Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1

Thursday 11 May 2017 (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]**.

2217 – 6116

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)

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

$$\_\_C_8H_{18}(g) + \_\_O_2(g) \rightarrow \_\_CO(g) + \_\_H_2O(l)$$

A. 26.5

B. 30

C. 53

D. 61

2. How many moles of oxygen atoms are there in 0.500 mol of hydrated iron(II) ammonium sulfate, $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O(s)$?

A. 4.00

B. 7.00

C. 8.00

D. 14.00

3. What is the maximum volume, in dm^3, of $CO_2(g)$ produced when 1.00 g of $CaCO_3(s)$ reacts with 20.0 cm^3 of 2.00 mol dm^{-3} $HCl(aq)$?

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Molar volume of gas $= 22.7\,dm^3\,mol^{-1}$; $M_r(CaCO_3) = 100.00$

A. $\frac{1}{2} \times \frac{20.0 \times 2.00}{1000} \times 22.7$

B. $\frac{20.0 \times 2.00}{1000} \times 22.7$

C. $\frac{1.00}{100.00} \times 22.7$

D. $\frac{1.00}{100.00} \times 2 \times 22.7$

4. Which factors affect the molar volume of an ideal gas?

I. Pressure
II. Temperature
III. Empirical formula

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

5. What does $^{24}_{12}Mg^{2+}$ represent?

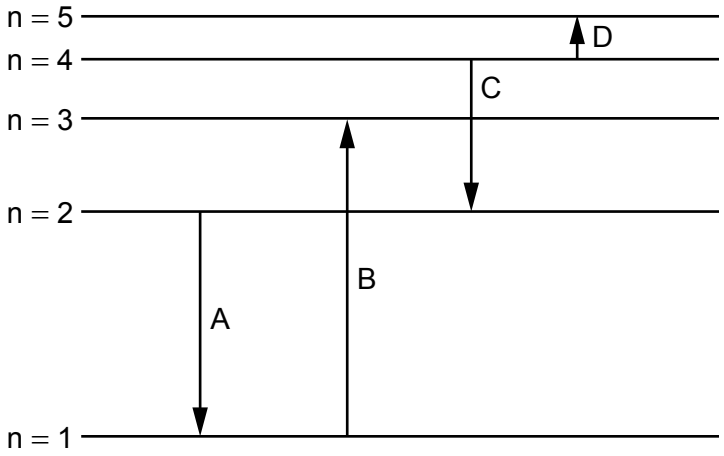
A. An ion with 12 protons and 24 neutrons

B. An ion with 14 protons and 24 neutrons

C. An ion with 12 protons and 12 neutrons

D. An ion with 12 protons and 22 neutrons

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



7. Which property increases down Group 1, the alkali metals?

A. Atomic radius

B. Electronegativity

C. First ionization energy

D. Melting point

8. Which element is a lanthanide?

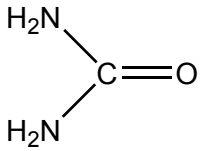
A. Hf

B. Tb

C. U

D. Y

9. How many bonding electrons are there in the urea molecule?



A. 8

B. 16

C. 20

D. 24

10. Which bonds cause the boiling point of water to be significantly greater than that of hydrogen sulfide?

A. London (dispersion)

B. Covalent

C. Ionic

D. Hydrogen

11. What are the approximate bond angles and structure of crystalline SiO_2?

	O–Si–O	**Structure**
A.	90°	giant molecule
B.	109°	giant molecule
C.	180°	small molecule
D.	180°	giant molecule

12. Which metal has the strongest metallic bond?

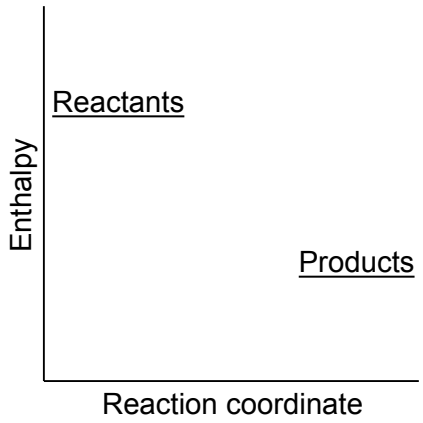
A. Li

B. Na

C. K

D. Rb

13. What can be deduced from this reaction profile?



A. The reactants are less stable than the products and the reaction is exothermic.

B. The reactants are less stable than the products and the reaction is endothermic.

C. The reactants are more stable than the products and the reaction is exothermic.

D. The reactants are more stable than the products and the reaction is endothermic.

14. Why is the value of the enthalpy change of this reaction calculated from bond enthalpy data less accurate than that calculated from standard enthalpies of formation?

$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$$

A. All the reactants and products are gases.

B. Bond enthalpy data are average values for many compounds.

C. Elements do not have standard enthalpy of formation.

D. Standard enthalpies of formation are per mole.

15. What can be deduced from the facts that ozone absorbs UV radiation in the region of 340 nm and molecular oxygen in the region of 242 nm?

A. The bond between atoms in molecular oxygen is a double bond.

B. The bonds in ozone are delocalized.

C. The bonds between atoms in ozone are stronger than those in molecular oxygen.

D. The bonds between atoms in molecular oxygen need more energy to break.

Questions 16 and 17 refer to the following reaction.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

16. Which change does **not** increase the initial rate of reaction when $CaCO_3(s)$ is added to excess $HCl(aq)$?

A. Decrease in the size of the $CaCO_3(s)$ particles

B. Increase in the temperature of the reaction mixture

C. Increase in the concentration of $HCl(aq)$, keeping the same volume

D. Increase in the volume of $HCl(aq)$, keeping the same concentration

17. Which methods can be used to monitor the progress of this reaction?

I. Change in colour of this reaction mixture
II. Change in mass of this reaction mixture
III. Change in volume of gas evolved

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

18. What is the equilibrium constant expression, K_c, for the following reaction?

$$2NH_3(g) + 2O_2(g) \rightleftharpoons N_2O(g) + 3H_2O(g)$$

A. $\frac{3[H_2O][N_2O]}{2[NH_3]2[O_2]}$

B. $\frac{[NH_3]^2[O_2]^2}{[N_2O][H_2O]^3}$

C. $\frac{2[NH_3]2[O_2]}{3[H_2O][N_2O]}$

D. $\frac{[N_2O][H_2O]^3}{[NH_3]^2[O_2]^2}$

19. Which of the following does **not** react with dilute $HCl(aq)$?

Extract from activity series

Increasing activity ↑
Na
Zn
H
Cu

A. Na_2CO_3

B. Cu

C. Zn

D. CuO

20. Which of the following is correct?

A. A weak acid is a proton donor and its aqueous solution shows good conductivity.

B. A weak acid is a proton donor and its aqueous solution shows poor conductivity.

C. A weak acid is a proton acceptor and its aqueous solution shows good conductivity.

D. A weak acid is a proton acceptor and its aqueous solution shows poor conductivity.

21. Which element is reduced in the following decomposition?

$$(NH_4)_2Cr_2O_7(s) \rightarrow N_2(g) + Cr_2O_3(s) + 4H_2O(g)$$

A. N

B. H

C. Cr

D. O

22. Which of the following is **not** a redox reaction?

A. $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

B. $C(s) + O_2(g) \rightarrow CO_2(g)$

C. $2CO(g) \rightarrow CO_2(g) + C(s)$

D. $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$

23. What occurs at the anode (positive electrode) during the electrolysis of molten strontium bromide?

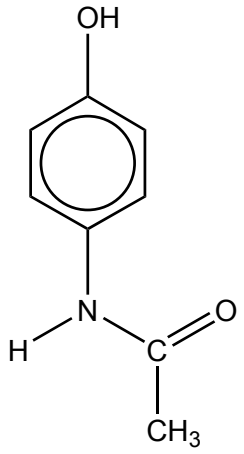
A. Formation of bromine and oxidation

B. Formation of bromine and reduction

C. Formation of strontium and oxidation

D. Formation of strontium and reduction

24. Which functional group is present in paracetamol?



A. Carboxyl

B. Amino

C. Nitrile

D. Hydroxyl

25. Which describes the reaction between a halogen and ethane?

	Mechanism	**Bond fission in halogen**
A.	free radical	homolytic
B.	free radical	heterolytic
C.	addition	homolytic
D.	addition	heterolytic

26. Which conditions are used to convert ethanol to ethanal?

A. Excess oxidizing agent and reflux

B. Excess oxidizing agent and distillation

C. Excess ethanol and reflux

D. Excess ethanol and distillation

27. Which compound contains a secondary carbon atom?

A. $CH_3CH(Cl)CH(CH_3)_2$

B. $(CH_3)_2CHCH_2Cl$

C. $(CH_3)_3CCl$

D. CH_3CH_2Cl

28. Which information can be gained from an infrared (IR) spectrum?

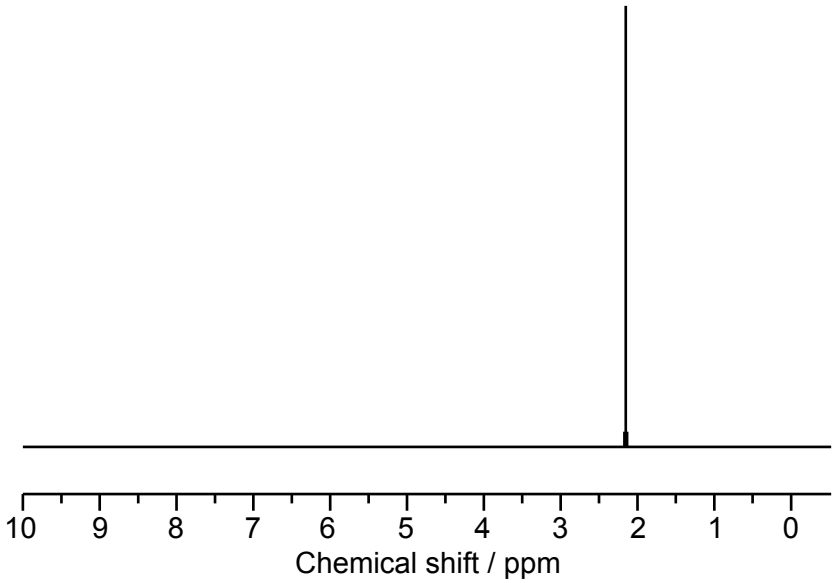
A. Ionization energy of the most abundant element

B. Number of different elements in the compound

C. Bonds present in a molecule

D. Molecular formula of the compound

29. What can be deduced from the following ^1H NMR spectrum?



A. There is only one hydrogen atom in the molecule.

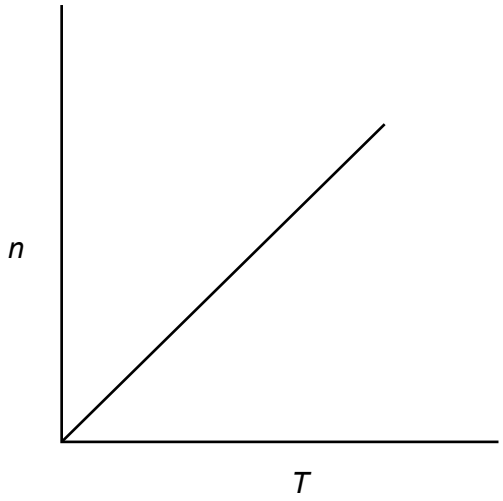
B. There is only one hydrogen environment in the molecule.

C. The molecule is a hydrocarbon.

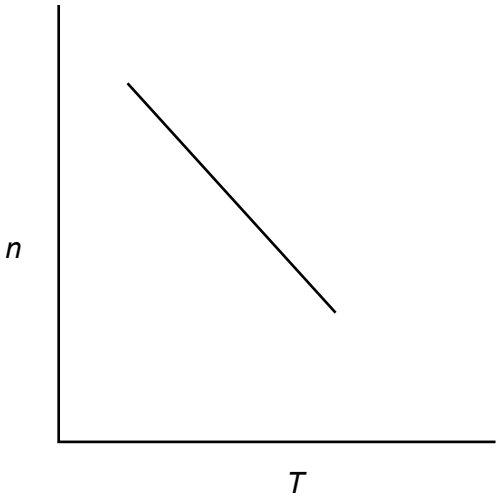
D. There is only one isotope in the element.

30. What is the graphical relationship between n and T in the ideal gas equation, $pV = nRT$, all other variables remaining constant?

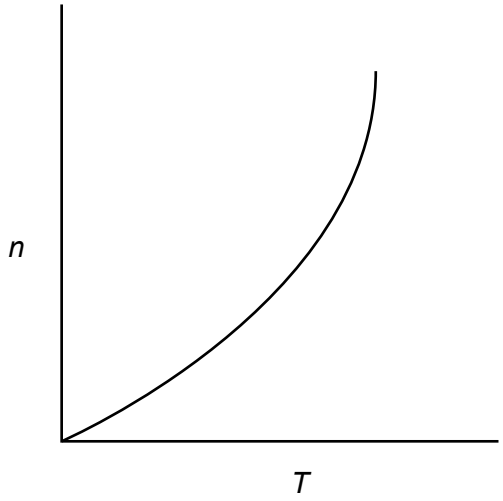
A.



B.



C.



D.