88136104

CHEMISTRY
STANDARD LEVEL
**PAPER 1**

Monday 18 November 2013 (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	0
1 **H** 1.01																		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)																

Atomic number

Element

Relative atomic mass

†	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 total number of oxygen atoms in 0.200 mol of glucose, $C_6H_{12}O_6$?

   A.   1.20

   B.   6.00

   C. 1.20×10^{23}

   D. 7.22×10^{23}

2.   Which represents an empirical formula?

   A. C_2H_4

   B. B_2H_6

   C. Al_2O_3

   D. C_6H_6

3.   What are the coefficients of $H_2SO_4(aq)$ and $H_3PO_4(aq)$ when the following equation is balanced using the smallest possible whole numbers?

$$\underline{\quad} Ca_3(PO_4)_2(s) + \underline{\quad} H_2SO_4(aq) \rightarrow \underline{\quad} CaSO_4(s) + \underline{\quad} H_3PO_4(aq)$$
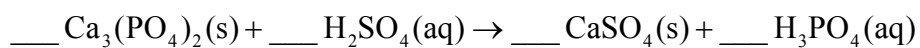
	Coefficient of $H_2SO_4(aq)$	Coefficient of $H_3PO_4(aq)$
A.	1	2
B.	2	3
C.	3	1
D.	3	2

4. What is the pressure, in Pa, if 3 mol of gas occupies $500 \, cm^3$ at $25 \, °C$?

Given: $R = 8.31 \, J \, K^{-1} \, mol^{-1}$
$10^{-3} \, m^3 = 10^3 \, cm^3$

A. $\dfrac{3 \times 8.31 \times 298}{500}$

B. $\dfrac{3 \times 8.31 \times 25}{0.0005}$

C. $\dfrac{3 \times 8.31 \times 25}{500}$

D. $\dfrac{3 \times 8.31 \times 298}{0.0005}$

5. $7.102 \, g$ of $Na_2SO_4 (M = 142.04 \, g \, mol^{-1})$ is dissolved in water to prepare $0.5000 \, dm^3$ of solution. What is the concentration of Na_2SO_4 in $mol \, dm^{-3}$?

A. 2.500×10^{-2}

B. 1.000×10^{-1}

C. 1.000×10

D. 1.000×10^2

6. What are the numbers of neutrons and electrons in the iodine ion, $^{125}I^+$?

	Neutrons	Electrons
A.	53	53
B.	72	52
C.	72	53
D.	125	52

7. In the emission spectrum of the hydrogen atom, which electronic transition would produce a line in the ultraviolet region of the electromagnetic spectrum?

A. $n = 1 \rightarrow n = 3$

B. $n = 3 \rightarrow n = 1$

C. $n = 3 \rightarrow n = 2$

D. $n = 10 \rightarrow n = 2$

8. Which statements are correct for magnesium?

I. The electron arrangement of the atom is 2,8,2.

II. The atom has two electrons in its outermost (valence) energy level.

III. Its oxide is basic.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

9. Which series is arranged in order of **increasing** radius?

A. $F < Cl^- < Cl$

B. $Rb < K < Na$

C. $Al^{3+} < Mg^{2+} < Na^+$

D. $I^- < Br^- < Cl^-$

10. What is the formula of calcium nitride?

    A. Ca_3N_2

    B. Ca_2N_3

    C. $Ca(NO_2)_2$

    D. $Ca(NO_3)_2$

11. Which compounds have an ionic lattice structure in the solid state?

    I.   Silicon dioxide

    II.   Sodium fluoride

    III.   Ammonium nitrate

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

12. The Lewis (electron dot) structure of aspirin is represented below.
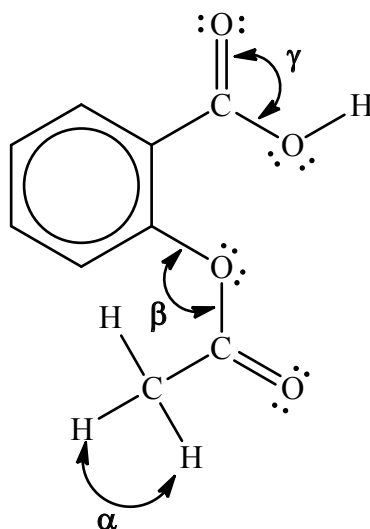
What are the approximate values of the bond angles **α**, **β** and **γ**, in the molecule?

	α	β	γ
A.	90°	104.5°	104.5°
B.	90°	120°	120°
C.	109.5°	120°	120°
D.	109.5°	104.5°	120°

13. Which intermolecular forces exist between the following molecules?

	H_2Se	CO	H_2
A.	van der Waals' and dipole-dipole	van der Waals' and dipole-dipole	van der Waals' only
B.	van der Waals', dipole-dipole and hydrogen bonding	van der Waals' only	van der Waals' and hydrogen bonding
C.	van der Waals', dipole-dipole and hydrogen bonding	van der Waals' and dipole-dipole	van der Waals' only
D.	van der Waals' and dipole-dipole	van der Waals' and dipole-dipole	van der Waals' and hydrogen bonding

14. Which compound has the highest boiling point?

A. CH_3CH_3

B. CH_3OH

C. CH_3CH_2OH

D. $CH_3CH_2CH_3$

15. Which processes are exothermic?

I. $CH_3CH_2CH_3(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

II. $Cl_2(g) \rightarrow 2Cl(g)$

III. $CH_3CH_2COOH(aq) + NaOH(aq) \rightarrow CH_3CH_2COONa(aq) + H_2O(l)$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

16. Consider the following two equations.

$$2Ca(s) + O_2(g) \rightarrow 2CaO(s) \qquad\qquad \Delta H^{\ominus} = +x \text{ kJ}$$
$$Ca(s) + 0.5O_2(g) + CO_2(g) \rightarrow CaCO_3(s) \qquad \Delta H^{\ominus} = +y \text{ kJ}$$
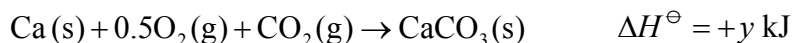
What is $\Delta H^{\ominus}$, in kJ, for the following reaction?

$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$$
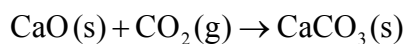
A. $y - 0.5x$

B. $y - x$

C. $0.5 - y$

D. $x - y$

17. Which factors can increase the rate of a chemical reaction?

       I.   Increasing the pressure in gaseous reactions

      II.   Increasing the temperature in gaseous reactions

      III.   Increasing the particle size of a solid in a reaction

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

18. The diagram below shows the energy changes for a reaction with and without a catalyst. Which symbols represent the activation energy, E_a, and the enthalpy change, ΔH, for the reaction with a catalyst?
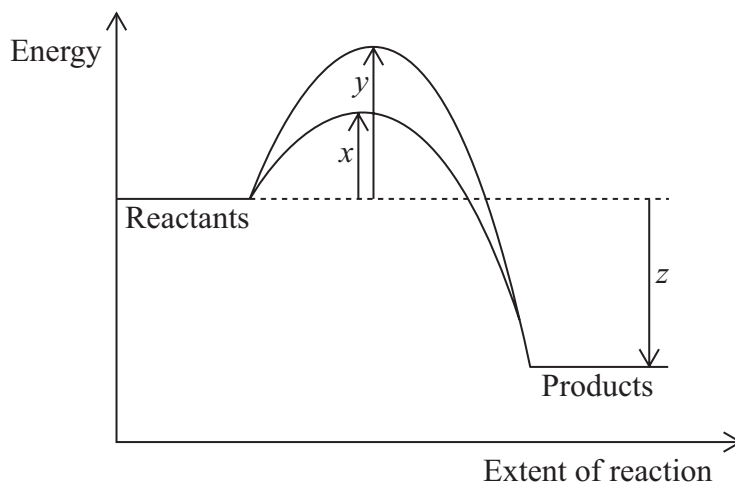
	E_a (with a catalyst)	ΔH
A.	x	z
B.	y	z
C.	z	x
D.	$y - x$	z

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

$$2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g)$$
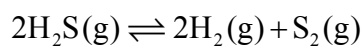
A. $K_c = \dfrac{[H_2S]^2}{[H_2]^2[S_2]}$

B. $K_c = \dfrac{[H_2][S_2]}{[H_2S]}$

C. $K_c = \dfrac{2[H_2] + [S_2]}{2[H_2S]}$

D. $K_c = \dfrac{[H_2]^2[S_2]}{[H_2S]^2}$

20. What happens to the position of equilibrium and the value of K_c in the following reaction when the temperature is decreased?

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H^\ominus = +57.2\,kJ$$
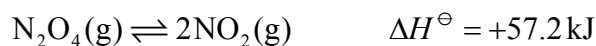
	Position of equilibrium	Value of K_c
A.	shifts towards reactants	decreases
B.	shifts towards reactants	increases
C.	shifts towards products	decreases
D.	shifts towards products	increases

21. What are the conjugate acid–base pairs in the following reaction?

$$HCO_3^-(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + H_2CO_3(aq)$$
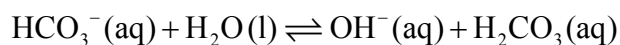
	Brønsted–Lowry acid	Brønsted–Lowry base	Conjugate acid	Conjugate base
A.	$HCO_3^-(aq)$	$H_2O(l)$	$H_2CO_3(aq)$	$OH^-(aq)$
B.	$H_2CO_3(aq)$	$OH^-(aq)$	$HCO_3^-(aq)$	$H_2O(l)$
C.	$H_2O(l)$	$HCO_3^-(aq)$	$H_2CO_3(aq)$	$OH^-(aq)$
D.	$H_2O(l)$	$HCO_3^-(aq)$	$OH^-(aq)$	$H_2CO_3(aq)$

22. Which group of three compounds contains only weak acids and bases?

A.	$Ba(OH)_2$	CH_3NH_2	CH_3COOH
B.	$CH_3CH_2CH_2COOH$	$CH_3CH_2NH_2$	$HCOOH$
C.	NH_3	HNO_3	CH_3CH_2COOH
D.	NH_3	$NaOH$	H_2CO_3

23. What is the name of $Co_3(PO_4)_2$?

A. Cobalt(II) phosphite

B. Cobalt(II) phosphate

C. Cobalt(III) phosphite

D. Cobalt(III) phosphate

24. Consider the following reaction.

$$Sn(s) + 4HNO_3(aq) \rightarrow SnO_2(s) + 4NO_2(g) + 2H_2O(g)$$
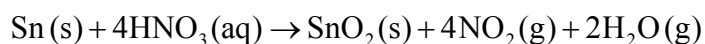
Which statement is correct?

A. HNO_3 is the oxidizing agent because it undergoes oxidation.

B. HNO_3 is the reducing agent because the oxidation number of nitrogen changes from +5 to +4.

C. Sn is the oxidizing agent because it undergoes reduction.

D. Sn is the reducing agent because the oxidation number of tin changes from 0 to +4.

25. Which statements are correct for the electrolysis of molten lead(II) bromide, $PbBr_2(l)$?

I. Pb^{2+} is reduced at the negative electrode (cathode).

II. Br^- is oxidized at the positive electrode (anode).

III. Bubbles of a brown gas are observed at the negative electrode (cathode).

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 $(CH_3)_3CCOCH_3$, applying IUPAC rules?

A. 2,2-dimethylbutan-3-one

B. 3,3-dimethylbutan-2-one

C. 2,2-dimethylbutanal

D. 3,3-dimethylbutanal

27. What is the function of the ultraviolet light used in the reaction between ethane and bromine?

    A.   It causes bromine free radicals to form bromine molecules.

    B.   It causes bromide ions to form bromine molecules.

    C.   It causes bromine molecules to form bromide ions.

    D.   It causes bromine molecules to form bromine free radicals.

28. What is the condensed structural formula of the organic compound that forms when concentrated sulfuric acid is added to 2,3-dimethylbut-2-ene, $(CH_3)_2C=C(CH_3)_2$, followed by water?

    A. $(CH_3)_2CHC(OSO_3H)(CH_3)_2$

    B. $(CH_3)_2CHC(OH)(CH_3)_2$

    C. $(CH_3)_2C(OH)C(OH)(CH_3)_2$

    D. $(CH_3)_2(CH_2)_2(CH_3)_2$

29. Which organic product forms in the following reaction?

$$(CH_3)_2CHOH \xrightarrow[\text{reflux}]{K_2Cr_2O_7/H^+}$$
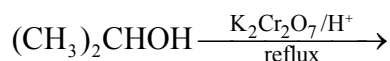
    A.   Ethanoic acid

    B.   Propanal

    C.   Propanone

    D.   Propanoic acid

30. A student measured the mass and volume of a piece of silver and recorded the following values.

Mass of empty weighing bottle	1.0800 g
Mass of weighing bottle with piece of silver	11.5700 g
Volume of silver	1.00 cm^3

Which value, in g cm^{-3}, for the density of silver should the student report in her laboratory notebook?

A.   10.49

B.   10.4900

C.   10.5

D.   10.500