

Chemistry
Standard level
Paper 1

Wednesday 16 May 2018 (afternoon)

45 minutes

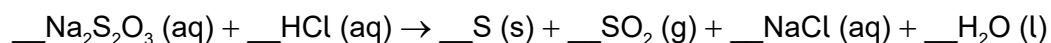
Instructions to candidates

- 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	<table border="1"> <tr> <td colspan="19">Atomic number</td> </tr> <tr> <td colspan="19">Element</td> </tr> <tr> <td colspan="19">Relative atomic mass</td> </tr> </table>																	Atomic number																			Element																			Relative atomic mass																		
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2	3 Li 6.94	4 Be 9.01																																																																									
3	11 Na 22.99	12 Mg 24.31																																																																									
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 Uut (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. What is the sum of the coefficients when the equation is balanced with the lowest whole number ratio?



- A. 6
- B. 7
- C. 8
- D. 9
2. What is the number of atoms of oxygen in 2.0 mol of hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$?
Avogadro's constant, L or N_A : $6.02 \times 10^{23} \text{ mol}^{-1}$
- A. 6
- B. 26
- C. 3.6×10^{24}
- D. 1.6×10^{25}
3. What is the volume, in cm^3 , of the final solution if 100 cm^3 of a solution containing 1.42 g of sodium sulfate, Na_2SO_4 , is diluted to the concentration of $0.020 \text{ mol dm}^{-3}$?
 $M_r (\text{Na}_2\text{SO}_4) = 142$
- A. 50
- B. 400
- C. 500
- D. 600

Turn over

4. What is the percentage yield when 2.0 g of ethene, C_2H_4 , is formed from 5.0 g of ethanol, C_2H_5OH ?
 M_r (ethene) = 28; M_r (ethanol) = 46

A. $\frac{2.0}{28} \times \frac{5.0}{46} \times 100$

B. $\frac{2.0}{\frac{28}{5.0}} \times 100$

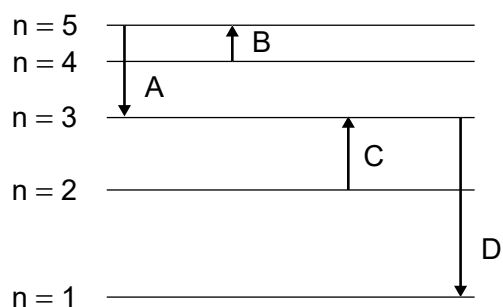
C. $\frac{28}{2.0} \times \frac{5.0}{46} \times 100$

D. $\frac{28}{\frac{2.0}{5.0}} \times 100$

5. What is the composition of the nucleus of ^{26}Mg ?

	Protons	Neutrons	Electrons
A.	12	14	12
B.	14	12	0
C.	14	12	14
D.	12	14	0

6. Which electron transition emits energy of the longest wavelength?



7. Which increase across a period from left to right?

A.	ionic radius	electronegativity
B.	atomic radius	ionic radius
C.	1st ionization energy	atomic radius
D.	1st ionization energy	electronegativity

8. Which element is in the p-block?

- A. Pb
- B. Pm
- C. Pt
- D. Pu

9. What is the formula of magnesium nitride?

- A. MgN
- B. Mg₂N₃
- C. Mg₃N
- D. Mg₃N₂

10. Which species has the longest carbon to oxygen bond length?

- A. CO
- B. CH₃OH
- C. CH₃CO₂⁻
- D. H₂CO

Turn over

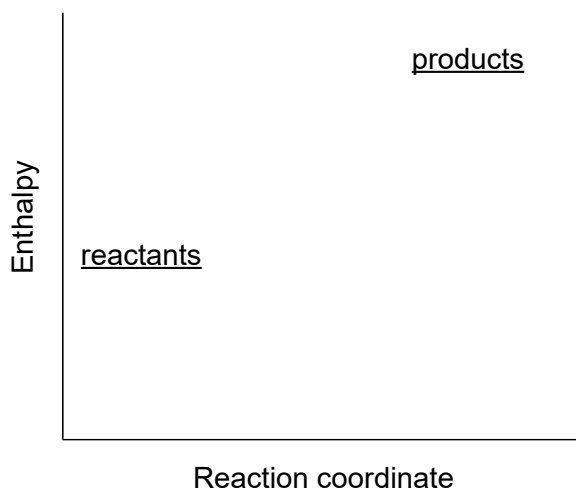
11. What are the predicted electron domain geometries around the carbon and both nitrogen atoms in urea, $(\text{NH}_2)_2\text{CO}$, applying VSEPR theory?

	Carbon atom	Nitrogen atoms
A.	trigonal planar	trigonal pyramidal
B.	trigonal planar	tetrahedral
C.	tetrahedral	tetrahedral
D.	trigonal pyramidal	trigonal planar

12. The compounds shown below have similar relative molecular masses. What is the correct order of increasing boiling point?

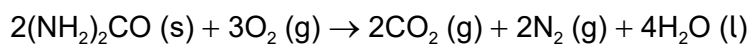
- A. $\text{CH}_3\text{COOH} < (\text{CH}_3)_2\text{CO} < (\text{CH}_3)_2\text{CHOH}$
 B. $\text{CH}_3\text{COOH} < (\text{CH}_3)_2\text{CHOH} < (\text{CH}_3)_2\text{CO}$
 C. $(\text{CH}_3)_2\text{CO} < \text{CH}_3\text{COOH} < (\text{CH}_3)_2\text{CHOH}$
 D. $(\text{CH}_3)_2\text{CO} < (\text{CH}_3)_2\text{CHOH} < \text{CH}_3\text{COOH}$

13. Which describes the reaction shown in the potential energy profile?



- A. The reaction is endothermic and the products have greater enthalpy than the reactants.
 B. The reaction is endothermic and the reactants have greater enthalpy than the products.
 C. The reaction is exothermic and the products have greater enthalpy than the reactants.
 D. The reaction is exothermic and the reactants have greater enthalpy than the products.

14. What is the enthalpy change of combustion of urea, $(\text{NH}_2)_2\text{CO}$, in kJ mol^{-1} ?



	$\Delta H_f / \text{kJ mol}^{-1}$
$(\text{NH}_2)_2\text{CO (s)}$	-333
$\text{CO}_2 \text{ (g)}$	-394
$\text{H}_2\text{O (l)}$	-286

- A. $2 \times (-333) - 2 \times (-394) - 4 \times (-286)$
- B. $\frac{1}{2} [2 \times (-394) + 4 \times (-286) - 2 \times (-333)]$
- C. $2 \times (-394) + 4 \times (-286) - 2 \times (-333)$
- D. $\frac{1}{2} [2 \times (-333) - 2 \times (-394) - 4 \times (-286)]$
15. Two 100 cm^3 aqueous solutions, one containing 0.010 mol NaOH and the other 0.010 mol HCl , are at the same temperature.

When the two solutions are mixed the temperature rises by $y^\circ\text{C}$.

Assume the density of the final solution is 1.00 g cm^{-3} .

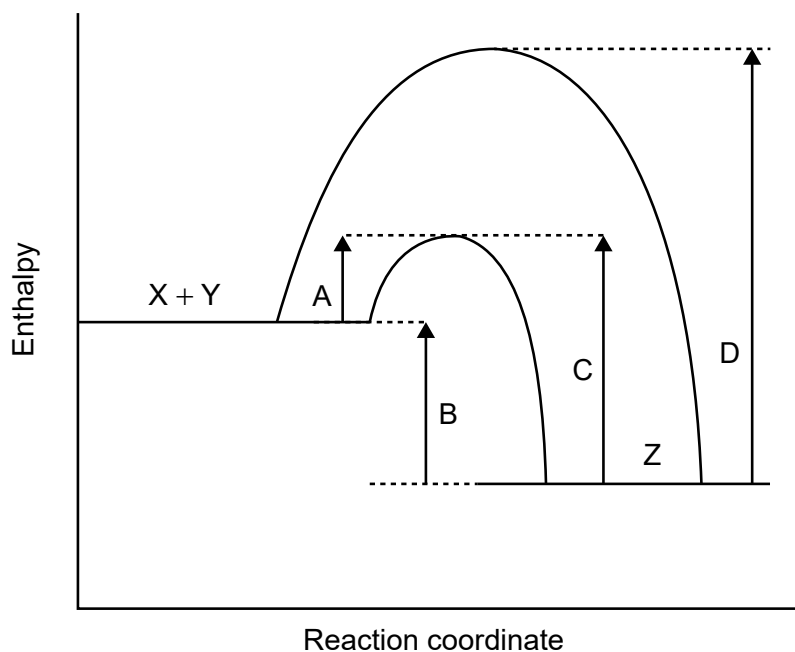
Specific heat capacity of water = $4.18 \text{ J g}^{-1} \text{ K}^{-1}$

What is the enthalpy change of neutralization in kJ mol^{-1} ?

- A. $\frac{200 \times 4.18 \times y}{1000 \times 0.020}$
- B. $\frac{200 \times 4.18 \times y}{1000 \times 0.010}$
- C. $\frac{100 \times 4.18 \times y}{1000 \times 0.010}$
- D. $\frac{200 \times 4.18 \times (y + 273)}{1000 \times 0.010}$

Turn over

16. The potential energy profile for the reversible reaction, $X + Y \rightleftharpoons Z$ is shown.



Which arrow represents the activation energy for the reverse reaction, $Z \rightarrow X + Y$, with a catalyst?

17. Which factors can affect the rate of reaction?

- I. Particle size of solid reactant
- II. Concentration of reacting solution
- III. Pressure of reacting gas

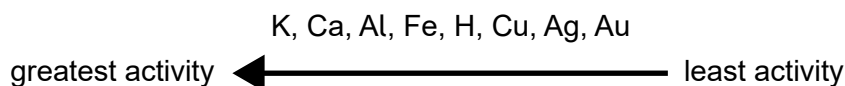
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

18. Which factor does **not** affect the position of equilibrium in this reaction?



- A. Change in volume of the container
- B. Change in temperature
- C. Addition of a catalyst
- D. Change in pressure

19. Activity series of selected elements:



Which react with dilute sulfuric acid?

- I. Cu
- II. CuO
- III. CuCO₃

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

20. Which statement is correct?

- A. A strong acid is a good proton donor and has a strong conjugate base.
- B. A weak acid is a poor proton acceptor and has a strong conjugate base.
- C. A strong acid is a good proton donor and has a weak conjugate base.
- D. A strong base is a good proton donor and has a weak conjugate acid.

21. Which element has the same oxidation number in both species?

- A. C in C₂H₄ and CO₂
- B. H in H₂O and NaH
- C. S in SO₄²⁻ and SO₃
- D. O in H₂O₂ and H₂O

22. Which can describe oxidation?

- A. Loss of hydrogen
- B. Decrease in oxidation number
- C. Gain of electrons
- D. Loss of oxygen

Turn over

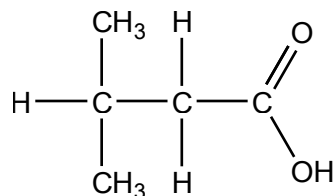
23. What are the products of the electrolysis of molten zinc bromide?

	Negative electrode (cathode)	Positive electrode (anode)
A.	zinc	bromine
B.	hydrogen	bromine
C.	bromine	zinc
D.	bromine	hydrogen

24. Which compounds belong to the same homologous series?

- A. $\text{CHCCH}_2\text{CH}_3$, $\text{CHCCH}_2\text{CH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$, $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$
- C. CH_2CHCH_3 , $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- D. CH_3COCH_3 , $\text{CH}_3\text{CH}_2\text{OCH}_3$

25. What is the name of this compound, using IUPAC rules?



- A. 1,1-dimethylpropanoic acid
 - B. 3,3-dimethylpropanoic acid
 - C. 2-methylbutanoic acid
 - D. 3-methylbutanoic acid
26. What is the mechanism for the reaction of propene with iodine in the dark?
- A. electrophilic addition
 - B. electrophilic substitution
 - C. free radical substitution
 - D. nucleophilic substitution

27. Which are structural isomers?

- I. $\text{CH}_3\text{CH}_2\text{OH}$ and CH_3OCH_3
- II. HOCH_2CH_3 and $\text{CH}_3\text{CH}_2\text{OH}$
- III. CH_3COOH and HCOOCH_3

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

28. Which feature of a molecule does infrared spectrometry detect?

- A. molecular mass
- B. bonds present
- C. total number of protons
- D. total number of proton environments

29. How are the uncertainties of two quantities combined when the quantities are multiplied together?

- A. Uncertainties are added.
- B. % uncertainties are multiplied.
- C. Uncertainties are multiplied.
- D. % uncertainties are added.

30. The rate of a reaction is studied at different temperatures.

Which is the best way to plot the data?

	x-axis	Type of variable on x-axis
A.	rate	dependent
B.	rate	independent
C.	temperature	independent
D.	temperature	dependent