

**Chemistry**  
**Standard level**  
**Paper 1**

Thursday 14 May 2015 (afternoon)

45 minutes

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**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

| Atomic number |                     | Element |                     | Relative atomic mass |                     |    |                     |    |                     |    |                    |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                    |    |                     |
|---------------|---------------------|---------|---------------------|----------------------|---------------------|----|---------------------|----|---------------------|----|--------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|--------------------|----|---------------------|
| 1             | <b>H</b><br>1.01    | 2       | <b>He</b><br>4.00   |                      |                     |    |                     |    |                     |    |                    |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                    |    |                     |
| 3             | <b>Li</b><br>6.94   | 4       | <b>Be</b><br>9.01   | 5                    | <b>B</b><br>10.81   | 6  | <b>C</b><br>12.01   | 7  | <b>N</b><br>14.01   | 8  | <b>O</b><br>16.00  | 9  | <b>F</b><br>19.00   | 10 | <b>Ne</b><br>20.18  |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                    |    |                     |
| 11            | <b>Na</b><br>22.99  | 12      | <b>Mg</b><br>24.31  | 13                   | <b>Al</b><br>26.98  | 14 | <b>Si</b><br>28.09  | 15 | <b>P</b><br>30.97   | 16 | <b>S</b><br>32.06  | 17 | <b>Cl</b><br>35.45  | 18 | <b>Ar</b><br>39.95  |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                    |    |                     |
| 19            | <b>K</b><br>39.10   | 20      | <b>Ca</b><br>40.08  | 21                   | <b>Sc</b><br>44.96  | 22 | <b>Ti</b><br>47.90  | 23 | <b>V</b><br>50.94   | 24 | <b>Cr</b><br>52.00 | 25 | <b>Mn</b><br>54.94  | 26 | <b>Fe</b><br>55.85  | 27 | <b>Co</b><br>58.93  | 28 | <b>Ni</b><br>58.71  | 29 | <b>Cu</b><br>63.55  | 30 | <b>Zn</b><br>65.37  | 31 | <b>Ga</b><br>69.72  | 32 | <b>Ge</b><br>72.59  | 33 | <b>As</b><br>74.92  | 34 | <b>Se</b><br>78.96  | 35 | <b>Br</b><br>79.90 | 36 | <b>Kr</b><br>83.80  |
| 37            | <b>Rb</b><br>85.47  | 38      | <b>Sr</b><br>87.62  | 39                   | <b>Y</b><br>88.91   | 40 | <b>Zr</b><br>91.22  | 41 | <b>Nb</b><br>92.91  | 42 | <b>Mo</b><br>95.94 | 43 | <b>Tc</b><br>98.91  | 44 | <b>Ru</b><br>101.07 | 45 | <b>Rh</b><br>102.91 | 46 | <b>Pd</b><br>106.42 | 47 | <b>Ag</b><br>107.87 | 48 | <b>Cd</b><br>112.40 | 49 | <b>In</b><br>114.82 | 50 | <b>Sn</b><br>118.69 | 51 | <b>Sb</b><br>121.75 | 52 | <b>Te</b><br>127.60 | 53 | <b>I</b><br>126.90 | 54 | <b>Xe</b><br>131.30 |
| 55            | <b>Cs</b><br>132.91 | 56      | <b>Ba</b><br>137.34 | 57 †                 | <b>La</b><br>138.91 | 72 | <b>Hf</b><br>178.49 | 73 | <b>Ta</b><br>180.95 | 74 | <b>W</b><br>183.85 | 75 | <b>Re</b><br>186.21 | 76 | <b>Os</b><br>190.21 | 77 | <b>Ir</b><br>192.22 | 78 | <b>Pt</b><br>195.09 | 79 | <b>Au</b><br>196.97 | 80 | <b>Hg</b><br>200.59 | 81 | <b>Tl</b><br>204.37 | 82 | <b>Pb</b><br>207.19 | 83 | <b>Bi</b><br>208.98 | 84 | <b>Po</b><br>(210)  | 85 | <b>At</b><br>(210) | 86 | <b>Rn</b><br>(222)  |
| 87            | <b>Fr</b><br>(223)  | 88      | <b>Ra</b><br>(226)  | 89 †                 | <b>Ac</b><br>(227)  |    |                     |    |                     |    |                    |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                    |    |                     |

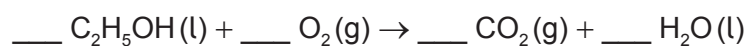
†

|    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |    |                     |
|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|
| 58 | <b>Ce</b><br>140.12 | 59 | <b>Pr</b><br>140.91 | 60 | <b>Nd</b><br>144.24 | 61 | <b>Pm</b><br>146.92 | 62 | <b>Sm</b><br>150.35 | 63 | <b>Eu</b><br>151.96 | 64 | <b>Gd</b><br>157.25 | 65 | <b>Tb</b><br>158.92 | 66 | <b>Dy</b><br>162.50 | 67 | <b>Ho</b><br>164.93 | 68 | <b>Er</b><br>167.26 | 69 | <b>Tm</b><br>168.93 | 70 | <b>Yb</b><br>173.04 | 71 | <b>Lu</b><br>174.97 |
|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|----|---------------------|

‡

|    |                     |    |                     |    |                    |    |                    |    |                    |    |                    |    |                    |    |                    |    |                    |    |                    |     |                    |     |                    |     |                    |     |                    |
|----|---------------------|----|---------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|-----|--------------------|-----|--------------------|-----|--------------------|-----|--------------------|
| 90 | <b>Th</b><br>232.04 | 91 | <b>Pa</b><br>231.04 | 92 | <b>U</b><br>238.03 | 93 | <b>Np</b><br>(237) | 94 | <b>Pu</b><br>(242) | 95 | <b>Am</b><br>(243) | 96 | <b>Cm</b><br>(247) | 97 | <b>Bk</b><br>(247) | 98 | <b>Cf</b><br>(251) | 99 | <b>Es</b><br>(254) | 100 | <b>Fm</b><br>(257) | 101 | <b>Md</b><br>(258) | 102 | <b>No</b><br>(259) | 103 | <b>Lr</b><br>(260) |
|----|---------------------|----|---------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|-----|--------------------|-----|--------------------|-----|--------------------|-----|--------------------|

1. Combustion of ethanol takes place according to the following unbalanced equation.



What is the mole ratio of ethanol to oxygen in the balanced equation?

- A. 1:1  
B. 2:1  
C. 1:3  
D. 2:7
2. Which sample contains the largest amount, in mol, of oxygen atoms?
- A. 0.20 mol  $\text{P}_2\text{O}_5$   
B. 0.30 mol  $\text{O}_3$   
C. 0.40 mol  $\text{CH}_3\text{COOH}$   
D. 0.80 mol  $\text{H}_2\text{O}$
3. Which compound has the highest percentage of carbon by mass?
- A.  $\text{CH}_4$   
B.  $\text{C}_2\text{H}_4$   
C.  $\text{C}_4\text{H}_{10}$   
D.  $\text{C}_6\text{H}_6$
4. Which solution contains the biggest amount, in mol, of chloride ions?
- A.  $20 \text{ cm}^3$  of  $0.50 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl}$   
B.  $60 \text{ cm}^3$  of  $0.20 \text{ mol dm}^{-3} \text{ MgCl}_2$   
C.  $70 \text{ cm}^3$  of  $0.30 \text{ mol dm}^{-3} \text{ NaCl}$   
D.  $100 \text{ cm}^3$  of  $0.30 \text{ mol dm}^{-3} \text{ ClCH}_2\text{COOH}$

5. Which statement about the isotopes of nitrogen is correct?

|    | Number of electrons | Number of neutrons | Mass number |
|----|---------------------|--------------------|-------------|
| A. | same                | same               | same        |
| B. | same                | same               | different   |
| C. | same                | different          | different   |
| D. | different           | different          | different   |

6. Ultraviolet radiation has a shorter wavelength than infrared radiation. How does the frequency and energy of ultraviolet radiation compare with infrared radiation?

|    | Frequency | Energy |
|----|-----------|--------|
| A. | higher    | higher |
| B. | higher    | lower  |
| C. | lower     | higher |
| D. | lower     | lower  |

7. What is the total number of valence electrons in  $\text{CH}_3\text{COO}^-$ ?

- A. 16
- B. 22
- C. 23
- D. 24

8. What is the definition of the term *first ionization energy*?

- A. The energy released when one mole of electrons is removed from one mole of gaseous atoms.
- B. The energy required to remove one mole of electrons from one mole of gaseous atoms.
- C. The energy released when one mole of gaseous atoms gains one mole of electrons.
- D. The energy required to add one mole of electrons to one mole of gaseous atoms.

9. What describes the structure of silicon and silicon dioxide?

|    | Silicon     |                              | Silicon Dioxide |                             |
|----|-------------|------------------------------|-----------------|-----------------------------|
|    | Shape       | Si–Si bonds per silicon atom | Shape           | Si–O bonds per silicon atom |
| A. | planar      | 4                            | planar          | 4                           |
| B. | linear      | 2                            | linear          | 2                           |
| C. | tetrahedral | 4                            | linear          | 2                           |
| D. | tetrahedral | 4                            | tetrahedral     | 4                           |

10. Which molecules react to form a dative covalent (coordinate) bond?

- A.  $\text{CH}_4$  and  $\text{NH}_3$
- B.  $\text{C}_2\text{H}_2$  and  $\text{Cl}_2$
- C.  $\text{NH}_3$  and  $\text{HF}$
- D.  $\text{Cl}_2$  and  $\text{HF}$

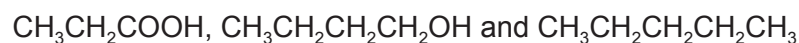
11. What describes the relationship between diamond, graphite and  $\text{C}_{60}$  fullerene?

- A. Allotropes
- B. Isomers
- C. Isotopes
- D. Polymers

12. Which forces are present between molecules of carbon dioxide in the solid state?

- A. Permanent dipole-permanent dipole interactions
- B. Temporary dipole-induced dipole interactions (London/dispersion forces)
- C. Covalent bonding
- D. Ionic bonding

13. The following compounds have similar molar masses:



What is the order of **increasing** boiling points?

- A.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{COOH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- B.  $\text{CH}_3\text{CH}_2\text{COOH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- C.  $\text{CH}_3\text{CH}_2\text{COOH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- D.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} < \text{CH}_3\text{CH}_2\text{COOH}$
14. Which processes are exothermic?
- I.  $\text{CH}_3\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{CH}_3\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- II.  $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g})$
- III.  $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

15. The heat change in a neutralization reaction can be determined by mixing equal volumes of  $\text{HCl}(\text{aq})$  and  $\text{NaOH}(\text{aq})$  of the same concentration in a glass beaker. The maximum temperature change is recorded using an alcohol thermometer.

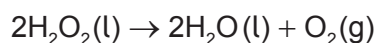
What is the biggest source of error in this experiment?

- A. Heat absorbed by the glass thermometer
- B. Random error in the thermometer reading
- C. Heat loss to the surroundings
- D. Systematic error in measuring the volumes of  $\text{HCl}(\text{aq})$  and  $\text{NaOH}(\text{aq})$  using burettes

16. Which equation corresponds to the bond enthalpy of the H–I bond?

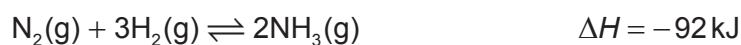
- A.  $\text{HI(g)} \rightarrow \frac{1}{2}\text{H}_2\text{(g)} + \frac{1}{2}\text{I}_2\text{(g)}$
- B.  $\text{HI(g)} \rightarrow \frac{1}{2}\text{H}_2\text{(g)} + \frac{1}{2}\text{I}_2\text{(s)}$
- C.  $\text{HI(g)} \rightarrow \text{H}^+\text{(g)} + \text{I}^-\text{(g)}$
- D.  $\text{HI(g)} \rightarrow \text{H(g)} + \text{I(g)}$

17. Which variable is best to use when determining the rate of decomposition of hydrogen peroxide?



- A. Volume of solution
- B. Volume of gas
- C. pH of solution
- D. Conductivity of solution

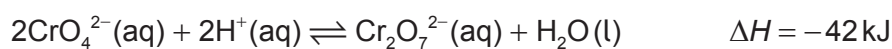
18. Nitrogen gas reacts with hydrogen gas according to the following equation.



Why is the rate of reaction slow at room temperature?

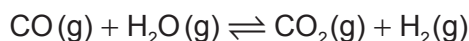
- A. The activation energy of the forward reaction is high.
- B. The activation energy of the forward reaction is low.
- C. The equilibrium constant is very small.
- D. The rate of the reverse reaction is greater than the rate of the forward reaction.

19. Which change will favour the **reverse** reaction in the equilibrium?



- A. Adding  $\text{OH}^-\text{(aq)}$
- B. Adding  $\text{H}^+\text{(aq)}$
- C. Increasing the concentration of  $\text{CrO}_4^{2-}\text{(aq)}$
- D. Decreasing the temperature of the solution

20. Carbon monoxide and water react together in the industrial production of hydrogen gas.

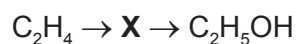


What is the impact of decreasing the volume of the equilibrium mixture at a constant temperature?

- A. The amount of  $\text{H}_2\text{(g)}$  remains the same but its concentration decreases.
  - B. The forward reaction is favoured.
  - C. The reverse reaction is favoured.
  - D. The value of  $K_c$  remains unchanged.
21. Which gas in the atmosphere causes the pH of unpolluted rain to be approximately 6?
- A. Carbon dioxide
  - B. Sulfur dioxide
  - C. Oxygen
  - D. Nitrogen
22. Which compound is a strong acid?
- A.  $\text{NH}_3$
  - B.  $\text{HNO}_3$
  - C.  $\text{H}_2\text{CO}_3$
  - D.  $\text{CH}_3\text{COOH}$
23. Which represents a redox reaction?
- A.  $\text{NaH(s)} + \text{H}_2\text{O(l)} \rightarrow \text{NaOH(aq)} + \text{H}_2\text{(g)}$
  - B.  $\text{CaCO}_3\text{(s)} \rightarrow \text{CaO(s)} + \text{CO}_2\text{(g)}$
  - C.  $\text{CuCl}_2\text{(aq)} + \text{K}_2\text{S(aq)} \rightarrow \text{CuS(s)} + 2\text{KCl(aq)}$
  - D.  $\text{HCl(aq)} + \text{NH}_3\text{(aq)} \rightarrow \text{NH}_4^+\text{Cl}^-\text{(aq)}$

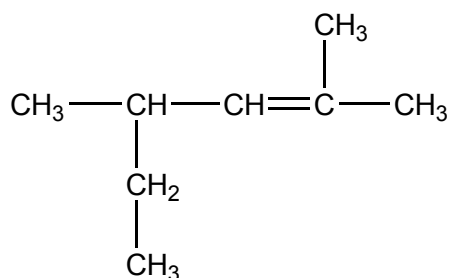


24. Which species can oxidize ethanol to ethanoic acid?
- A.  $I^-$
  - B. Fe
  - C.  $O^{2-}$
  - D. Acidified  $K_2Cr_2O_7$
25. Two half-cells are connected via a salt bridge to make a voltaic cell. Which statement about this cell is correct?
- A. Oxidation occurs at the positive electrode (cathode).
  - B. It is also known as an electrolytic cell.
  - C. Ions flow through the salt bridge.
  - D. It requires a power supply to operate.
26. Which compound could be **X** in the two-stage reaction pathway?



- A.  $C_2H_6$
- B.  $C_2H_3OH$
- C.  $C_2H_5Br$
- D.  $C_2H_4Cl_2$

27. Applying IUPAC rules, what is the name of the compound?



- A. 1-ethyl-1,3-dimethylbut-2-ene
- B. 2-ethyl-4-methylpent-3-ene
- C. 2-methyl-4-ethylpent-3-ene
- D. 2,4-dimethylhex-2-ene
28. Which statements about the chlorine free radical are correct?
- I. It has 18 electrons.
- II. It is an uncharged species.
- III. It is formed by homolytic fission.
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III
29. Which statement is correct about the polymerization of ethene to poly(ethene)?
- A. The polymer is an alkene.
- B. The monomer ethene and the repeating unit have the same empirical formula.
- C. The monomer ethene is less reactive than the polymer.
- D. The polymer contains C–C single and C=C double bonds.

30. A student weighs a standard 70.00 g mass five times using the same balance. Each time she obtains a reading of 71.20 g. Which statement is correct about the precision and accuracy of the measurements?
- A. Precise and accurate
  - B. Precise but inaccurate
  - C. Accurate but not precise
  - D. Neither accurate nor precise
-