powder.
Step (2) : 0.204 g of the powder was put into a conical flask. After that, 25.00 cm^3 of 0.200 M HCl(aq) and 5 cm^3 of ethanol were added.
Step (3) : The mixture was heated for 15 minutes.
Step (4) : After cooling down, the mixture was titrated with 0.102 M NaOH(aq) using an indicator **X**.

(a) Explain why the sample was ground into powder in Step (1).

(1 mark)

(b) Suggest why ethanol was added in Step (2).

(1 mark)

(c) Suggest why the mixture was heated for 15 minutes in Step (3).

(1 mark)

(d) The mixture turned from colourless to pale pink at the end point of titration in Step (4). Name indicator **X**.

(1 mark)

(e) 16.85 cm^3 of NaOH(aq) was needed to reach the end point of titration in Step (4). Calculate the percentage by mass of calcium carbonate in the sample.
(Relative atomic masses : C = 12.0, O = 16.0, Ca = 40.1)

(3 marks)

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5. The molecular formula of an organic compound **W** is $C_4H_6O_4$. It is soluble in water.

(a) When a piece of magnesium ribbon is placed into an aqueous solution of **W**, hydrogen gas evolves. According to this observation, suggest a functional group that **W** may contain.

(1 mark)

(b) It is known that one mole of **W** can completely react with two moles of NaOH.

(i) Draw TWO possible structures of **W**.

(ii) Consider the following thermochemical equation of a neutralisation reaction in standard conditions :

$$C_4H_6O_4(aq) + 2NaOH(aq) \rightarrow Na_2C_4H_4O_4(aq) + 2H_2O(l) \quad \Delta H^{\ominus} = \mathbf{y}\ kJ\ mol^{-1}$$

State the meaning of the term 'standard enthalpy change of neutralisation', and deduce the standard enthalpy change of neutralisation for this reaction in terms of **y**.

(iii) The standard enthalpy change of neutralisation between HCl(aq) and NaOH(aq) is $-57.3\ kJ\ mol^{-1}$. Explain whether the enthalpy change deduced in (ii) above should be more negative than, less negative than or equal to $-57.3\ kJ\ mol^{-1}$.

(6 marks)

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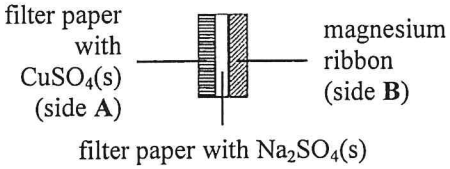
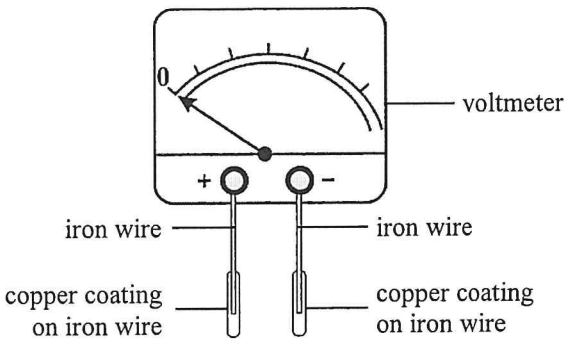
6. The diagrams below show the component of a chemical cell, an experimental set-up and how the pointer of the voltmeter deflects when the set-up is connected to the component.

component of a chemical cell



experimental set-up



The pointer of the voltmeter deflects to a positive reading when a few drops of water are added to the component

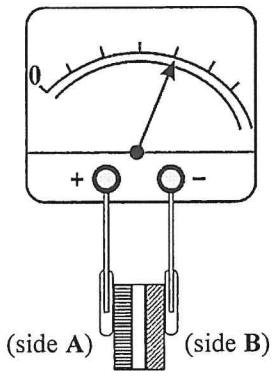


Diagram (1)

(a) Why does the pointer of the voltmeter deflect as shown when a few drops of water are added to the component ?

(2 marks)

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6. (b) Write the half equation for the change that occurs at each of the following electrodes when the pointer of the voltmeter deflects :

(i) anode

(ii) cathode

(2 marks)

(c) Consider the following design modified from **Diagram (1)** by only removing the copper coating at side **A** :

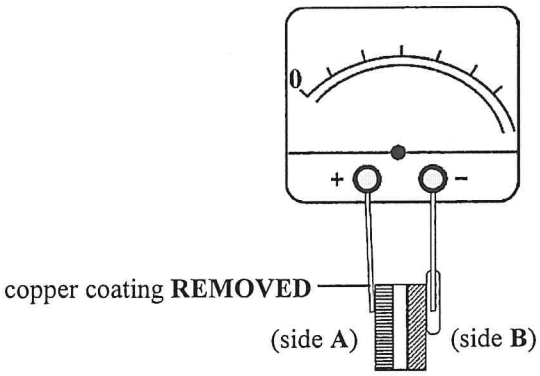

Diagram (2)

Draw on **Diagram (2)** the expected position of the pointer of the voltmeter when water is added to the component.

(1 mark)

(d) In the design in part (c) above, a redox reaction occurs at side **A** when water is added to the component.

(i) Write a chemical equation for the reaction.

(ii) Name this type of reaction.

(2 marks)

Go on to the next page

7. An experiment is performed to study the following reaction :

$Ba(OH)_2 \cdot 8H_2O(s) + 2NH_4Cl(s) \rightarrow BaCl_2(s) + 10H_2O(l) + 2NH_3(g)$

(a) When the two solid reactants are mixed and stirred in a conical flask, ammonia gas with a characteristic pungent smell is formed. Explain how ammonia gas can be tested.

(2 marks)

(b) $Ba(OH)_2 \cdot 8H_2O(s)$ is an alkali. What is meant by the term 'alkali' ?

(1 mark)

(c) The standard enthalpy change of formation of $Ba(OH)_2 \cdot 8H_2O(s)$ is -3345 kJ mol^{-1}.

(i) Write a thermochemical equation for the standard enthalpy change of formation of $Ba(OH)_2 \cdot 8H_2O(s)$.

(ii) Calculate the standard enthalpy change of the reaction between $Ba(OH)_2 \cdot 8H_2O(s)$ and $NH_4Cl(s)$.
(Standard enthalpy changes of formation :
$NH_3(g) = -46$ kJ mol^{-1}, $H_2O(l) = -286$ kJ mol^{-1}, $NH_4Cl(s) = -314$ kJ mol^{-1},
$BaCl_2(s) = -859$ kJ mol^{-1})

(iii) Hence, explain whether the temperature of the mixture would increase, decrease or remain unchanged during the reaction.

(4 marks)

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*8. Describe how 1,2-dibromoethane can be produced from crude oil, via an alkene, using appropriate chemicals and processes. Write the chemical equations for the reactions involved.

(6 marks)

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PART II

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

9. Consider the following reaction mixture at 25°C in a closed container of fixed volume :

$$\underset{\text{brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{N_2O_4(g)}$$

(a) With reference to the table below, calculate **a**. Hence, determine the equilibrium constant K_c for the reaction at 25°C.

	$NO_2(g)$	$N_2O_4(g)$
Concentration at start / mol dm^{-3}	0.0400	0.0010
Concentration at equilibrium / mol dm^{-3}	0.0323	**a**

(3 marks)

(b) The temperature of the mixture is increased to 55 °C and its colour eventually turns darker. Deduce whether the reaction above is endothermic or exothermic.

(2 marks)

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10. The structure of a compound **Y** is shown below :

$$H_2C{=}CHCH_2OH$$

(a) **Y** can be prepared from reacting 3-chloropropene with an appropriate reagent.

(i) Write a chemical equation for this reaction.

(ii) Name this type of reaction.

(2 marks)

(b) On heating under reflux, a compound **L** reacts with KOH(aq) to give **Y** and $CH_3COO^-K^+$.

(i) Suggest the structural formula of **L**.

(ii) Draw a labelled diagram to show the set-up for this reaction.

(3 marks)

(c) Under suitable conditions, **Y** can form a polymer. Write the repeating unit of the polymer.

(1 mark)

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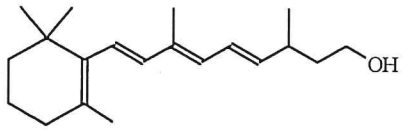
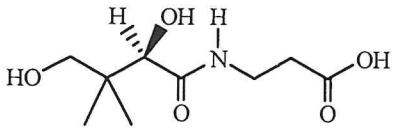
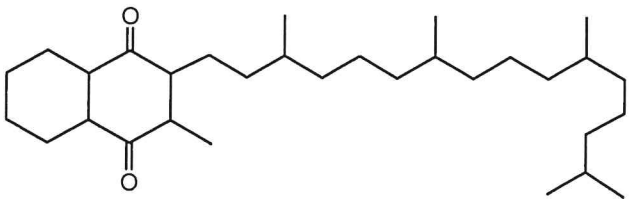
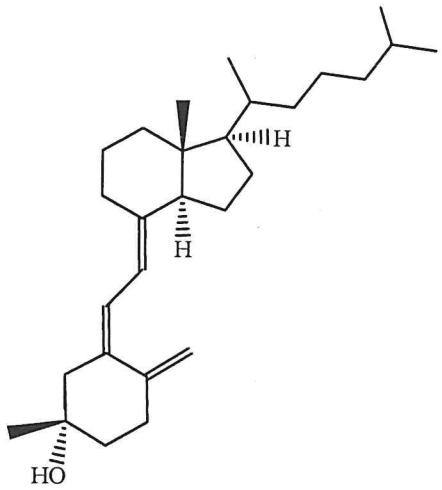
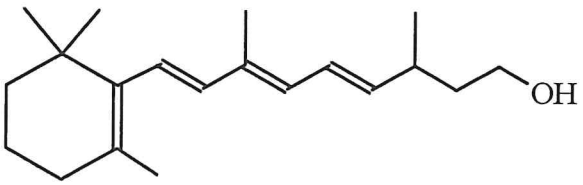
11. The structures of some compounds are shown below :

Compound	Structure
W	
X	
Y	
Z	

(a) Which one of **W**, **X**, **Y** or **Z** is a tertiary alcohol ?

(1 mark)

(b) Label all chiral centre(s), if any, by using '*' on the structure of **W** below.



(1 mark)

11. (c) Heating **X** under reflux in 2 M NaOH(aq) can form an **optically active** organic compound **U** and an **optically inactive** organic compound **V**. Draw the respective structures of **U** and **V**.

U :

V :

(2 marks)

(d) Consider the following reagents :

$Br_2(aq)$ acidified $K_2Cr_2O_7(aq)$ $Na_2CO_3(aq)$

(i) Suggest which one of the reagents can be used to perform a chemical test, in order to distinguish **X** from **W**, **Y** and **Z**.

(ii) State the observation in the test involved in (i). Explain your answer.

(3 marks)

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12. An experiment was performed to study the following reaction :

$KO_2CCH(OH)CH(OH)CO_2Na(aq) + 3H_2O_2(aq) \rightarrow HCO_2K(aq) + HCO_2Na(aq) + 2CO_2(g) + 4H_2O(l)$
(colourless)

When 10 cm^3 of 0.25 M $KO_2CCH(OH)CH(OH)CO_2Na(aq)$ and 3 cm^3 of 6% $H_2O_2(aq)$ were mixed at 60°C, it was found that only a few gas bubbles evolved. Then a small amount of pink $CoCl_2(aq)$ solution was added to the mixture. Gas bubbles formed vigorously and the mixture turned to green due to the formation of a cobalt(III) compound. When no more gas evolved, the green mixture turned back to pink.

There is a view saying that cobalt illustrates THREE characteristics of transition metals according to the observation of this experiment. Suggest reasons to support this view.

(4 marks)

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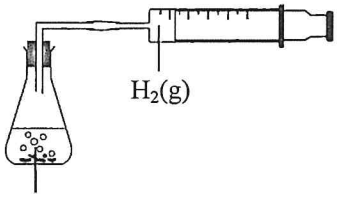
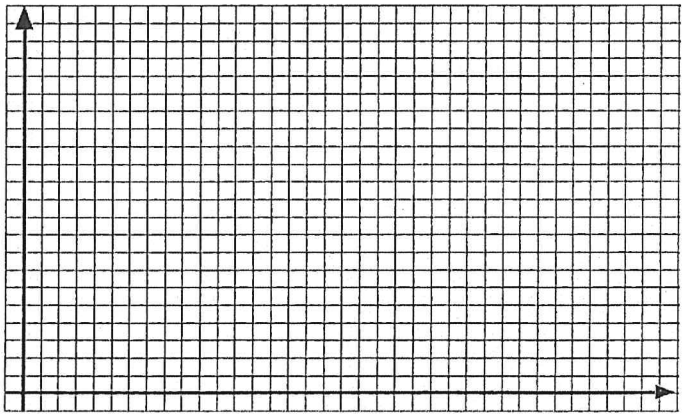
*13. With reference to the set-up shown below, describe how the effect of concentration of HCl(aq) on the rate of the reaction can be studied. Your answer should include **TWO** labelled curves sketched on the graph below, one using **solid line** and the other one using **dotted line**. Label all curves and axes.

(6 marks)



HCl(aq) + Zn(s)
(excess) (fixed mass)



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PERIODIC TABLE 周期表

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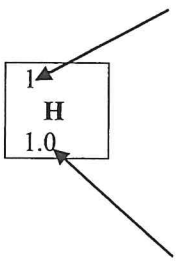

I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 * **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ** **Ac** (227)	104 **Rf** (261)	105 **Db** (262)													

*	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
**	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)