Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1

Friday 13 November 2015 (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]**.

8815 – 6104

The Periodic Table

1	2											3	4	5	6	7	0
1 **H** 1.01			Atomic number **Element** Relative Atomic Mass														2 **He** 4.00
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
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.21	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)															

†	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 146.92	62 **Sm** 150.35	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
‡	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (242)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

1. What is the number of atoms of oxygen in 0.250 mol of hydrated zinc nitrate, $Zn(NO_3)_2 \cdot 6H_2O$?

A. 3.00

B. 12.0

C. 1.81×10^{24}

D. 7.22×10^{24}

2. What is the mass, in g, of 0.500 mol of 1,2-dibromoethane, CH_2BrCH_2Br?
$A_r(H) = 1$; $A_r(C) = 12$; $A_r(Br) = 80$

A. 23.5

B. 47.0

C. 94.0

D. 188

3. The equation for the **complete** combustion of propene, C_3H_6, is shown below.

$$2C_3H_6(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$$

Which mixture, when ignited, will lead to **incomplete** combustion and the formation of CO (g)?

A. 2 dm^3 of propene and 10 dm^3 of oxygen

B. 0.5 dm^3 of propene and 2.3 dm^3 of oxygen

C. 1 dm^3 of propene and 4 dm^3 of oxygen

D. 3 dm^3 of propene and 14 dm^3 of oxygen

4. What is the percentage yield when 1.1 g of ethanal, CH_3CHO, is obtained from 4.6 g of ethanol, CH_3CH_2OH? $M_r(CH_3CH_2OH) = 46$; $M_r(CH_3CHO) = 44$

$$CH_3CH_2OH(l) + [O] \rightarrow CH_3CHO(l) + H_2O(l)$$

A. $\frac{1.1 \times 46 \times 100}{44 \times 4.6}$

B. $\frac{1.1 \times 100}{4.6}$

C. $\frac{4.6 \times 44 \times 100}{4.6 \times 1.1}$

D. $\frac{1.1 \times 46}{44 \times 4.6}$

5. Which species has 16 protons and 17 electrons?

A. S^-

B. S

C. Cl

D. Cl^-

6. Which ion would be deflected **most** in a mass spectrometer?

A. $^{79}Br^+$

B. $^{79}Br^{2+}$

C. $^{81}Br^+$

D. $^{81}Br^{2+}$

7. Which element has the greatest first ionization energy?

A. Al

B. Ar

C. Cl

D. Cs

8. Which element produces hydrogen gas at the greatest rate when added to water?

A. Ca

B. Cs

C. Li

D. Rb

9. Which element forms more than one stable positive ion?

A. Ca

B. Cr

C. Zn

D. Ba

10. Which statement best describes the lattice structure of solid sodium chloride?

A. Each sodium ion is surrounded by one chloride ion.

B. Each chloride ion is surrounded by two sodium ions.

C. Each chloride ion is surrounded by four sodium ions.

D. Each sodium ion is surrounded by six chloride ions.

11. Which compound contains covalent bonds?

A. $CaCO_3$

B. Ca_3N_2

C. CaO

D. CaF_2

12. Which molecule is polar?

A. C_2H_6

B. CH_2Cl_2

C. CO_2

D. CCl_4

13. Which best describes the bonding in iron?

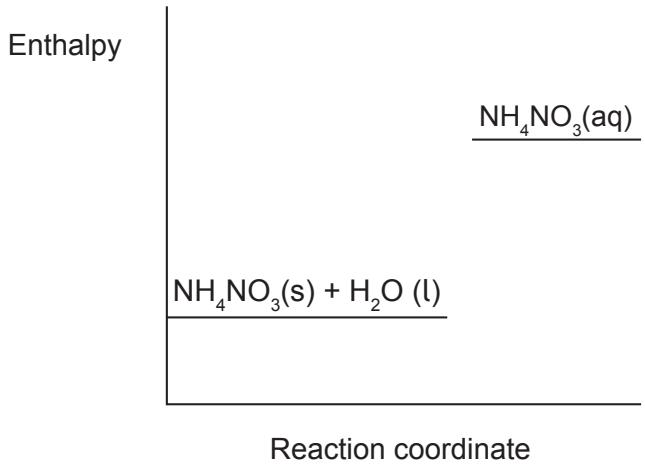
A. Lattice of nuclei in a sea of delocalized electrons

B. Lattice of protons in a sea of negative ions

C. Lattice of positive ions in a sea of negative ions

D. Lattice of positive ions in a sea of delocalized electrons

14. What is correct for the reaction represented in the diagram?



A. The product is more stable than the reactants and the sign of ΔH is negative.

B. The product is more stable than the reactants and the sign of ΔH is positive.

C. The product is less stable than the reactants and the sign of ΔH is negative.

D. The product is less stable than the reactants and the sign of ΔH is positive.

15. What is the heat energy change, in kJ, when the temperature of a 10 g piece of tungsten increases from 15 °C to 20 °C? (Specific heat capacity of tungsten = $0.13\,kJ\,kg^{-1}K^{-1}$)

A. $\dfrac{0.13 \times 10 \times (273 + 5)}{1000}$

B. $\dfrac{0.13 \times 10 \times 5}{1000}$

C. $0.13 \times 10 \times (273 + 5)$

D. $0.13 \times 10 \times 5$

16. Which equation represents the average bond enthalpy of the C–F bond?

A. $\frac{1}{4}CF_4(g) \rightarrow \frac{1}{4}C(g) + F(g)$

B. $\frac{1}{4}CF_4(g) \rightarrow \frac{1}{4}C(s) + F(g)$

C. $\frac{1}{4}CF_4(s) \rightarrow \frac{1}{4}C(s) + \frac{1}{2}F_2(g)$

D. $\frac{1}{4}CF_4(g) \rightarrow \frac{1}{4}C(g) + \frac{1}{2}F_2(g)$

17. Which best describes the particles in a gas when the temperature rises from 23 °C to 46 °C?

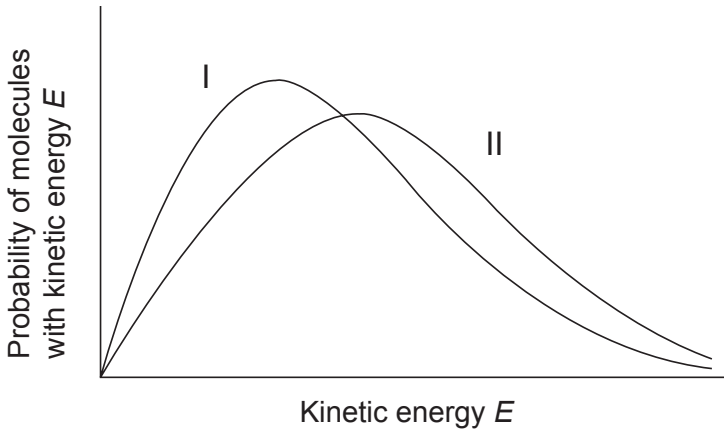
A. The average energy doubles.

B. The average energy increases.

C. The average velocity of the particles increases by a factor of $\sqrt{2}$.

D. The average energy remains constant but the velocity of some particles increases.

18. Curves I and II represent samples of the same gas at a constant pressure but at different temperatures. The areas under curves I and II are equal. What does curve II represent?



A. Curve II is at the lower temperature and there are less molecules in the sample.

B. Curve II is at the lower temperature and there are the same number of molecules in the samples.

C. Curve II is at the higher temperature and there are more molecules in the sample.

D. Curve II is at the higher temperature and there are the same number of molecules in the samples.

19. What is the equilibrium constant expression for the following reaction?

$$2CH_3OH(g) + O_2(g) \rightleftharpoons 2CH_2O(g) + 2H_2O(g)$$

A. $K_c = \dfrac{[CH_2O]^2 + [H_2O]^2}{[CH_3OH]^2 + [O_2]}$

B. $K_c = \dfrac{[CH_2O][H_2O]^2}{[CH_3OH][O_2]}$

C. $K_c = \dfrac{[CH_2O]^2\,[H_2O]^2}{[CH_3OH]^2\,[O_2]}$

D. $K_c = \dfrac{[CH_3OH][O_2]}{[CH_2O][H_2O]}$

20. Which best describes a reaction in a state of equilibrium?

A. The rates of the forward and reverse reactions are zero and the concentrations of products and reactants are equal.

B. The rate of the forward reaction equals the rate of the reverse reaction and the concentrations of products and reactants are equal.

C. The rates of the forward and reverse reactions are zero and the concentrations of products and reactants are constant.

D. The rate of the forward reaction equals the rate of the reverse reaction and the concentrations of products and reactants are constant.

21. Which of the following molecules can act as a Lewis acid but not as a Brønsted–Lowry acid?

A. BF_3

B. PCl_3

C. NH_3

D. H_2O

22. Which is a $0.001\,mol\,dm^{-3}$ solution of a weak acid?

	Conductivity	pH
A.	poor	5
B.	good	7
C.	poor	10
D.	good	3

23. Which element undergoes reduction in the following reaction?

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

A. Cr

B. H

C. N

D. O

24. Which best describes reduction?

A. Increase in oxidation number and gain of electrons

B. Increase in oxidation number and loss of electrons

C. Decrease in oxidation number and gain of electrons

D. Decrease in oxidation number and loss of electrons

25. Which is **not** an essential component of a voltaic cell?

A. Negative electrode (anode)

B. Positive electrode (cathode)

C. Electrolyte

D. Voltmeter

26. Which pair of compounds can be distinguished by reacting them with dilute bromine water in the dark?

A. CH_3CH_2COOH and CH_3CH_2CHO

B. $CH_3CH_2CHCHCH_3$ and $CH_3CH_2CH_2CH_2CH_3$

C. $CH_3CH_2CH(CH_3)_2$ and $CH_3CH_2CH_2CH_2CH_3$

D. $CH_3CH_2CH_2CHBrCH_3$ and $CH_3CH_2CHBrCH_2CH_3$

27. Which is **not** a possible product when propane, C_3H_8, reacts with chlorine in sunlight?

A. H_2

B. C_6H_{14}

C. C_3H_7Cl

D. Cl_2

28. Which compound is most soluble in water?

A. CH_3CH_2CHO

B. $CH_3CH_2CH_2CHO$

C. $CH_3CH_2CO_2H$

D. $CH_3CH_2CH_2CO_2H$

29. Which are features of successive members of a homologous series?

I. Similar chemical properties
II. Same general formula
III. Differ by $-CH_2-$

A. I and II only

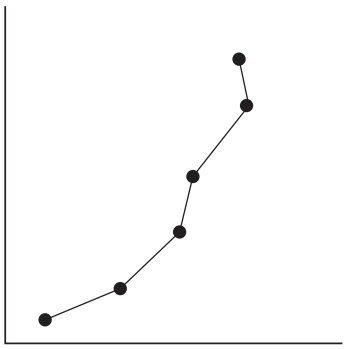
B. I and III only

C. II and III only

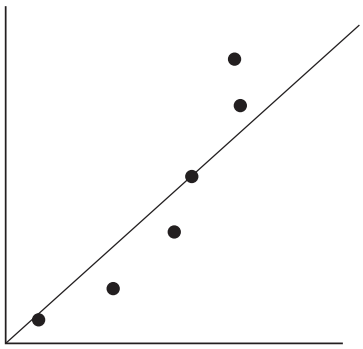
D. I, II and III

30. Which is the best-fit line or best-fit curve for the points plotted on the graph?

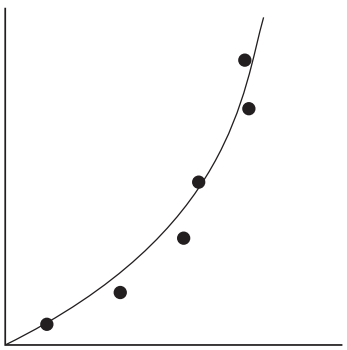
A.



B.



C.



D.