Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1

Friday 14 May 2021 (morning)

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]**.

2221 – 6116

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			Atomic number **Element** Relative atomic mass														2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											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)

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1. 0.20 mol of magnesium is mixed with 0.10 mol of hydrochloric acid.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Which is correct?

	Limiting reagent	Maximum yield of H_2 / mol
A.	HCl	0.10
B.	Mg	0.20
C.	HCl	0.05
D.	Mg	0.10

2. Which amount, in mol, of sodium chloride is needed to make 250 cm^3 of 0.10 mol dm^{-3} solution?

A. 4.0×10^{-4}

B. 0.025

C. 0.40

D. 25

3. Which molecule has the same empirical formula as molecular formula?

A. CH_3COOH

B. C_2H_5OH

C. C_2H_4

D. C_4H_{10}

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

$$\_\_Sn(OH)_4(aq) + \_\_NaOH(aq) \rightarrow \_\_Na_2SnO_3(aq) + \_\_H_2O(l)$$

A. 4

B. 5

C. 6

D. 7

5. What is represented by "$^{2-}$" in $^{A}_{Z}X^{2-}$?

A. loss of electron

B. gain of electron

C. loss of proton

D. gain of proton

6. How are emission spectra formed?

A. Photons are absorbed when promoted electrons return to a lower energy level.

B. Photons are absorbed when electrons are promoted to a higher energy level.

C. Photons are emitted when electrons are promoted to a higher energy level.

D. Photons are emitted when promoted electrons return to a lower energy level.

7. Which property increases down group 1?

A. atomic radius

B. electronegativity

C. first ionization energy

D. melting point

8. Which is a d-block element?

A. Ca

B. Cf

C. Cl

D. Co

9. Which compound has the greatest volatility under the same conditions?

A. SO_2

B. SiO_2

C. SnO_2

D. SrO

10. Which compound has the shortest C to N bond?

A. HCN

B. $CH_3CH_2NH_2$

C. CH_3CHNH

D. $(CH_3)_2NH$

11. What is the formula of the compound formed from Ca^{2+} and PO_4^{3-}?

A. $CaPO_4$

B. $Ca_3(PO_4)_2$

C. $Ca_2(PO_4)_3$

D. $Ca(PO_4)_2$

12. Which is the correct order based on **increasing** strength?

A. covalent bonds < hydrogen bonds < dipole–dipole forces < dispersion forces

B. dipole–dipole forces < dispersion forces < hydrogen bonds < covalent bonds

C. dispersion forces < dipole–dipole forces < hydrogen bonds < covalent bonds

D. dispersion forces < dipole–dipole forces < covalent bonds < hydrogen bonds

13. Which describes an exothermic reaction?

	Heat transfer	Enthalpy
A.	from surroundings to system	reactants > products
B.	from surroundings to system	products > reactants
C.	from system to surroundings	products > reactants
D.	from system to surroundings	reactants > products

14. What is the heat change, in kJ, when 100.0 g of aluminium is heated from 19.0 °C to 32.0 °C?

Specific heat capacity of aluminium: $0.90\,J\,g^{-1}\,K^{-1}$

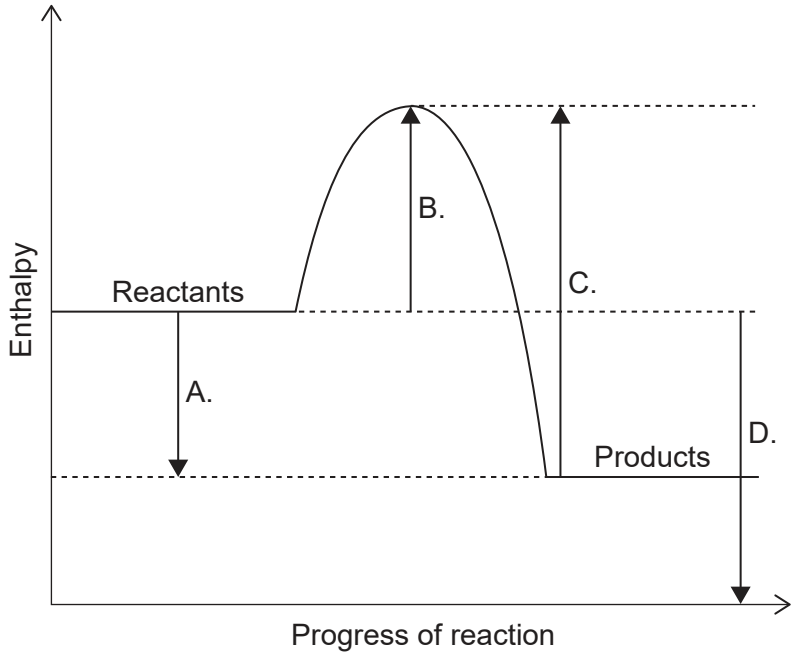
A. $0.90 \times 100.0 \times 13.0$

B. $0.90 \times 100.0 \times 286$

C. $\dfrac{0.90 \times 100.0 \times 13.0}{1000}$

D. $\dfrac{0.90 \times 100.0 \times 286}{1000}$

15. Which is the enthalpy change of reaction, ΔH?

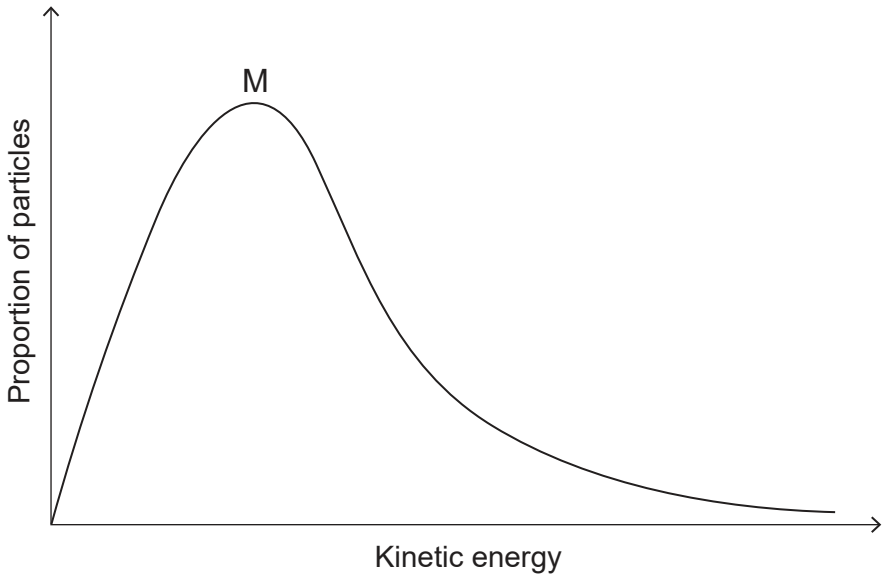


16. Which change causes the greatest increase in the initial rate of reaction between nitric acid and magnesium?

$$2HNO_3(aq) + Mg(s) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$$

	$[HNO_3]$	**Size of metal pieces**
A.	doubled	halved
B.	doubled	doubled
C.	halved	halved
D.	halved	doubled

17. The graph shows the Maxwell–Boltzmann energy distribution curve for a given gas at a certain temperature.



How would the curve change if the temperature of the gas decreases while the other conditions remain constant?

A. The maximum would be lower and to the left of M.

B. The maximum would be lower and to the right of M.

C. The maximum would be higher and to the left of M.

D. The maximum would be higher and to the right of M.

18. What effect does a catalyst have on the position of equilibrium and the value of the equilibrium constant, K_c, for an exothermic reaction?

	Position of equilibrium	**Value of equilibrium constant**
A.	moves to products	increases
B.	stays the same	increases
C.	stays the same	stays the same
D.	moves to products	stays the same

19. Which **cannot** act as a Brønsted–Lowry base?

A. HPO_4^{2-}

B. H_2O

C. CH_4

D. NH_3

20. Which causes acid deposition?

A. SO_2

B. SiO_2

C. SrO

D. CO_2

21. What is the oxidation state of oxygen in H_2O_2?

A. –2

B. –1

C. +1

D. +2

22. What are the products of the electrolysis of molten potassium chloride, KCl (l)?

	Anode (positive electrode)	Cathode (negative electrode)
A.	K	Cl
B.	Cl_2	K
C.	Cl	K
D.	K	Cl_2

23. What occurs at an anode?

	Voltaic cell	Electrolytic cell
A.	oxidation	reduction
B.	reduction	oxidation
C.	reduction	reduction
D.	oxidation	oxidation

24. Which is in the same homologous series as CH_3OCH_3?

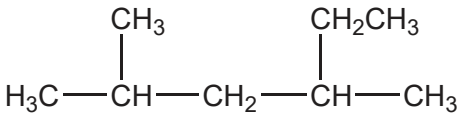
A. CH_3COCH_3

B. CH_3COOCH_3

C. $CH_3CH_2CH_2OH$

D. $CH_3CH_2CH_2OCH_3$

25. What is the IUPAC name of the molecule shown?



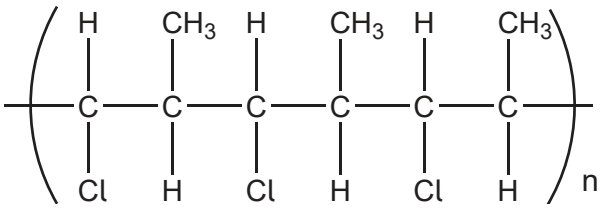
A. 2,4-dimethylhexane

B. 3,5-dimethylhexane

C. 2-methyl-4-ethylpentane

D. 2-ethyl-4-methylpentane

26. Which monomer forms the polymer shown?



A. $CH(Cl)=CH(CH_3)$

B. $CH_2=C(Cl)CH_3$

C. $(CH_3)_2CHCl$

D. $CH_2=CHCl$

27. Which is a propagation step in the free-radical substitution mechanism of ethane with chlorine?

A. $Cl_2 \rightarrow 2\ \bullet Cl$

B. $\bullet C_2H_5 + Cl_2 \rightarrow C_2H_5Cl + \bullet Cl$

C. $\bullet C_2H_5 + \bullet Cl \rightarrow C_2H_5Cl$

D. $C_2H_6 + \bullet Cl \rightarrow C_2H_5Cl + \bullet H$

28. Which spectra would show the difference between propan-2-ol, $CH_3CH(OH)CH_3$, and propanal, CH_3CH_2CHO?

I. mass

II. infrared

III. ^1H NMR

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

29. How should the difference between 27.0 ± 0.3 and 9.0 ± 0.2 be shown?

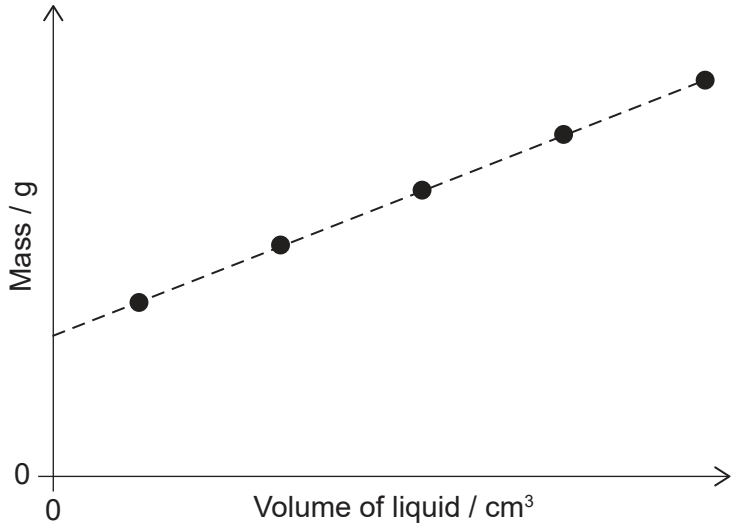
A. 18.0 ± 0.1

B. 18.0 ± 0.3

C. 18.0 ± 0.5

D. 18.0 ± 0.6

30. A liquid was added to a graduated cylinder. What can be deduced from the graph?



	Gradient	*y*-intercept
A.	density of liquid	amount of liquid
B.	density of liquid	mass of empty cylinder
C.	rate of adding liquid	amount of liquid
D.	rate of adding liquid	mass of empty cylinder

References: