Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1

8 May 2024

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

45 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.
- The maximum mark for this examination paper is **[30 marks].**

2224 – 6204

11 pages

The Periodic Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 1.01																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01				Atomic number **Element** Relative atomic mass							5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.90
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.96	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
6	55 **Cs** 132.91	56 **Ba** 137.33	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)	104 **Rf** (267)	105 **Db** (268)	106 **Sg** (269)	107 **Bh** (270)	108 **Hs** (269)	109 **Mt** (278)	110 **Ds** (281)	111 **Rg** (281)	112 **Cn** (285)	113 **Unt** (286)	114 **Uug** (289)	115 **Uup** (288)	116 **Uuh** (293)	117 **Uus** (294)	118 **Uuo** (294)

†	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
‡	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	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** (262)

1. Which descriptions of a chemical compound are correct?

I. Contains atoms of more than one element.

II. Atoms retain their individual properties.

III. Atoms are in fixed ratios.

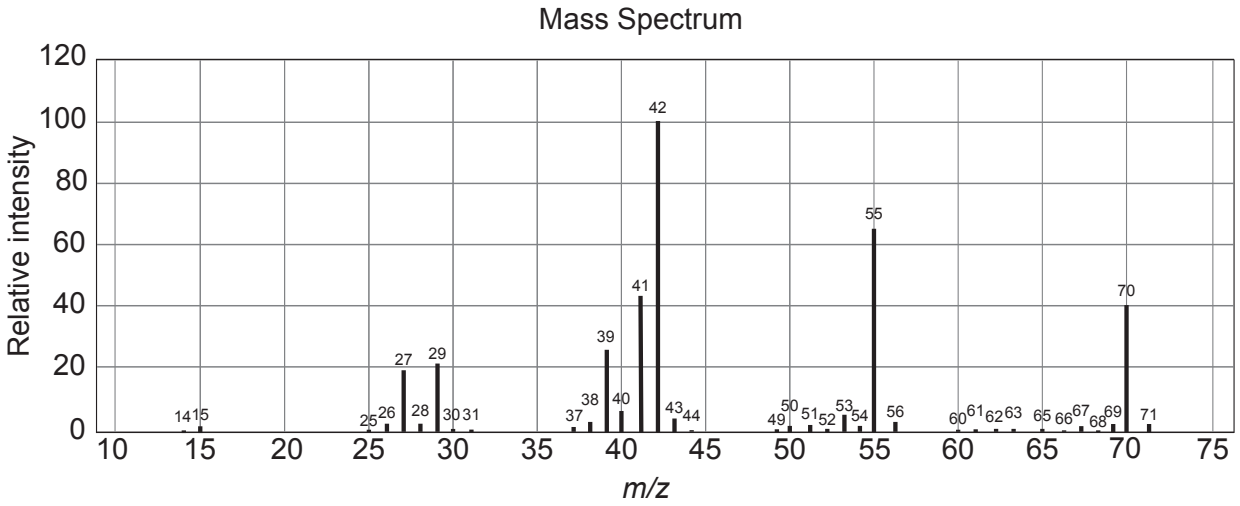
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

2. What is the molecular formula of the compound with empirical formula CH_2 and the following mass spectrum?



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A. C_2H_4

B. C_3H_6

C. C_4H_8

D. C_5H_{10}

3. What is the sum of the coefficients when the equation is balanced with the smallest whole numbers?

$$\_\_Al(OH)_3(s) + \_\_H_2SO_4(aq) \rightarrow \_\_H_2O(l) + \_\_Al_2(SO_4)_3(aq)$$

A. 8

B. 9

C. 11

D. 12

4. Which species are present after 15 dm^3 of buta-1,3-diene has reacted with 18 dm^3 of hydrogen to produce butane?

$$CH_2CHCHCH_2(g) + 2H_2(g) \rightarrow CH_3CH_2CH_2CH_3(g)$$

A. 9 dm^3 of butane and 6 dm^3 of hydrogen

B. 9 dm^3 of butane and 6 dm^3 of buta-1,3-diene

C. 15 dm^3 of butane and 3 dm^3 of hydrogen

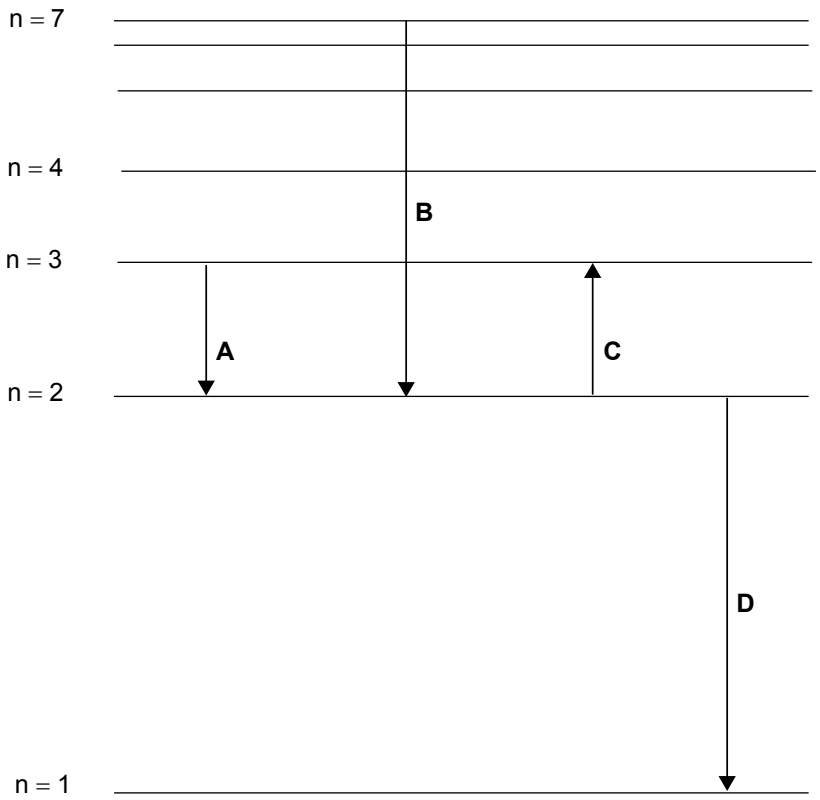
D. 18 dm^3 of butane and 3 dm^3 of buta-1,3-diene

5. What is the correct number of subatomic particles for ${}^{79}_{34}Se^{2-}$?

	Protons	**Electrons**	**Neutrons**
A.	34	36	79
B.	34	36	45
C.	36	45	36
D.	79	81	34

6. Which electron transition corresponds to the red line in the hydrogen line emission spectrum?

diagram not to scale



7. Which element is an actinoid?

A. Rf

B. Ra

C. Pr

D. Pa

8. Which oxide produces an aqueous solution with the highest pH?

A. Na_2O

B. P_4O_{10}

C. NO_2

D. CO_2

9. What is the correct formula for ammonium phosphate?

A. NH_4PO_4

B. $(NH_4)_2PO_4$

C. $(NH_4)_3PO_4$

D. $(NH_3)_3PO_4$

10. Which bond is the most polar?

A. C–H

B. N–H

C. O–H

D. F–H

11. Which species have resonance structures?

I. CH_2CHCH_3

II. O_3

III. NO_3^-

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

12. Which combination best describes NO_2^-?

	Number of electron domains around N	**Molecular geometry**	**Bond angle**
A.	2	linear	180°
B.	3	bent	105°
C.	3	bent	117°
D.	4	trigonal planar	120°

13. How much heat energy, in J, does a 2.00 g block of copper metal at 65.0 °C lose when it is dropped into 100.0 cm^3 of water and cools to 15.0 °C?

The specific heat capacity of copper is 0.385 $J\,g^{-1}\,K^{-1}$ and the specific heat capacity of water is 4.18 $J\,g^{-1}\,K^{-1}$.

A. $2.00 \times 0.385 \times (65.0 - 15.0)$

B. $2.00 \times 0.385 \times (65.0 - 15.0 + 273)$

C. $100.0 \times 4.18 \times (65.0 - 15.0)$

D. $100.0 \times 4.18 \times (65.0 - 15.0 + 273)$

14. What is the enthalpy change of reaction, $\Delta H^{\ominus}$ in $kJ\,mol^{-1}$, for the hydrogenation of propyne to propene?

$C_3H_4(g) + H_2(g) \rightarrow C_3H_6(g) \quad \Delta H^{\ominus} = ?$

$C_3H_4(g) + 2H_2(g) \rightarrow C_3H_8(g) \quad \Delta H^{\ominus} = -290\,kJ\,mol^{-1}$

$C_3H_6(g) + H_2(g) \rightarrow C_3H_8(g) \quad \Delta H^{\ominus} = -125\,kJ\,mol^{-1}$

A. $(-290) + (-125)$

B. $(-290) - (-125)$

C. $-(-290) + (-125)$

D. $-(-290) - (-125)$

15. What is the correct formula for calculating enthalpy change of reaction, $\Delta H^{\ominus}$ reaction?

A. $\Delta H^{\ominus}$ reaction $= \Sigma \Delta H_f^{\ominus}$ reactants $- \Sigma \Delta H_f^{\ominus}$ products

B. $\Delta H^{\ominus}$ reaction $= \Sigma \Delta H_c^{\ominus}$ products $- \Sigma \Delta H_c^{\ominus}$ reactants

C. $\Delta H^{\ominus}$ reaction $= \Sigma \Delta H_{bonds}^{\ominus}$ reactants $- \Sigma \Delta H_{bonds}^{\ominus}$ products

D. $\Delta H^{\ominus}$ reaction $= \Sigma \Delta H_{bonds}^{\ominus}$ products $- \Sigma \Delta H_{bonds}^{\ominus}$ reactants

16. Which change would decrease the rate of reaction between magnesium ribbon and hydrochloric acid?

A. increasing the length of the magnesium ribbon

B. increasing the temperature of the acid

C. cutting the magnesium ribbon into smaller pieces

D. adding water to the hydrochloric acid

17. Which methods could be used to determine the rate of this reaction?

$C_4H_9Br(l) + H_2O(l) \rightarrow C_4H_9OH(aq) + H^+(aq) + Br^-(aq)$

I. change in pH

II. change in electrical conductivity

III. change in mass

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

18. The equilibrium constant for $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is $K_c = 0.0059$ at 298 K.

What is the value of the equilibrium constant at 298 K for $4NO_2(g) \rightleftharpoons 2N_2O_4(g)$?

A. $\frac{1}{0.0059}$

B. $\frac{1}{0.0059^2}$

C. 0.0059

D. 0.0059^2

19. Which products form in the reaction between sulfuric acid and sodium hydrogencarbonate?

A. $NaSO_4 + CO_2$

B. $Na_2SO_4 + H_2O + CO_2$

C. $Na_2SO_4 + CO_2$

D. $NaSO_4 + H_2O + CO_2$

20. What is the pH change when $0.100\,mol\,dm^{-3}$ $HCl\,(aq)$ is diluted to $0.00100\,mol\,dm^{-3}$?

A. increases by 2

B. increases by 1

C. decreases by 1

D. decreases by 2

21. The following equations represent reactions that occur spontaneously.

$Fe(NO_3)_2\,(aq) + Zn\,(s) \rightarrow Zn(NO_3)_2\,(aq) + Fe\,(s)$

$Ni(NO_3)_2\,(aq) + Fe\,(s) \rightarrow Fe(NO_3)_2\,(aq) + Ni\,(s)$

$Sn(NO_3)_2\,(aq) + Ni\,(s) \rightarrow Ni(NO_3)_2\,(aq) + Sn\,(s)$

What is the increasing order of activity of the metals?

A. $Zn < Fe < Ni < Sn$

B. $Sn < Fe < Ni < Zn$

C. $Sn < Ni < Fe < Zn$

D. $Ni < Sn < Zn < Fe$

22. Which statement is correct for a voltaic cell?

A. Reduction occurs at the negative electrode.

B. Electrical energy is converted to chemical energy.

C. The anode is the positive electrode.

D. Reduction occurs at the cathode.

23. What are the products of the electrolysis of molten magnesium chloride, $MgCl_2(l)$?

A. $Mg^{2+}(l) + 2Cl^-(l)$

B. $Mg^{2+}(l) + Cl_2(g)$

C. $Mg(l) + Cl_2(g)$

D. $Mg(l) + 2Cl^-(l)$

24. Which compounds belong to the same homologous series?

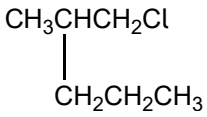
A. CH_3CH_3, $CH_3CH_2CH_3$, $CH_3CHCHCH_3$

B. CH_3CHCH_2, $CH_3CH_2CHCH_2$, $CH_2CHCH(CH_3)_2$

C. CH_3OH, HCHO, HCOOH

D. CH_3CH_2CHO, $(CH_3)_2CO$, CH_3CHO

25. What is the name of this compound?



A. 1-chloro-2-propylpropane

B. 1-chloro-2-methylpentane

C. 2-propyl-3-chloropropane

D. 1-chlorohexane

26. What is the organic product when $(CH_3)_2CH(OH)$ and acidified potassium manganate(VII), $H^+/KMnO_4(aq)$, are heated together?

A. CH_3CH_2COOH

B. $(CH_3)_2CO$

C. $(CH_3)_2CH(OH)$

D. CH_3CH_2CHO

27. Which products may be formed during incomplete combustion of octane?

A. CO_2 and H_2

B. CO and H_2

C. CO and H_2O

D. C, CO and H_2

28. 50.0 cm^3 samples of water measured using a graduated cylinder were found to weigh 48.88, 48.89 and 48.86 grams. Water has a density of 1.00 $g\,cm^{-3}$.

What is the best description of the measurements?

A. accurate and precise

B. accurate but not precise

C. precise but not accurate

D. neither accurate nor precise

29. A 50.0 cm^3 sample of sodium hydroxide solution, NaOH (aq), weighed 53.894 g at 25 °C. What is the density of the solution in $g\,cm^{-3}$?

A. 1.08

B. 1.078

C. 1.0779

D. 1.07788

30. Which region of the electromagnetic spectrum is used in ^1H NMR spectroscopy?

A. X-ray

B. ultraviolet

C. infrared

D. radio waves

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References:

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