

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

Thursday 11 May 2017 (afternoon)

45 minutes

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**Instructions to candidates**

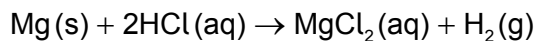
- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.
- The 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 H 1.01	Atomic number																
2 Li 6.94	4 Be 9.01	Element															
3 Na 22.99	12 Mg 24.31	Relative atomic mass															
4 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 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 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 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 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

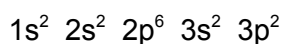
4. What is the expression for the volume of hydrogen gas, in  $\text{dm}^3$ , produced at STP when 0.30 g of magnesium reacts with excess hydrochloric acid solution?



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	$120^\circ$
B.	3	tetrahedral	trigonal pyramidal	$109.5^\circ$
C.	4	trigonal pyramidal	trigonal pyramidal	$107^\circ$
D.	4	tetrahedral	trigonal pyramidal	$107^\circ$

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

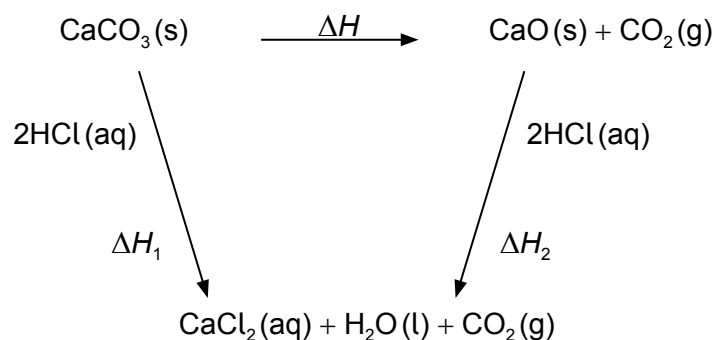
	$\text{CH}_4$	$\text{CH}_3\text{Cl}$	$\text{CH}_3\text{NH}_2$
A.	dipole-dipole	London forces	hydrogen bonding
B.	London forces	dipole-dipole	hydrogen bonding
C.	hydrogen bonding	London forces	dipole-dipole
D.	London forces	hydrogen bonding	dipole-dipole

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.  $\frac{1367 \times 46.0}{683.5}$

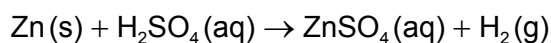
14. Which expression gives the enthalpy change,  $\Delta H$ , for the thermal decomposition of calcium carbonate?



- 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?

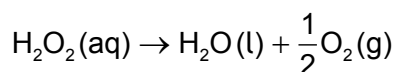
- A.  $\text{H}_2\text{O}_2 < \text{O}_2 < \text{O}_3$
- B.  $\text{H}_2\text{O}_2 < \text{O}_3 < \text{O}_2$
- C.  $\text{O}_2 < \text{O}_3 < \text{H}_2\text{O}_2$
- D.  $\text{O}_3 < \text{H}_2\text{O}_2 < \text{O}_2$

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

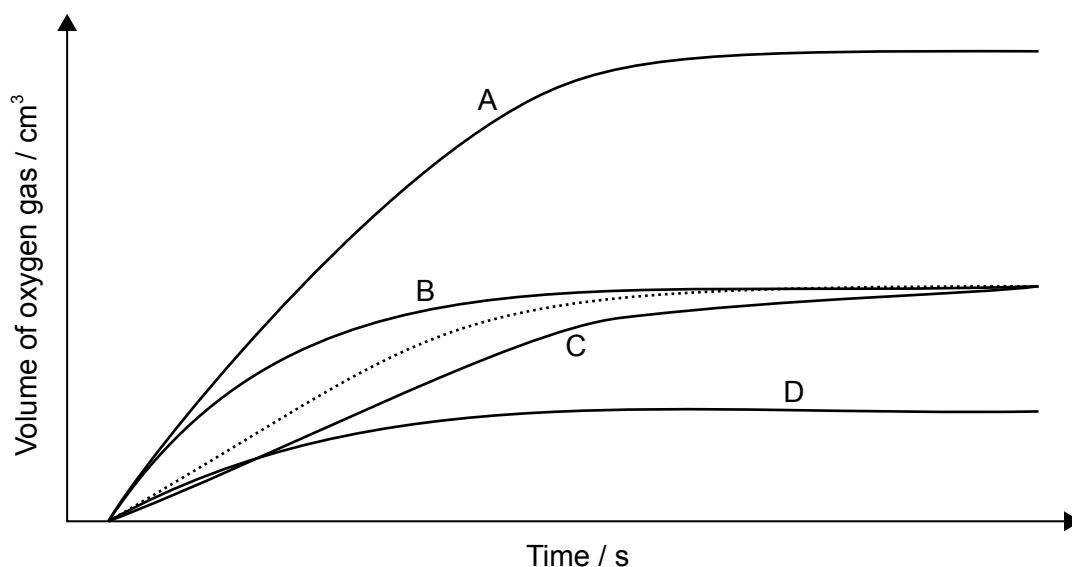


Why does copper affect the reaction?

- 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  $\text{NO}_2(\text{g})$ .

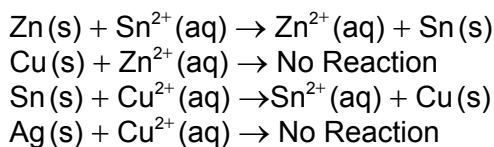


Which changes shift the position of equilibrium to the right?

- I. Increasing the temperature
- II. Decreasing the pressure
- III. Adding a catalyst

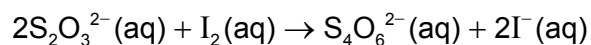
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III
19. Which is an acid-base conjugate pair?
- A.  $\text{H}_3\text{O}^+ / \text{OH}^-$
  - B.  $\text{H}_2\text{SO}_4 / \text{SO}_4^{2-}$
  - C.  $\text{CH}_3\text{COOH} / \text{H}_3\text{O}^+$
  - D.  $\text{CH}_3\text{NH}_3^+ / \text{CH}_3\text{NH}_2$
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?

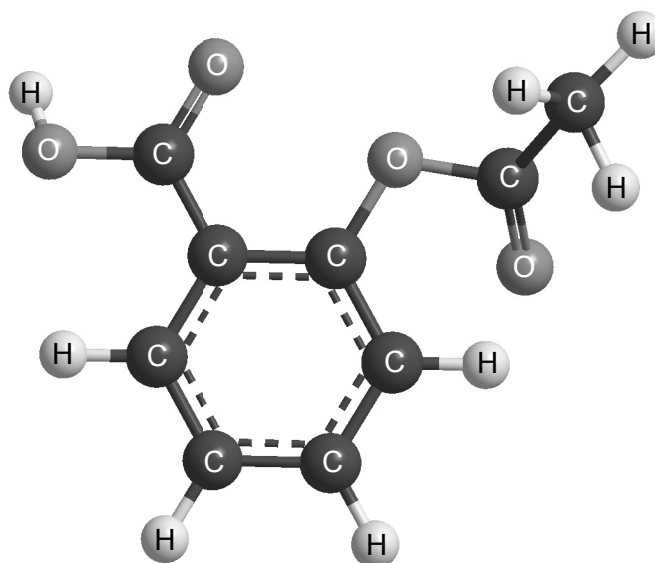
- I. A spontaneous redox chemical reaction produces electrical energy.
- II. Oxidation occurs at the cathode (negative electrode).
- III. Electrons flow from anode (negative electrode) to cathode (positive electrode).

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

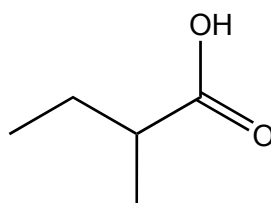
25. What are the functional groups in the aspirin molecule?



- 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
-