# Year 11 Yearly Chemistry 2009 Answers

**Part A: Answer grid for multiple choice questions**

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| | | | | |
|---|---|---|---|---|
| 1. | A O | B O | C O | D √ |
| 2. | A O | B O | C O | D √ |
| 3. | A O | B O | C √ | D O |
| 4. | A O | B √ | C O | D O |
| 5. | A O | B √ | C O | D O |
| 6. | A √ | B O | C O | D O |
| 7. | A O | B √ | C O | D O |
| 8. | A O | B O | C O | D √ |
| 9. | A O | B √ | C O | D O |
| 10. | A O | B √ | C O | D O |
| 11. | A O | B O | C √ | D O |
| 12. | A O | B O | C √ | D O |

**Marks:** ……

1. Various interactions can occur between covalent molecular substances such as:

(i) dipole-dipole interaction

(ii) hydrogen bonding

(iii) dispersion forces

(iv) dipole-induced dipole interaction

What interactions can occur between molecules of iodine and water?

(A) (i), (ii), (iii) and (iv)

(B) (i) only

(C) (i) and (ii) only

**(D) (iii) and (iv) only**

**Outcome(s)**: P8, P13

2. What is the best explanation for the relatively high surface tension of water?

(A) high melting and boiling point of water

(B) strong cohesion between water molecules but weak adhesion to any

other substance

(C) dispersion forces between water molecules

**(D) hydrogen bonding between water molecules**

**Outcome(s)**: P8, P13

3. What happens in a saturated solution of LiCl?

(A) Nothing! All processes (dissolution and precipitation) stop

.

(B) The rate of precipitation of the LiCl is greater than the rate of dissolution

**(C) The rate of dissolution of LiCl is equal to the rate of precipitation of LiCl**

(D) The LICl continues to dissolve until the solution becomes supersaturated.

**Outcome(s)**:P8, P13

4. Why does sucrose dissolve in water?

(A) water breaks the covalent bonds in sucrose

**(B) water hydrogen bonds with the –OH groups in sucrose**

(C) there are strong dispersion forces between water and sucrose

(D) an ionic bond is formed between sucrose and water .

**Outcome(s)**:P 8

5. Given the following **solubility rules**:

1. All common compounds of Group I and ammonium ions are soluble.
2. All nitrates, acetates, and chlorates are soluble.
3. All binary compounds of the halogens (other than F) with metals are soluble, except those of Ag, Hg(I), and Pb. Pb halides are soluble in hot water.)
4. All sulfates are soluble, except those of barium, strontium, calcium, lead, silver, and mercury (I). The latter three are slightly soluble.
5. Except for rule 1, carbonates, hydroxides, oxides, silicates, and phosphates are insoluble.
6. Sulfides are insoluble except for calcium, barium, strontium, magnesium, sodium, potassium, and ammonium.

Based on the solubility rules, which of the following pairs of reactants will not produce a precipitate?

(A) $NaCl + AgNO_3 \rightarrow$

**(B) $CuSO_4 + MgCl_2 \rightarrow$**

(C) $Ca(NO_3)_2 + Na_2CO_3 \rightarrow$

(D) $Ba(NO_3)_2 + H_2SO_4 \rightarrow$

**Outcome(s)**:P8, P13

6. In the past, pharmacists used to recommend the use of a 1.5% (w/v) solution of boric acid as an eye wash.

   What mass of pure solid boric acid ( $H_3BO_3$) is required to prepare 20.0 mL of a 1.5% (w/v) solution?

   **(A) 0.3 g**

   (B) 0.60 g

   (C) 0.075 g

   (D) 0.037 g

**Outcome(s)**:P10, P13

7.The following are the molecular formula of some organic compounds.

Which is also an empirical formula ?

A. $C_2H_2Br_4$

**B. $C_2H_3Br_3$**

C. $C_2H_4Br_2$

D. $C_3H_3Br_3$

8. One mole is equal to ;

A. $6.02 \times 10^{23}$
B. The number of hydrogen molecules in 1.00g of hydrogen
C. 1/3 the number of oxygen atoms in 100.09g of calcium carbonate
**D. The number of carbon atoms exactly 12.000g of carbon – 12**

9. The molar mass of magnesium sulfide (MgS) is :

A. 58.44 g $mol^{-1}$
**B. 56.38 g $mol^{-1}$**
C. 63.58 g $mol^{-1}$
D. 53.56 g $mol^{-1}$

10. Which equation correctly describes the complete combustion of ethane ?

A. $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$

B. **$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(l)}$**

C. $C_2H_{6(g)} + 7O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$

D..$2C_2H_{6(g)} + 5O_{2(g)} \rightarrow 4CO_{(g)} + 6H_2O_{(l)}$

11. For the reaction between magnesium metal and hydrochloric acid, the rate of the reaction can be increased by :

A. using larger pieces of magnesium.
B. Diluting the acid
**C. Using powdered magnesium.**
D. Increasing the pressure in the reaction vessel.

12. Explosives reactions have :

A. high activation energy and large enthalpy of reaction.
B. High activation energy and small enthalpy of reaction.
**C. Low activation energy and large enthalpy of reaction.**
D. Low activation energy and small energy of reaction.

**Extended Response Questions**

**Question 13** (2 marks)

The density of water at 4 $^{o}$C is 1.00 g/mL. while that of ice at -20 $^{o}$C (temperature inside a household freezer) is 0.920 g/mL.

A student placed 198.00 mL of water at 4.0 $^{o}$C in a 200.0 mL glass bottle. She capped the bottle tightly and then placed this inside a freezer. Will the bottle remain intact after overnight freezing? Justify your answer with a calculation.

*Sample Answer*:

*No, the mass of water is unchanged but the volume changes with temperature.*

$$mass = density \ x \ volume \ ;$$

$$d_2 v_2 \ = \ d_1 v_1 \ = 0.920 \ x \ v \ = \ 1.00 \ x \ 198$$

$$v = \frac{198}{0.920} \ = \ 215 \ mL$$

*Therefore, the volume of the liquid will be too large for the container.*

| *Criteria* | *Marks* |
|---|---|
| formula for density used correctly | 2 |
| formula correct but not used correctly | 1 |

**Outcome(s)**:P10, P13

**Question 14** (4 marks)

When $(NH_4)_2SO_4$ solution is reacted with barium chloride solution, solid barium sulfate and aqueous ammonium chloride are formed.

(a) Write a complete ionic equation for the reaction.(1 mark)

*Answer:* $2\ NH_4^+ + SO_4^{2-} + Ba^{2+} + 2\ Cl^- \rightarrow BaSO_4(s) + 2\ NH_4^+ + 2\ Cl^-$

| *Criteria* | *Mark(s)* |
|---|---|
| *Correct complete ionic equation including states* | *1* |

(b) How much solid barium sulfate is formed if 50.00 mL of a 0.200 molL$^{-1}$

solution of barium chloride is added to 100.0 mL of a 0.200 molL$^{-1}$ solution of ammonium sulfate? (3 marks)

*Sample Answer:*

*moles $BaCl_2$ = 0.050 x 0.2 = 0.0100*

*moles $(NH_4)_2SO_4$ = 0.2 x 0.100 = 0.02* (1 mark)

*∴limiting reagent is $BaCl_2$*

*∴moles $BaSO_4$ = moles $BaCl_2$ = 0.0100* ( 1 mark)

*mass $BaSO_4$ = 0.0100 x ( 137.3 + 32.07 + 4 x 16.00) = 2.33 g* ( 1 mark)

**Outcome(s)**:P10, P13, P14

**Question 15** ( 6 marks)

The table shows the boiling point of water, ammonia, hydrogen sulfide and methane

| *Substance* | *Boiling point, $^oC$* |
|---|---|
| methane | -162 |
| hydrogen sulfide | -60 |
| ammonia | -33 |
| water | 100 |

3. Explain the differences in the boiling point of water, ammonia, hydrogen sulfide and methane

**Outcome(s)**:P6, P7, P8

*Sample Answer:*

*From the data observed, the boiling points increase in the order, methane < hydrogen sulfide < ammonia < water. Boiling points depend on intermolecular forces. The molecule with the greater intermolecular forces will have the higher boiling point. Molecules can exhibit different intermolecular forces: dispersion forces, the weakest, dipole-dipole interaction and then dispersion forces. Non-polar molecules such as methane can only exhibit dispersion forces as no dipoles are present, hence has the lowest boiling point*

*Hydrogen sulfide can exhibit both dispersion forces and dipole-dipole interaction, hence its boiling point is higher than that of methane. Both ammonia and water exhibit dispersion, dipole-dipole interaction and hydrogen bonding, hence both exhibit higher boiling points than hydrogen sulfide and methane. Water has the higher boiling point than ammonia because of the higher electronegativity of oxygen compared with nitrogen and the more efficient hydrogen bonding exhibited by water compared with ammonia.*

| ***Criteria*** | ***Marks*** |
|---|---|
| Statement of the dependence of boiling point on intermolecular forces | 1 |
| Explanation on the relative strength of intermolecular forces | 1 |
| Explanation of the type of forces exhibited by methane | 1 |
| Explanation of the type of forces exhibited by hydrogen sulfide | 1 |
| Explanation of the type of forces exhibited by ammonia and water | 1 |
| Differentiation between ammonia and water | 1 |

**Question 16** (7 marks)

(a) How will you prepare a 200.0 mL solution of 0.0542 mol $L^{-1}$ of sodium carbonate solution. In point form, outline the steps you need to do. (5 marks)

*Sample Answer*

- *Calculation of the mass of sodium carbonate required*

*moles of sodium carbonate = C x V = 0.0542 x 0.200 =0.01084 moles*

*mass of sodium carbonate = moles x molar mass = 0.01084 x (2x22.99 + 12.01 + 3x 16.00) = 1.15 grams*

*Procedure*

- *Weigh out exactly 1.15 g of sodium carbonate*
- *Dissolve in a small amount of water and then transfer to a 200 mL volumetric flask*
- *Dilute to mark (i.e. to the fill line)*
- *Stopper and mix thoroughly*
- *Label with the name of the solution, the concentration and the date prepared*

| *Criteria* | *Marks* |
|---|---|
| correct calculation | 2 |
| correct steps : weighing the calculated amount<br>correct description of use of volumetric flask for diluting<br>mixing and labelling | 1<br>1<br>1 |

(b) What is the concentration of the carbonate ion in parts per million (ppm)? 2 marks)

*Sample Answer:*

*moles of sodium carbonate = C x V = 0.0542 x 0.200 =0.01084 moles*

*moles carbonate = moles sodium carbonate = 0.01084*

*mass carbonate = moles carbonate x molar mass of carbonate*

*= 0.01084 x ( 12.01 + 3 x 16.00) = 0.650g = 650 mg (* 1 mark)

*ppm = mass (mg) / volume in L =* $\frac{650}{0.200} = 3250$ (1 mark)

**Outcome(s)**:P10, P13

**Question17**.Ammonium nitrate decomposed explosively according to the following equation, once the reaction has been started by a detonator.(8 marks)

$2NH_4NO_{3(s)}$ ---→ 3 / 2 $N_{2(g)}$ + $NO_{2(g)}$ + $4H_2O_{(g)}$

a. Describe the role of the detonator required to start the reaction. (2M)

(b) Calculate the volume of nitrogen produced at 250C when 2.00g of ammonium nitrate decomposes. (3 marks)

(c) Draw an energy profile pathway for the decomposition reaction. (3marks)

a. The dentonator provides the activation energy required to break bonds of $NH_4NO_3$. The activation energy is the energy required to start the reaction

b.

| Marking criteria | Marks |
|---|---|
| | |
| | |

c. Diagram of energy profile is that for an exothermic reaction.

Answer : An energy profile diagram showing an activation energy, negative enthalpy change and correctly labeled axes.

| Marking Criteria | Marks |
|---|---|
| Correctly shaped curve for an exothermic reaction with labels for axes, activation energy point and negative enthalpy change. | 3 |
| One of the above incorrect | 2 |
| Two of the above incorrect | 1 |

**Question18.** 1.0g of manganese (IV) oxide is added to 50mL of a solution of hydrogen peroxide. This breaks down to form oxygen and water. The oxygen is collected and its volume measured, at timed intervals. (10 marks)

| Time(minutes) | Volume of oxygen(mL) |
|---|---|
| 0 | 1 |
| 1 | 20 |
| 2 | 33 |
| 3 | 44 |
| 4 | 52 |
| 5 | 58 |
| 6 | 59 |
| 7 | 60 |
| 8 | 60 |

The equation for the reaction is :

$2H_2O_2 \rightarrow 2H_2O + O_2$

a. (i) Plot a graph of volume of oxygen (vertically) against time. Label this curve X.(4M)

(ii) Mark on curve X the time at which the rate of reaction is fastest. Label this point and justify your choice.(2M)

(iii) The experiment is repeated using 1.0g of the same catalyst 25.0mL of the hydrogen peroxide solution and 25.0mL of water. Sketch the curve obtained from the results of this experiment between the same axes. Label this curve Z. (1M)

Answer :

a. i. time with appropriate scale and units on x-axis ; volume with appropriate scale and units on y-axis; correctly plotted points and line of best fit curve labeled X.

| Marking criteria | Marks |
|---|---|
| Correctly plotted, sketched and labeled graph and axes. | 4 |
| One of the above incorrect | 3 |
| Two of the above incorrect | 2 |
| Three of the above incorrect | 1 |

ii. Label X at correct point on graph and justification that rate here was fastest as change per unit time is greatest here or this is the steepest point of the curve thus decomposition is occurring at the fastest rate.

| Marking Criteria | Marks |
|---|---|
| Correct point labeled and appropriate justification | 2 |
| Correct point labeled OR correct justification | 1 |

iii. Diluted solution thus the slope of the curve will be flatter on the graph than before and should be correctly labeled Z.

| Marking Criteria | Mark |
|---|---|
| Correct shaped and labeled Z curve | 1 |

b. Explain the effect of heating the solution of hydrogen peroxide on the rate of

reaction in terms of reaction kinetics. (3M)

Answer : Heating the solution gives the particles more energy thus a greater number of particles moving around faster thus a greater chance of particles colliding with the catalyst thus a faster rate of reaction ie faster decomposition of $H_2O_2$.

| Marking Criteria | Marks |
|---|---|
| Thorough explanation of the effect of heating with increasing kinetic energy of particles thus increased successful collisions thus increased reaction rate | 3 |
| Description of increasing reaction rate | 2 |
| Identification of an increase in rate of reaction | 1 |