

**Chemistry**  
**Standard level**  
**Paper 1**

Thursday 11 May 2017 (afternoon)

45 minutes

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**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]**.

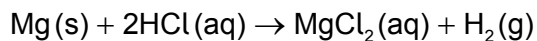
The Periodic Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 <b>H</b> 1.01																	2 <b>He</b> 4.00
2	3 <b>Li</b> 6.94	4 <b>Be</b> 9.01															9 <b>F</b> 19.00	10 <b>Ne</b> 20.18
3	11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31															17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
4	19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.87	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.38	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.63	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.90
5	37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.96	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.91	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.60	53 <b>I</b> 126.90	54 <b>Xe</b> 131.29
6	55 <b>Cs</b> 132.91	56 <b>Ba</b> 137.33	57 † <b>La</b> 138.91	72 <b>Hf</b> 178.49	73 <b>Ta</b> 180.95	74 <b>W</b> 183.84	75 <b>Re</b> 186.21	76 <b>Os</b> 190.23	77 <b>Ir</b> 192.22	78 <b>Pt</b> 195.08	79 <b>Au</b> 196.97	80 <b>Hg</b> 200.59	81 <b>Tl</b> 204.38	82 <b>Pb</b> 207.2	83 <b>Bi</b> 208.98	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
7	87 <b>Fr</b> (223)	88 <b>Ra</b> (226)	89 ‡ <b>Ac</b> (227)	104 <b>Rf</b> (267)	105 <b>Db</b> (268)	106 <b>Sg</b> (269)	107 <b>Bh</b> (270)	108 <b>Hs</b> (269)	109 <b>Mt</b> (278)	110 <b>Ds</b> (281)	111 <b>Rg</b> (281)	112 <b>Cn</b> (285)	113 <b>Uut</b> (286)	114 <b>Uug</b> (289)	115 <b>Uup</b> (288)	116 <b>Uuh</b> (293)	117 <b>Uus</b> (294)	118 <b>Uuo</b> (294)
			†	58 <b>Ce</b> 140.12	59 <b>Pr</b> 140.91	60 <b>Nd</b> 144.24	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.36	63 <b>Eu</b> 151.96	64 <b>Gd</b> 157.25	65 <b>Tb</b> 158.93	66 <b>Dy</b> 162.50	67 <b>Ho</b> 164.93	68 <b>Er</b> 167.26	69 <b>Tm</b> 168.93	70 <b>Yb</b> 173.05	71 <b>Lu</b> 174.97	
			‡	90 <b>Th</b> 232.04	91 <b>Pa</b> 231.04	92 <b>U</b> 238.03	93 <b>Np</b> (237)	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (262)	

Atomic number
<b>Element</b>
Relative atomic mass

1. Which compound has the greatest percentage by mass of nitrogen atoms?
- A.  $\text{N}_2\text{H}_4$
  - B.  $\text{NH}_3$
  - C.  $\text{N}_2\text{O}_4$
  - D.  $\text{NaNO}_3$
2. Which statements about mixtures are correct?
- I. The components may be elements or compounds.
  - II. All components must be in the same phase.
  - III. The components retain their individual properties.
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III
3.  $5.0\text{ cm}^3$  of  $2.00\text{ mol dm}^{-3}$  sodium carbonate solution,  $\text{Na}_2\text{CO}_3(\text{aq})$ , was added to a volumetric flask and the volume was made up to  $500\text{ cm}^3$  with water. What is the concentration, in  $\text{mol dm}^{-3}$ , of the solution?
- A. 0.0050
  - B. 0.0040
  - C. 0.020
  - D. 0.010

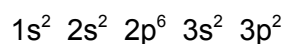
4. What is the expression for the volume of hydrogen gas, in  $\text{dm}^3$ , produced at STP when 0.30 g of magnesium reacts with excess hydrochloric acid solution?



Molar volume of an ideal gas at STP =  $22.7 \text{ dm}^3 \text{ mol}^{-1}$

- A.  $\frac{0.30 \times 2 \times 22.7}{24.31}$
- B.  $\frac{0.30 \times 22.7}{24.31}$
- C.  $\frac{0.30 \times 24.31}{22.7}$
- D.  $\frac{0.30 \times 22.7}{24.31 \times 2}$
5. In which set do all the species contain more electrons than neutrons?
- A.  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{11}\text{C}$
- B.  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{11}\text{C}^{4-}$
- C.  $^{14}\text{N}^{3-}$ ,  $^{16}\text{O}^{2-}$ ,  $^{11}\text{C}$
- D.  $^{14}\text{N}^{3-}$ ,  $^{16}\text{O}^{2-}$ ,  $^{11}\text{C}^{4+}$
6. Which electron transition in the hydrogen atom emission spectrum emits radiation with the longest wavelength?
- A.  $n = 2 \rightarrow n = 1$
- B.  $n = 1 \rightarrow n = 2$
- C.  $n = 4 \rightarrow n = 1$
- D.  $n = 3 \rightarrow n = 2$

7. The full electron configuration of an element is:



To which group and period does the element belong?

	Group	Period
A.	2	3
B.	3	2
C.	3	4
D.	14	3

8. Which oxide, when added to water, produces the solution with the highest pH?

- A.  $\text{Na}_2\text{O}$
- B.  $\text{SO}_3$
- C.  $\text{MgO}$
- D.  $\text{CO}_2$

9. A substance has the following properties:

Melting point / °C	Electrical conductivity	
	Molten	Solid
1414	poor	poor

What is the most probable structure of this substance?

- A. Network covalent
- B. Polar covalent molecule
- C. Ionic lattice
- D. Metallic lattice

10. Which two atoms form the most polar bond?

- A. C and F
- B. C and Cl
- C. Si and F
- D. Si and Cl

11. Which combination describes the sulfate(IV) ion,  $\text{SO}_3^{2-}$  (also known as sulfite ion)?

	Number of electron domains around S	Electron domain geometry	Molecular geometry	O-S-O angle
A.	3	trigonal planar	trigonal planar	120°
B.	3	tetrahedral	trigonal pyramidal	109.5°
C.	4	trigonal pyramidal	trigonal pyramidal	107°
D.	4	tetrahedral	trigonal pyramidal	107°

12. Which correctly states the strongest intermolecular forces in the compounds below?

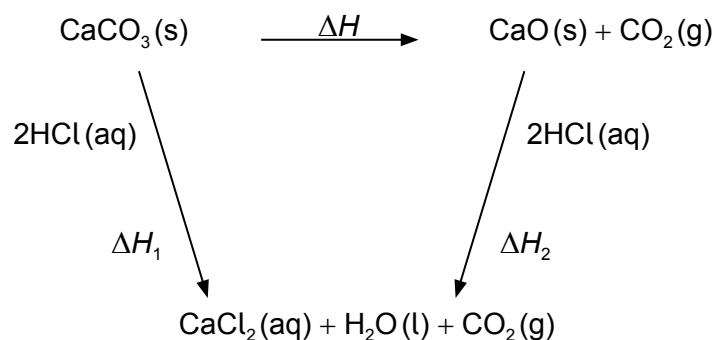
	$\text{CH}_4$	$\text{CH}_3\text{Cl}$	$\text{CH}_3\text{NH}_2$
A.	dipole-dipole	London forces	hydrogen bonding
B.	London forces	dipole-dipole	hydrogen bonding
C.	hydrogen bonding	London forces	dipole-dipole
D.	London forces	hydrogen bonding	dipole-dipole

13. Which expression gives the mass, in g, of ethanol required to produce 683.5 kJ of heat upon complete combustion?

( $M_r$  for ethanol = 46.0,  $\Delta H_c^\ominus = -1367 \text{ kJ mol}^{-1}$ )

- A.  $\frac{683.5}{1367 \times 46.0}$
- B.  $\frac{1367}{683.5 \times 46.0}$
- C.  $\frac{683.5 \times 46.0}{1367}$
- D.  $\frac{1367 \times 46.0}{683.5}$

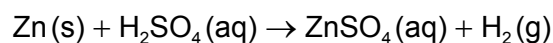
14. Which expression gives the enthalpy change,  $\Delta H$ , for the thermal decomposition of calcium carbonate?



- A.  $\Delta H = \Delta H_1 - \Delta H_2$
- B.  $\Delta H = 2\Delta H_1 - \Delta H_2$
- C.  $\Delta H = \Delta H_1 - 2\Delta H_2$
- D.  $\Delta H = \Delta H_1 + \Delta H_2$
15. In which order does the oxygen–oxygen bond enthalpy increase?

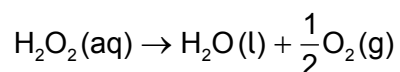
- A.  $\text{H}_2\text{O}_2 < \text{O}_2 < \text{O}_3$
- B.  $\text{H}_2\text{O}_2 < \text{O}_3 < \text{O}_2$
- C.  $\text{O}_2 < \text{O}_3 < \text{H}_2\text{O}_2$
- D.  $\text{O}_3 < \text{H}_2\text{O}_2 < \text{O}_2$

16. Copper catalyses the reaction between zinc and dilute sulfuric acid.

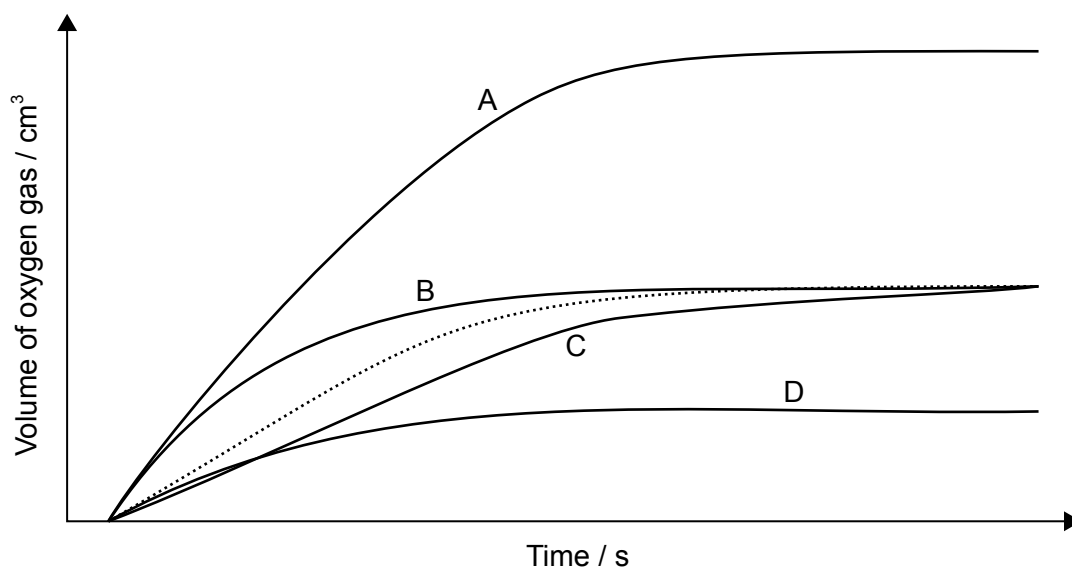


Why does copper affect the reaction?

- A. Decreases the activation energy
  - B. Increases the activation energy
  - C. Increases the enthalpy change
  - D. Decreases the enthalpy change
17. 100 cm<sup>3</sup> of 10% hydrogen peroxide solution decomposes at 298 K to form water and oxygen.



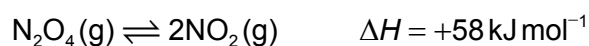
The dotted line graph represents the volume of oxygen produced.



Which graph represents the decomposition of an equal volume of a 20% solution under the same conditions?



18. Consider the equilibrium between  $\text{N}_2\text{O}_4(\text{g})$  and  $\text{NO}_2(\text{g})$ .



Which changes shift the position of equilibrium to the right?

- I. Increasing the temperature
  - II. Decreasing the pressure
  - III. Adding a catalyst
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

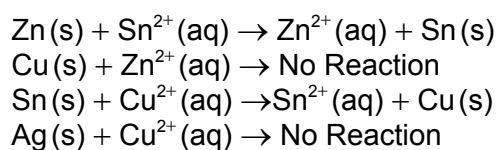
19. Which is an acid-base conjugate pair?

- A.  $\text{H}_3\text{O}^+ / \text{OH}^-$
- B.  $\text{H}_2\text{SO}_4 / \text{SO}_4^{2-}$
- C.  $\text{CH}_3\text{COOH} / \text{H}_3\text{O}^+$
- D.  $\text{CH}_3\text{NH}_3^+ / \text{CH}_3\text{NH}_2$

20. Which  $1.0 \text{ mol dm}^{-3}$  solution has the highest pH?

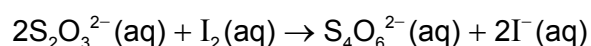
- A. Ammonium chloride
- B. Sulfuric acid
- C. Sodium chloride
- D. Ammonia

21. What is the order of decreasing reactivity of the metals (most reactive first)?



- A. Zn > Cu > Sn > Ag
- B. Sn > Zn > Ag > Cu
- C. Ag > Cu > Zn > Sn
- D. Zn > Sn > Cu > Ag

22. What is the oxidation half-equation in the redox reaction?



- A.  $\text{I}_2(\text{aq}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$
- B.  $2\text{I}^-(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{e}^-$
- C.  $2\text{S}_2\text{O}_3^{2-}(\text{aq}) \rightarrow \text{S}_4\text{O}_6^{2-}(\text{aq}) + 2\text{e}^-$
- D.  $\text{S}_4\text{O}_6^{2-}(\text{aq}) + 2\text{e}^- \rightarrow 2\text{S}_2\text{O}_3^{2-}(\text{aq})$

23. Which statements are correct for a voltaic cell?

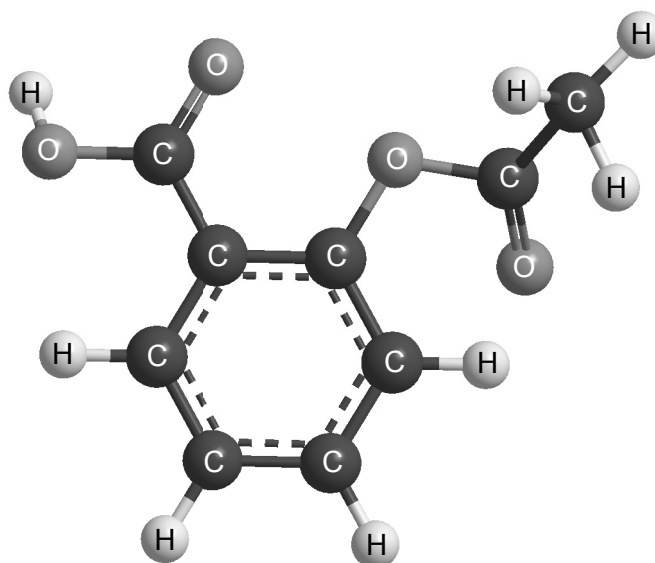
- I. A spontaneous redox chemical reaction produces electrical energy.
- II. Oxidation occurs at the cathode (negative electrode).
- III. Electrons flow from anode (negative electrode) to cathode (positive electrode).

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

24. What is the order of increasing boiling point?

- A.  $\text{C}_4\text{H}_{10} < \text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- B.  $\text{C}_4\text{H}_{10} < \text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{COOH}$
- C.  $\text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{CHO} < \text{C}_4\text{H}_{10}$
- D.  $\text{C}_4\text{H}_{10} < \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{CHO} < \text{CH}_3\text{COOH}$

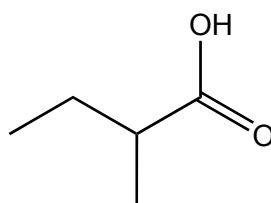
25. What are the functional groups in the aspirin molecule?



- I. Ether
- II. Carboxyl
- III. Ester

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

26. What is the name of the compound with this molecular structure applying IUPAC rules?



- A. 1-methylpropanoic acid
- B. 2-methylpropanoic acid
- C. 2-methylbutanoic acid
- D. 3-methylbutanoic acid

27. Which molecule has a tertiary nitrogen?
- A.  $(\text{CH}_3)_2\text{NH}$
  - B.  $(\text{C}_2\text{H}_5)_4\text{N}^+\text{I}^-$
  - C.  $\text{C}_3\text{H}_7\text{N}(\text{CH}_3)_2$
  - D.  $\text{C}_6\text{H}_5\text{NH}_2$
28. What can be determined about a molecule from the number of signals in its  $^1\text{H}$  NMR spectrum?
- A. Bonds present
  - B. Molecular formula
  - C. Molecular mass
  - D. Number of hydrogen environments
29. What is the density, in  $\text{g cm}^{-3}$ , of a 34.79 g sample with a volume of  $12.5 \text{ cm}^3$ ?
- A. 0.359
  - B. 0.36
  - C. 2.783
  - D. 2.78
30. What is the Index of Hydrogen Deficiency (IHD) for 1,3,5-hexatriene ( $\text{C}_6\text{H}_8$ )?
- A. 1
  - B. 3
  - C. 5
  - D. 6
-