Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1

11 May 2023

Zone A afternoon | **Zone B** morning | **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].**

2223 – 6110

12 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)

2223–6110

1. What are the units of molar mass?

A. amu

B. g

C. mol g^{-1}

D. g mol^{-1}

2. Which information does the molecular formula provide?

A. The simplest ratio of atoms in a molecule

B. The actual numbers of atoms in a molecule

C. The number of molecules in one mole

D. The types of bonds in a molecule

3. A student heated a known mass of zinc powder in an open crucible until there was no further mass change and recorded the final mass.

What would the student be able to derive from this data?

I. Percentage composition of zinc oxide

II. Empirical formula of zinc oxide

III. Molecular formula of zinc oxide

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

4. What is the molar mass of a gas according to the following experimental data?

Mass of gas	40.0 g
Volume	220 cm^3
Temperature	17 °C
Pressure	98 kPa

Ideal gas constant = 8.31 J K^{-1} mol^{-1}
PV = nRT

A. $\frac{40.0 \times 8.31 \times 290}{98 \times 0.220}$

B. $\frac{98 \times 0.220}{40.0 \times 8.31 \times 290}$

C. $\frac{40.0 \times 8.31 \times 17}{98 \times 0.220}$

D. $\frac{98 \times 220}{40.0 \times 8.31 \times 17}$

5. What is the maximum number of electrons in energy level n = 4?

A. 8

B. 18

C. 32

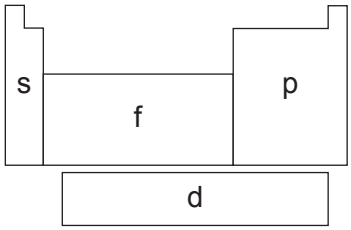
D. 50

6. What are the numbers of neutrons and electrons in $^{32}_{16}S^{2-}$?

	Neutrons	**Electrons**
A.	32	18
B.	16	18
C.	16	16
D.	16	14

7. What is the correct labelling of the blocks of the periodic table?

A.



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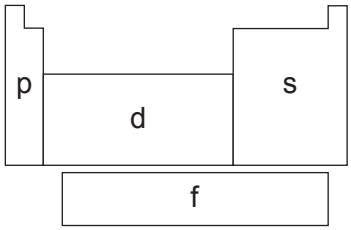

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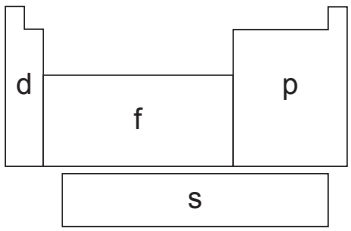
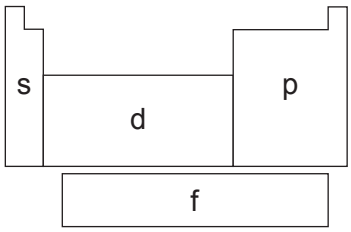


D.



8. What can be deduced from the period number of an element?

I. Highest occupied energy level

II. Number of sub-levels in the outer shell

III. Number of outer electrons

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

9. How many electrons will be gained or lost when the element with electron configuration $1s^2 2s^2 2p^3$ forms an ionic bond?

A. Two electrons lost

B. Two electrons gained

C. Three electrons lost

D. Three electrons gained

10. Which substance is likely to have an ionic lattice structure at 298 K and 100 kPa?

	Melting point	Conducts electricity in a liquid state?
A.	low	yes
B.	low	no
C.	high	no
D.	high	yes

11. Why does the melting point of the elements decrease down group 1?

A. Atomic mass increases

B. Number of electrons increases

C. Radius of metal ion increases

D. First ionization energy decreases

12. In which molecule does the central atom have an incomplete octet of electrons?

A. H_2Se

B. PH_3

C. OF_2

D. BF_3

13. Which allotrope, oxygen or ozone, has the stronger bond between O atoms, and which absorbs higher frequency UV radiation in the atmosphere?

	Stronger bond between O atoms	Absorbs higher frequency UV
A.	ozone	ozone
B.	ozone	oxygen
C.	oxygen	oxygen
D.	oxygen	ozone

14. What is the enthalpy of combustion of propan-1-ol, in **kJ mol^{-1}**, according to the following calorimetry data?

Mass of water in calorimeter	75 g
Amount of propan-1-ol burned	0.015 mol
Temperature rise	24 °C
Specific heat capacity of water	4.2 J g^{-1} K^{-1}

A. $\dfrac{-0.015 \times 4.2 \times 24}{0.075}$

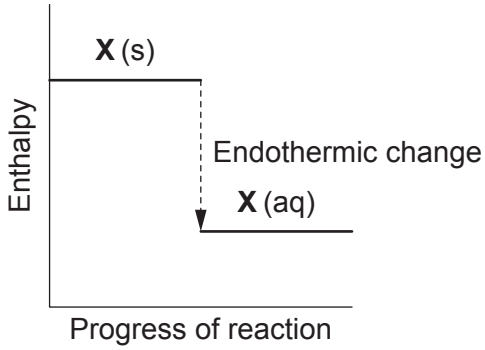
B. $\dfrac{-75 \times 4.2 \times 24}{0.015}$

C. $\dfrac{-0.015 \times 4.2 \times 24}{75}$

D. $\dfrac{-75 \times 4.2 \times 24}{0.015 \times 1000}$

15. Which diagram shows the enthalpy change for dissolving solid, **X**, in water, if the temperature of the solution decreases?

A.



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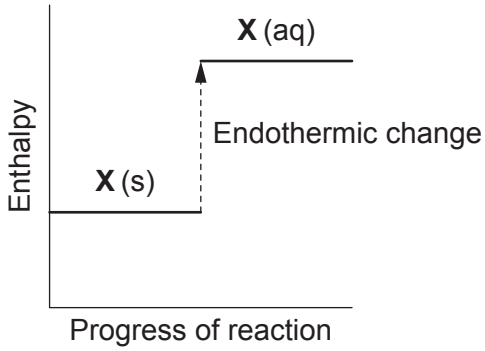

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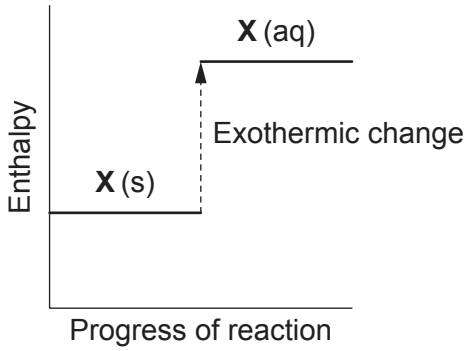
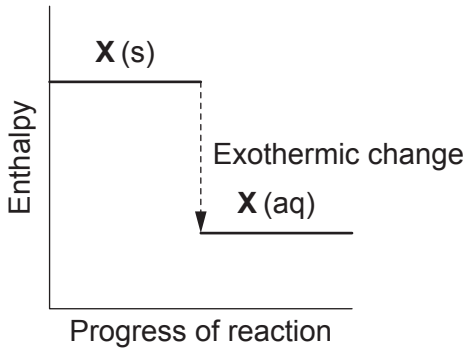
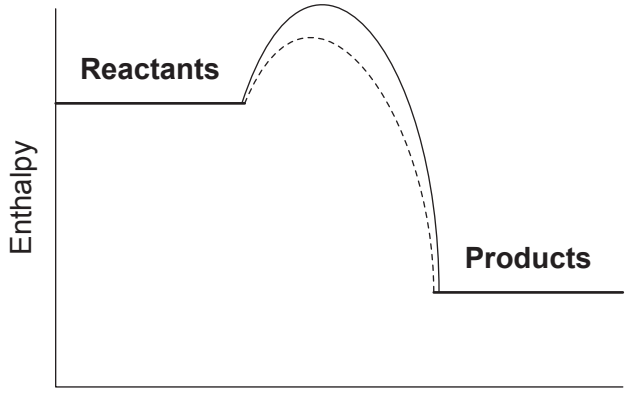


D.



16. What is represented by the dotted line on the enthalpy profile?



A. Reaction carried out at a lower temperature

B. Reaction is reversible

C. A catalyst is used

D. Collision frequency has increased

17. What happens to the average kinetic energy, KE, of the particles in a gas when the absolute temperature is doubled?

$$KE = \frac{1}{2} mv^2$$

A. Increases by a factor of 2

B. Decreases by a factor of 2

C. Increases by a factor of 4

D. Decreases by a factor of 4

18. Which value of the reaction quotient, Q, shows the lowest relative amount of products at a particular point in time?

A. 4.9×10^{-3}

B. 8.2×10^{-3}

C. 4.9×10^{2}

D. 8.2×10^{2}

19. Which products are formed from the neutralization of nitric acid by calcium hydroxide?

A. Calcium oxide and ammonia

B. Calcium nitrate and water

C. Calcium nitrate and ammonia

D. Calcium nitrate and hydrogen

20. Which combination describes a strong Brønsted–Lowry acid?

	Proton donor	Conjugate base
A.	good	strong
B.	good	weak
C.	poor	strong
D.	poor	weak

21. Which change involves oxidation of N?

A. NH_3 to N_2

B. NO_2 to NO

C. N_2 to AlN

D. NO_2 to N_2O_4

22. What is the formula of copper (I) sulfide?

A. CuS

B. Cu_2S

C. $CuSO_3$

D. Cu_2SO_3

23. Which combination describes an electrolytic cell?

	Energy change	Spontaneity
A.	chemical to electrical	non-spontaneous
B.	electrical to chemical	non-spontaneous
C.	chemical to electrical	spontaneous
D.	electrical to chemical	spontaneous

24. Which formula represents an ether?

A. C_6H_5OH

B. CH_3CHO

C. CH_3COCH_3

D. CH_3OCH_3

25. Which statement explains the increase in boiling point for the homologous series of the primary alcohols?

A. London dispersion forces become stronger

B. Hydrogen bonds become stronger

C. Polarity of hydroxyl group increases

D. Standard state of the compound changes to solid

26. Why does benzene undergo substitution more readily than addition?

A. Benzene is unsaturated.

B. Addition could produce an alkane.

C. Resonance makes carbon–carbon bonds too strong to break.

D. A benzene molecule is planar.

27. The orange colour disappears when bromine water is added to compound X in the dark.

Which compound is X?

A. Ethene

B. Ethane

C. Ethanol

D. Ethanoic acid

28. What is the percentage error if the enthalpy of combustion of a substance is determined experimentally to be $-2100\,kJ\,mol^{-1}$, but the literature value is $-3500\,kJ\,mol^{-1}$?

A. 80 %

B. 60 %

C. 40 %

D. 20 %

29. In which case would repetition produce an improvement in accuracy?

A. A thermometer always gives low readings.

B. An electronic balance has not been zeroed.

C. A student always reads the burette from a seated position.

D. Judgement of the end-point of a titration.

30. Which technique is most likely to be used for identification of functional groups?

A. Combustion analysis

B. Determination of melting point

C. Infra-red (IR) spectroscopy

D. Mass spectroscopy (MS)

References: