Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1

Thursday 12 May 2016 (morning)

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]**.

2216 – 6104

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. Which equation represents sublimation?

A. $2Al(s) + 3I_2(g) \rightarrow 2AlI_3(s)$

B. $HgCl_2(s) \rightarrow HgCl_2(g)$

C. $I_2(g) \rightarrow I_2(s)$

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

2. For which compound is the empirical formula the same as the molecular formula?

$A_r(H) = 1$; $A_r(C) = 12$; $A_r(O) = 16$

	Empirical formula	**Molar mass / g mol^{-1}**
A.	CO_2H	90
B.	CH_3O	62
C.	C_2H_4O	88
D.	C_4H_8O	72

3. In which mixture is NaOH the limiting reagent?

A. 0.20 mol NaOH + 0.10 mol H_2SO_4

B. 0.10 mol NaOH + 0.10 mol H_2SO_4

C. 0.20 mol NaOH + 0.10 mol HNO_3

D. 0.10 mol NaOH + 0.10 mol HNO_3

4. Why do gases deviate from the ideal gas law at high pressures?

A. Molecules have finite volume.

B. Cohesive forces increase the volume from the ideal.

C. Increasing pressure increases the temperature of the gas.

D. Collisions between molecules occur more frequently as pressure increases.

5. Which is correct for the chromium isotope $^{53}_{24}Cr$?

A. 24 neutrons and 53 nucleons

B. 24 protons and 29 nucleons

C. 24 protons and 29 neutrons

D. 24 electrons and 53 neutrons

6. Which electron configuration is correct for the selenide ion, Se^{2-}?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^4$

B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^6$

C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$

D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$

7. Which element is a metalloid?

A. Co

B. As

C. Cs

D. Es

8. Which periodic trend is described correctly?

	Trend in	Down the group (top to bottom)	Across the period (left to right)
A.	atomic radius	increases	increases
B.	ionic radius	decreases	increases
C.	first ionization energy	decreases	decreases
D.	electronegativity	decreases	increases

9. Which molecule is non-polar?

A. OF_2

B. NH_3

C. BF_3

D. SO_2

10. Which compound contains both ionic and covalent bonds?

A. SiH_4

B. $NaNO_3$

C. H_2CO

D. Na_2S

11. Which compound has resonance structures?

A. C_6H_{12}

B. CH_3CHO

C. NaBr

D. Na_2CO_3

12. Which of the following are van der Waals' forces?

I. Dipole-dipole forces
II. Hydrogen bonds
III. London (dispersion) forces

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

13. When 25.0 cm^3 0.100 mol dm^{-3} NaOH (aq) is mixed with 25.0 cm^3 0.100 mol dm^{-3} HCl (aq) at the same temperature, a temperature rise, ΔT, is recorded. What is the expression, in kJ mol^{-1}, for the enthalpy of neutralisation? (Assume the density of the mixture = 1.00 g cm^{-3} and its specific heat capacity = 4.18 kJ kg^{-1} K^{-1} = 4.18 J g^{-1} K^{-1})

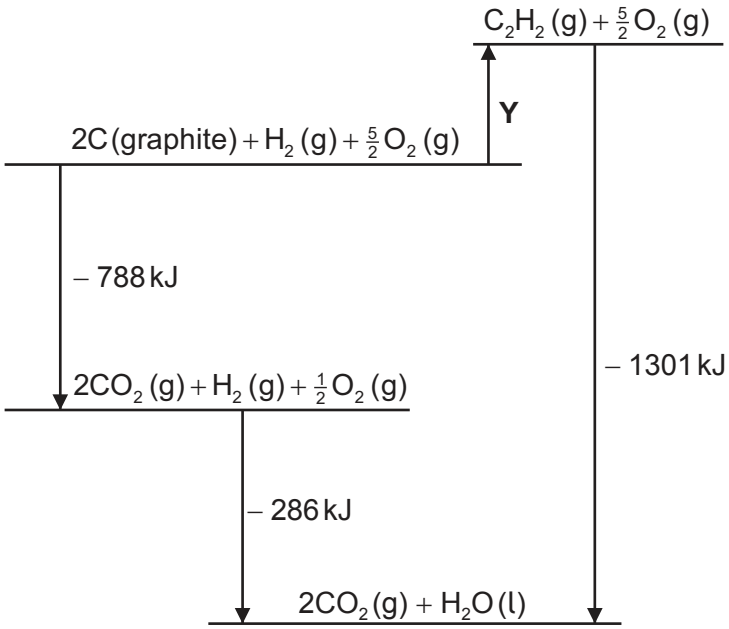
A. $-\frac{25.0 \times 4.18 \times \Delta T}{50.0 \times 0.100}$

B. $-\frac{25.0 \times 4.18 \times \Delta T}{25.0 \times 0.100}$

C. $-\frac{50.0 \times 4.18 \times \Delta T}{50.0 \times 0.100}$

D. $-\frac{50.0 \times 4.18 \times \Delta T}{25.0 \times 0.100}$

14. What is the enthalpy of formation of ethyne, in kJ mol^{-1}, represented by the arrow **Y** on the diagram?



A. – 788 – 286 + 1301

B. – 788 – 286 – 1301

C. + 788 + 286 – 1301

D. + 788 + 286 + 1301

15. Which equation represents the average bond enthalpy of the Si–H bond in SiH_4?

A. $SiH_4(g) \rightarrow SiH_3(g) + H(g)$

B. $\frac{1}{4} SiH_4(g) \rightarrow \frac{1}{4} Si(g) + H(g)$

C. $SiH_4(g) \rightarrow SiH_3(g) + \frac{1}{2} H_2(g)$

D. $SiH_4(g) \rightarrow Si(g) + 4H(g)$

16. Which conditions must be met for a reaction to take place?

I. Reactants collide with sufficient energy.
II. Reactants collide with correct orientation.
III. Reactants must be in the same state.

A. I and II only

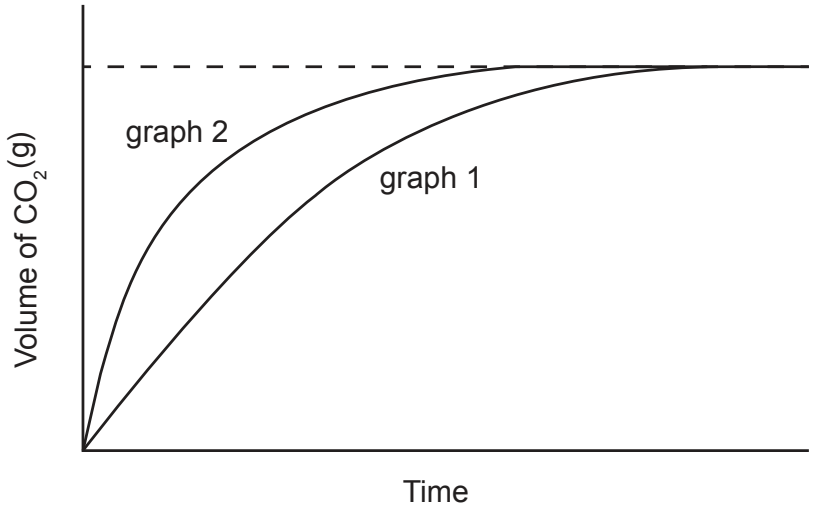
B. I and III only

C. II and III only

D. I, II and III

17. Graph 1 shows a plot of volume of $CO_2(g)$ against time for the reaction of $CaCO_3(s)$ with $1.00\,mol\,dm^{-3}$ $HCl(aq)$. The acid is the limiting reagent and entirely covers the lumps of $CaCO_3(s)$.

Which set of conditions is most likely to give the data plotted in graph 2 when the same mass of $CaCO_3(s)$ is reacted with the same volume of $HCl(aq)$ at the same temperature?



	Size of lumps	Concentration of acid / $mol\,dm^{-3}$
A.	larger	1.00
B.	smaller	0.05
C.	smaller	1.00
D.	larger	0.05

18. What is the effect of increasing temperature on the equilibrium?

$$ClNO_2(g) + NO(g) \rightleftharpoons ClNO(g) + NO_2(g) \qquad \Delta H^{\ominus} = -18.4\,kJ$$

	Position of equilibrium	K_c
A.	moves to left	decreases
B.	moves to left	no change
C.	moves to right	no change
D.	moves to right	increases

19. Which is a conjugate Brønsted–Lowry acid-base pair?

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

A. CH_3COO^- / H_3O^+

B. H_2O / CH_3COO^-

C. H_2O / H_3O^+

D. CH_3COOH / H_2O

20. Which of the following gases does **not** result in acid deposition?

A. CO_2

B. NO_2

C. NO

D. SO_2

21. Applying IUPAC rules, what is the name of MnO_2?

A. Magnesium(II) oxide

B. Manganese(II) oxide

C. Magnesium(IV) oxide

D. Manganese(IV) oxide

22. Which statement is correct for a voltaic but **not** for an electrolytic cell?

A. An electrolyte is required.

B. The anode is where oxidation occurs.

C. Ions move in the electrolyte.

D. Electrons flow from the negative electrode to the positive electrode.

23. How many alcohols have the general formula $C_4H_{10}O$?

A. 3

B. 4

C. 5

D. 6

24. What is the general formula of the alkyne series?

A. C_nH_n

B. C_nH_{2n-2}

C. C_nH_{2n}

D. C_nH_{2n+2}

25. Which compound can both be esterified and turn acidified potassium dichromate(VI) solution green?

A. $(CH_3)_3COH$

B. $CH_3CH_2CO_2H$

C. $(CH_3)_2CHOH$

D. $CH_3CH_2COCH_3$

26. What is the mechanism of the reaction between ethane and chlorine in sunlight?

A. Free radical substitution

B. Free radical addition

C. Electrophilic substitution

D. Electrophilic addition

27. A measuring cylinder was used to obtain a known volume of a liquid. The volume was read from the top of the meniscus and the liquid completely emptied into a flask. The exact same process was then repeated. Which statement is correct about the overall described procedure and the volumes measured?

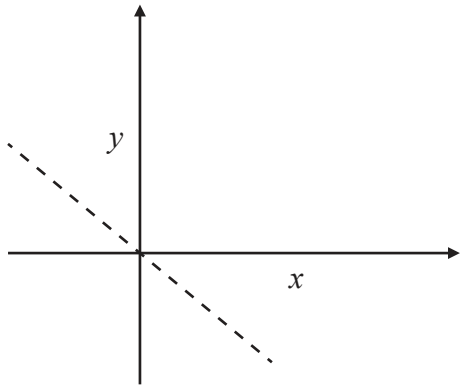
A. There is a systematic error and the volumes measured are accurate.

B. There is a random error and the volumes measured are accurate.

C. There is a random error and the volumes measured are inaccurate.

D. There is a systematic error and the volumes measured are inaccurate.

28. What is the relationship between the two variables sketched on the graph?



A. y is proportional to x

B. y is inversely proportional to x

C. y is proportional to $-x$

D. y decreases exponentially with an increase in x

29. Which feature of a molecule can be determined from its ^{1}H NMR spectrum?

A. Number of hydrogen environments

B. Total mass of hydrogen atoms present

C. Vibration frequency of C–H bonds

D. Ionization energy of a hydrogen atom

30. Which molecule has an index of hydrogen deficiency (IHD) = 1?

A. C_6H_6

B. C_2Cl_2

C. C_4H_9N

D. C_2H_6O