

No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without written permission from the IB.

Additionally, the license tied with this product prohibits commercial use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, is not permitted and is subject to the IB's prior written consent via a license. More information on how to request a license can be obtained from <http://www.ibo.org/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite de l'IB.

De plus, la licence associée à ce produit interdit toute utilisation commerciale de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, n'est pas autorisée et est soumise au consentement écrit préalable de l'IB par l'intermédiaire d'une licence. Pour plus d'informations sur la procédure à suivre pour demander une licence, rendez-vous à l'adresse <http://www.ibo.org/fr/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin que medie la autorización escrita del IB.

Además, la licencia vinculada a este producto prohíbe el uso con fines comerciales de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales— no está permitido y estará sujeto al otorgamiento previo de una licencia escrita por parte del IB. En este enlace encontrará más información sobre cómo solicitar una licencia: <http://www.ibo.org/es/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

Chemistry
Standard level
Paper 1

Wednesday 13 November 2019 (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]**.

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	Atômico number																	
2	3 Li 6.94	4 Be 9.01	Element																
3	11 Na 22.99	12 Mg 24.31	Relative atomic mass																
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. 0.10 mol of hydrochloric acid is mixed with 0.10 mol of calcium carbonate.



Which is correct?

	Limiting reagent	Maximum yield of CO_2 / mol
A.	HCl(aq)	0.10
B.	$\text{CaCO}_3(\text{s})$	0.05
C.	HCl(aq)	0.05
D.	$\text{CaCO}_3(\text{s})$	0.10

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



- A. 6
- B. 7
- C. 8
- D. 9
3. Which is correct?
- A. Mixtures are either homogeneous or heterogeneous and their chemical properties are an average of the individual component properties.
- B. Mixtures are never heterogeneous and their chemical properties are an average of the individual component properties.
- C. Mixtures are either homogeneous or heterogeneous and the components retain their individual chemical properties.
- D. Mixtures are never homogeneous and the components retain their individual chemical properties.

Turn over

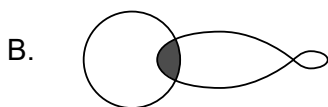
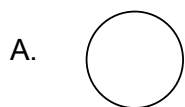
4. Which contains the greatest number of moles of oxygen atoms?

- A. 0.05 mol $\text{Mg}(\text{NO}_3)_2$
- B. 0.05 mol $\text{C}_6\text{H}_4(\text{NO}_2)_2$
- C. 0.1 mol H_2O
- D. 0.1 mol NO_2

5. What is represented by A in ${}^A_Z\text{X}^{2-}$?

- A. Number of electrons
- B. Number of neutrons
- C. Number of nucleons
- D. Number of protons

6. Which represents the shape of an s atomic orbital?



7. Which property shows a general increase from left to right across period 2, Li to F?

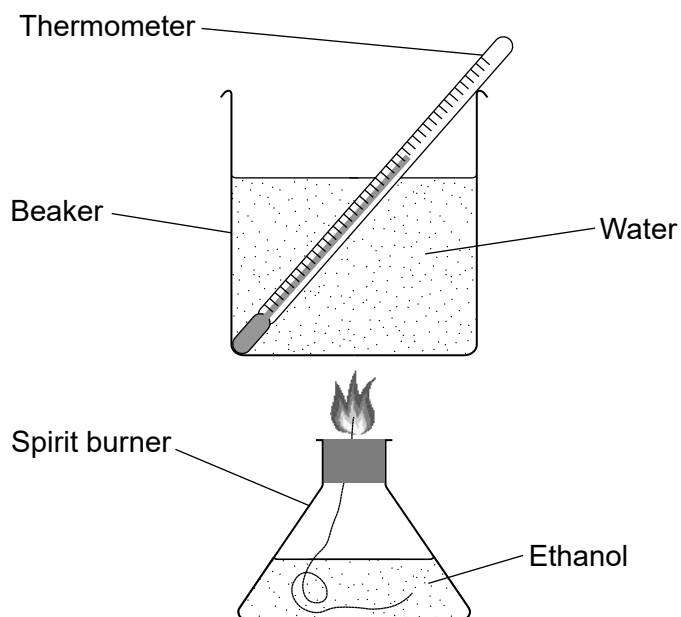
- A. Melting point
- B. Electronegativity
- C. Ionic radius
- D. Electrical conductivity

8. Which is an f-block element?
- A. Sc
B. Sm
C. Sn
D. Sr
9. Which is correct for all solid ionic compounds?
- A. High volatility
B. Poor electrical conductivity
C. Low melting point
D. Good solubility in water
10. Which compound has the shortest C to O bond?
- A. CH_3CHO
B. CO
C. CO_2
D. $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
11. Which describes a resonance structure?
- A. Double bond can be drawn in alternative positions.
B. Bonds vibrate by absorbing IR radiation.
C. A double and a single bond in the molecule
D. A Lewis structure
12. What is the structure and bonding in $\text{SiO}_2(\text{s})$?

	Structure	Bonding
A.	giant	covalent
B.	giant	ionic
C.	bent molecule	covalent
D.	linear molecule	covalent

Turn over

Questions 13 and 14 are about an experiment to measure the enthalpy of combustion, ΔH_c , of ethanol, using the apparatus and setup shown.



13. What is the enthalpy of combustion, ΔH_c , of ethanol in kJ mol^{-1} ?

Maximum temperature of water: 30.0°C

Initial temperature of water: 20.0°C

Mass of water in beaker: 100.0 g

Loss in mass of ethanol: 0.230 g

M_r (ethanol): 46.08

Specific heat capacity of water: $4.18 \text{ J g}^{-1} \text{ K}^{-1}$

$q = mc\Delta T$

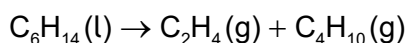
A.
$$-\frac{100.0 \times 4.18 \times (10.0 + 273)}{\frac{0.230}{46.08} \times 1000}$$

B.
$$-\frac{0.230 \times 4.18 \times 10.0}{\frac{100.0}{46.08} \times 1000}$$

C.
$$-\frac{100.0 \times 4.18 \times 10.0}{\frac{0.230}{46.08} \times 1000}$$

D.
$$-\frac{100.0 \times 4.18 \times 10.0}{\frac{0.230}{46.08}}$$

14. Which quantity is likely to be the most inaccurate due to the sources of error in this experiment?
- A. Mass of ethanol burnt
- B. Molecular mass of ethanol
- C. Mass of water
- D. Temperature change
15. What is the enthalpy change of the reaction?



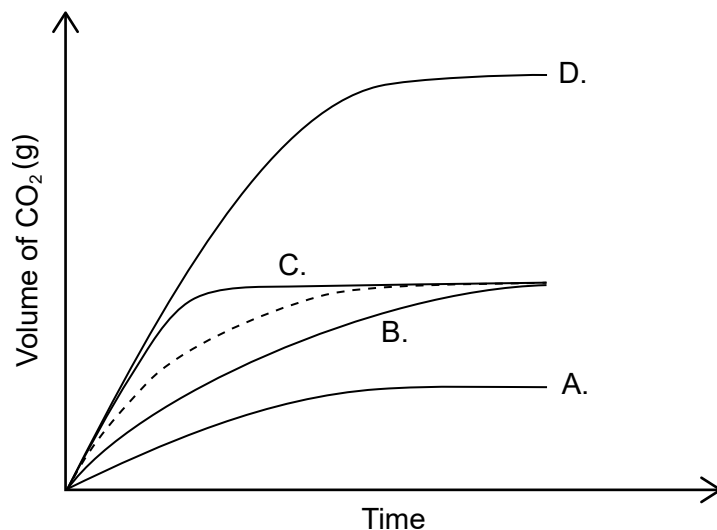
	Enthalpy of combustion / kJ mol^{-1}
$\text{C}_6\text{H}_{14}(\text{l})$	-4163
$\text{C}_2\text{H}_4(\text{g})$	-1411
$\text{C}_4\text{H}_{10}(\text{g})$	-2878

- A. + 1411 + 2878 + 4163
- B. + 1411 - 2878 - 4163
- C. + 1411 + 2878 - 4163
- D. - 1411 - 2878 + 4163
16. Which equation represents the N-H bond enthalpy in NH_3 ?
- A. $\text{NH}_3(\text{g}) \rightarrow \text{N}(\text{g}) + 3\text{H}(\text{g})$
- B. $\frac{1}{3}\text{NH}_3(\text{g}) \rightarrow \frac{1}{3}\text{N}(\text{g}) + \text{H}(\text{g})$
- C. $\text{NH}_3(\text{g}) \rightarrow \frac{1}{2}\text{N}_2(\text{g}) + \frac{3}{2}\text{H}_2(\text{g})$
- D. $\text{NH}_3(\text{g}) \rightarrow \cdot\text{NH}_2(\text{g}) + \cdot\text{H}(\text{g})$

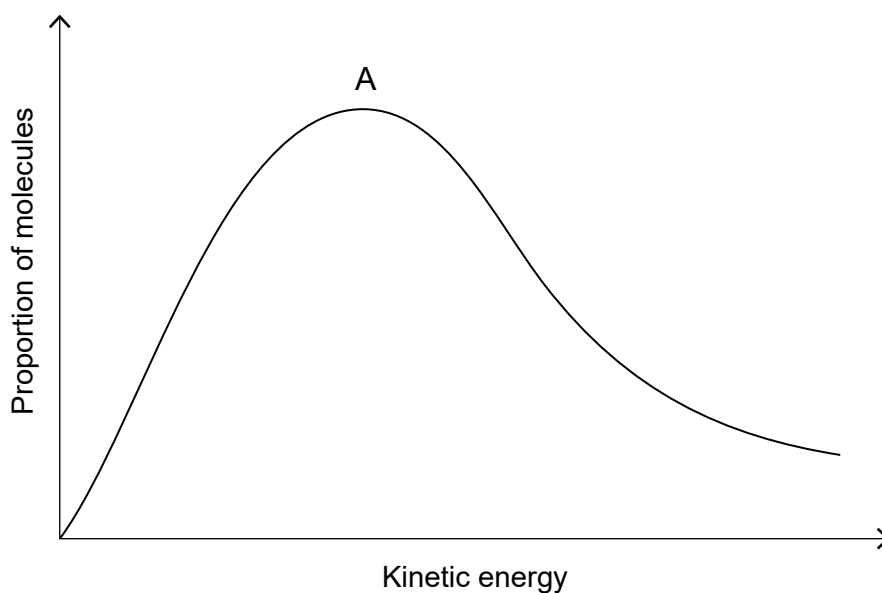
Turn over

17. The dotted line represents the volume of carbon dioxide evolved when excess calcium carbonate is added to hydrochloric acid.

Which graph represents the production of carbon dioxide when excess calcium carbonate is added to the same volume of hydrochloric acid of double concentration?



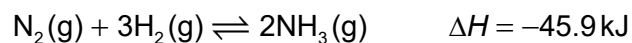
18. The graph shows the Maxwell-Boltzmann energy distribution curve for a given gas at a certain temperature.



How will the curve change if the temperature of the gas is increased, while other conditions remain constant?

- A. The maximum is higher and to the left of A.
- B. The maximum is higher and to the right of A.
- C. The maximum is lower and to the right of A.
- D. The maximum is lower and to the left of A.

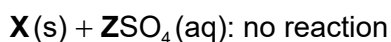
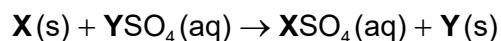
19. What effect does increasing both pressure and temperature have on the equilibrium constant, K_c ?



- A. Decreases
- B. Increases
- C. Remains constant
- D. Cannot be predicted as effects are opposite
20. What is the difference between a conjugate Brønsted–Lowry acid–base pair?
- A. Electron pair
- B. Positive charge
- C. Proton
- D. Hydrogen atom
21. Which is an example of an amphoteric species?
- A. Al_2O_3
- B. CO_3^{2-}
- C. P_4O_{10}
- D. HPO_4^{2-}
22. In which species does sulfur have the same oxidation state as in SO_3^{2-} ?
- A. $\text{S}_2\text{O}_3^{2-}$
- B. SO_4^{2-}
- C. H_2S
- D. SOCl_2

Turn over

23. The following occurs when metal **X** is added to **Y** sulfate solution and **Z** sulfate solution. (**X**, **Y** and **Z** represent metal elements but not their symbols.)



What is the order of increasing reactivity?

- A. $X < Y < Z$
 B. $Y < X < Z$
 C. $Z < Y < X$
 D. $Z < X < Y$
24. What is formed at the electrodes during the electrolysis of molten sodium bromide?

	Positive electrode	Negative electrode
A.	Na^+	Br^-
B.	Na	Br_2
C.	Br^-	Na^+
D.	Br_2	Na

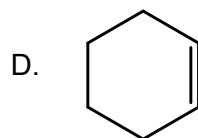
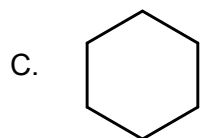
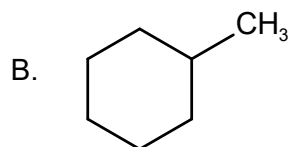
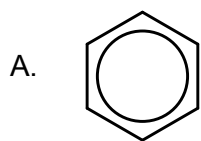
25. Which compound is **not** in the same homologous series as the others?

- A. C_5H_{12}
 B. C_6H_{12}
 C. C_7H_{16}
 D. C_8H_{18}

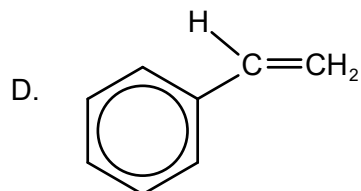
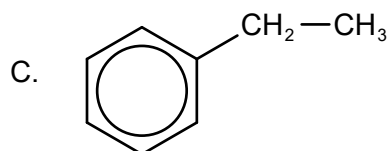
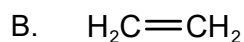
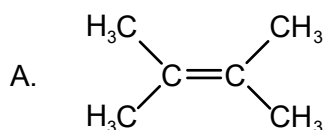
26. What type of reaction occurs when $\text{C}_6\text{H}_{13}\text{Br}$ becomes $\text{C}_6\text{H}_{13}\text{OH}$?

- A. Nucleophilic substitution
 B. Electrophilic substitution
 C. Radical substitution
 D. Addition

27. Which will react with a halogen by an electrophilic substitution mechanism?



28. Which compound **cannot** undergo addition polymerization?



29. What is the value of the temperature change?

Initial temperature: $2.0 \pm 0.1^\circ\text{C}$

Final temperature: $15.0 \pm 1.0^\circ\text{C}$

A. $13.0 \pm 0.1^\circ\text{C}$

B. $13.0 \pm 0.9^\circ\text{C}$

C. $13.0 \pm 1.0^\circ\text{C}$

D. $13.0 \pm 1.1^\circ\text{C}$

30. Which technique is used to detect the isotopes of an element?

A. Mass spectrometry

B. Infrared spectroscopy

C. Titration

D. Recrystallization