Student Number……

Mark ……..

James Ruse Agricultural High School

Theory

Year 11 Preliminary Chemistry Exam 2008

General Instructions

- **Reading Time**: 5 minutes
- **Working Time**: 50 minutes
- Write using black or blue pen
- Board approved calculators may be used
- Write your Student Number at the top of this page

Total Marks 45

Part A

Multiple Choice: 13 marks
Attempt Questions 1-13

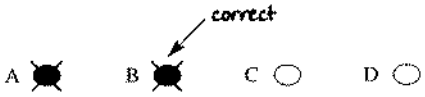
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word ***correct*** and drawing an arrow as follows.



Mark your answers for Questions 1 – 13 in the Answer Box on page 8

1. Which of the following accurately describes the percentage and distribution of water in the atmosphere, lithosphere and hydrosphere?

	Atmosphere	Lithosphere	Hydrosphere
(A)	0.001	0.6	99.4
(B)	0.2	12.9	86.9
(C)	0.6	0.001	99.4
(D)	12.9	0.2	86.9

2. Identify the compound that has the empirical formula CH_2.

(A) CH_4

(B) $CH_3 - CH_3$

(C) $(CH_3)_2C = CH_2$

(D) $CH_3 - C \equiv C - H$

3. Which of the following will NOT dissolve in water?

(A) sodium chloride

(B) hydrogen chloride

(C) oxygen

(D) silicon dioxide

4. How many chloride ions are there in 0.25 mole of calcium chloride?

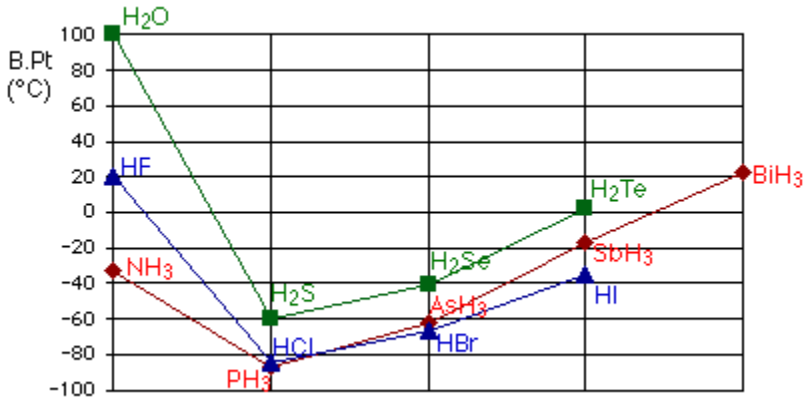
(A) 0.50

(B) 0.25

(C) 3.01×10^{23}

(D) 1.51×10^{23}

5. The diagram shows a graph of the hydrides of groups 5, 6, 7 elements.



What type of intermolecular force(s) exhibited by H_2O, HF and NH_3 specifically explains the elevated boiling points of these substances?

(A) dipole-dipole interaction

(B) hydrogen bonding

(C) dispersion forces

(D) dispersion forces and dipole-dipole interaction

6. Which of the following statements is true regarding a saturated solution of $Ca(OH)_2$ in water at 25^oC?

(A) $[Ca^{2+}] = 2 \times [OH^-]$

(B) solubility of $Ca(OH)_2$ in mol L^{-1} $25^oC = [Ca^{2+}]$

(C) solubility of $Ca(OH)_2$ in mol L^{-1} $25^oC = [OH^-]$

(D) $[Ca^{2+}] = [OH^-]$

7. Which of the following phenomena is explained by the comparatively large specific heat capacity of water?

(A) ice floating on water

(B) high viscosity of water

(C) cooling effect of evaporating perspiration

(D) the moderating effect of oceans on the Earth's temperature

8. Match the indicated measures of concentration with the appropriate substances

	% v/v	**% w/v**	**ppm**	**mol L^{-1}**
(A)	alcohol in wine	vinegar (aq)	Se in soil	HCl (aq)
(B)	vinegar (aq)	HCl (aq)	alcohol in wine	Se in soil
(C)	HCl (aq)	Se in soil	vinegar (aq)	alcohol in wine
(D)	alcohol in wine	HCl (aq)	Se in soil	vinegar (aq)

9. What is a result of an increase in the temperature of a substance?

(A) An increase in the substance's chemical energy.

(B) A decrease in the substance's chemical energy.

(C) An increase in the average kinetic energy of the substance's particles.

(D) A decrease in the average kinetic energy of the substance's particles.

10. Which condition determines whether a reaction is classified as explosive?

(A) release of heat energy

(B) the amount of oxygen available to react

(C) rapid rate of reaction

(D) heat absorbed

11. The ignition temperatures of various fuels are given in the table.

Fuel	Ignition temperature (^oC)
Butane	405
Petrol (octane)	390
Ethanol	392
oil	350

Which type of fuel would most likely spontaneously ignite without the need for a spark?

(A) butane

(B) petrol

(C) ethanol

(D) oil

12. Nitrogen may be formed from reacting oxygen with hydrazine.

$$H_2NNH_2\ (l) + O_2\ (g) \rightarrow 2N_2\ (g) + 2H_2O\ (l)$$

Which chemical bonds require energy to break and which bonds release energy when hydrazine reacts with oxygen?

	Bonds requiring energy to break	Bonds releasing energy when formed
(A)	N-N	H-N
(B)	H-N	N-N
(C)	H-O	O-O
(D)	O-O	H-N

13. Which equations represent complete combustion and incomplete combustion?

	complete combustion	incomplete combustion
(A)	$2C_8H_{18(l)} + 25O_{2(g)} \rightarrow 16CO_{2(g)} + 18H_2O_{(l)}$	$CH_{4(l)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$
(B)	$2C_3H_{8(g)} + 7O_{2(g)} \rightarrow 6CO_{(g)} + 8H_2O_{(l)}$	$2C_3H_{8(g)} + 10O_{2(g)} \rightarrow 6CO_{2(g)} + 8H_2O_{(l)}$
(C)	$2C_8H_{18(l)} + 17O_{2(g)} \rightarrow 16CO_{(g)} + 18H_2O_{(l)}$	$2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}$
(D)	$2C_6H_{6(l)} + 15O_{2(g)} \rightarrow 12CO_{2(g)} + 6H_2O_{(l)}$	$2C_8H_{18(l)} + 8O_{2(g)} \rightarrow 7CO_{(g)} + 9C_{(s)} + 9H_2O_{(l)}$

Student No. .....

Part A: Answer grid for multiple choice questions

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

Marks: …….

14. The electron dot structure of a substance shows the electron distribution in that substance.

(a) Draw the electron dot structure for H_2O and for NH_3.(1 mark)

H_2O NH_3

(b) Compare the shape of the water molecule with the shape of the ammonia molecule.(2 marks)

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15. Water has a number of unusual properties which can be traced to its molecular structure.

(a) Discuss the implications, in terms of physical properties of water, if the water molecule was *linear*. (2 marks)

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(b) Discuss the environmental implications, for aquatic invertebrates, of the unusually high surface tension of water . (2 marks)

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16. $Ba(OH)_2$ reacts with H_2SO_4 to produce a precipitate of $BaSO_4$ and water.

(a) Write a balanced net ionic equation for this reaction. Include the states of the substances (1 mark)

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(b) Calculate the mass of solid $BaSO_4$ produced if 20.0 mL of 0.20 $molL^{-1}$ $Ba(OH)_2$ is mixed with 40.0 mL of 0.20 $molL^{-1}$ H_2SO_4.(2 marks)

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17. An unscrupulous factory owner dumped about 6.0 kg of solid NaOH in a 75,000L pond. If the heat of solution of NaOH is 44.2 kJ mol^{-1},

(a) Calculate how much heat is released with the complete dissolution of the NaOH in the pond. (2 marks)

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(b) What will be the final temperature of the pond if the original temperature was 10^0C? (1 mark)

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(c) Does this constitute thermal pollution of the pond? Explain your answer. (1 mark)

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18. The equation for the production of phosgene is

$$CO\ (g) + Cl_2\ (g) \rightarrow COCl_2\ (g)$$

(a) State one variable that would need to be controlled when investigating the effect of concentration on the rate of the reaction for the production of phosgene. (1 mark)

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(b) Explain the effect of increasing the concentration of the reactants on the rate of the reaction. (2 marks)

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(c) Identify one other factor that may influence the rate of the reaction. (1 mark)

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19. Describe one condition in industrial environments that may contribute to an explosion. (1 mark)

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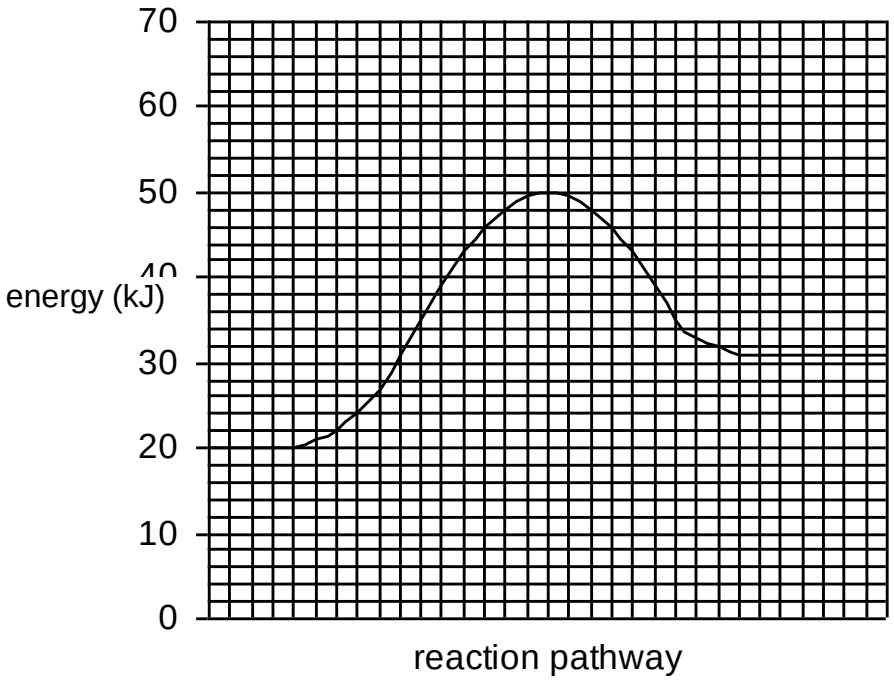
20. The energy pathway for the following reaction is shown in the graph.

$2AB\ (g) \rightarrow A_2\ (g) + B_2\ (g)$



(a) Identify the reaction as endothermic or exothermic. (1 mark)

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(b) Give a reason for your answer to (a). (1 mark)

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(c) State the activation energy for the reaction. (1 mark)

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(d) On the graph above, construct a graph for the reaction to show the effect of using a catalyst on the reaction pathway. (1 mark)

(e) Identify the effect of using a catalyst on this reaction. (1 mark)

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21. Fluorine gas was passed over solid tin(II)sulfide at 500^0C and the products were sulfur hexafluoride gas and a solid. The solid contained 61% by mass of tin and 39% by mass of fluorine.

(a) Determine the empirical formula of the solid produced. (1 mark)

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(b) Name the solid (1 mark)

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22. 2.25 g scandium metal reacts with excess hydrochloric acid to give 1.86 L hydrogen gas at 25^0C and 100 kPa and a salt.

(a) How many moles of scandium reacted? (1 mark)

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(b) How many moles of hydrogen were produced? (1 mark)

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(c) Use your answers in (a) and (b) to write an equation for this reaction. (1 mark)

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23. Dimethyl hydrazine, $(CH_3)_2N.NH_2$, together with the nitrogen dioxide is the fuel mixture sometimes used in rockets. The combustion equation is

$$6NO_2(g) + 2(CH_3)_2N.NH_2(g) \rightarrow 4CO(g) + 8H_2O(g) + 5N_2(g)$$

At the temperature of the reaction, all reactants and products are gaseous.

(a) How many litres of nitrogen dioxide gas would have to be supplied to produce 85 L of gaseous product in this reaction? Assume all gases were measured at the same temperature and pressure (500^0 C and 350 kPa). (2 marks)

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(b) Whose Law of Combining Volumes of Gases is used to determine the answer in (a)? (1 mark)

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Answers Year 11 Yearly 2008

1. Which of the following accurately describes the percentage and distribution of water in the atmosphere, lithosphere and hydrosphere?

	Atmosphere	Lithosphere	Hydrosphere
(A)	**0.001**	**0.6**	**99.4**
(B)	0.2	12.9	86.9
(C)	0.6	0.001	99.4
(D)	12.9	0.2	86.9

Outcomes : P4

2. Identify the compound that has the empirical formula CH_2.

(A) CH_4

(B) $CH_3 - CH_3$

(C) $(CH_3)_2C = CH_2$

(D) $CH_3 - C \equiv C - H$

Outcomes : P10

3. Which of the following will NOT dissolve in water?

(A) sodium chloride

(B) hydrogen chloride

(C) oxygen

(D) silicon dioxide

Outcomes : P2, P11

4. How many chloride ions are there in 0.25 mole of calcium chloride?

(A) 0.50

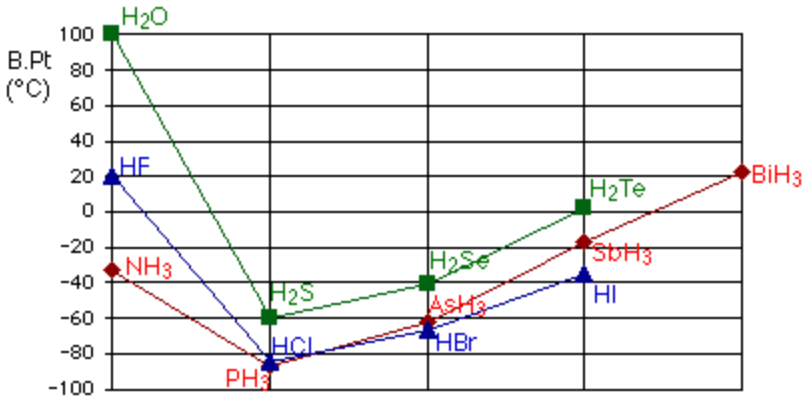
(B) 0.25

(C) 3.01×10^{23}

(D) 1.51×10^{23}

Outcomes : P10

5. The diagram shows a graph of the hydrides of groups 5, 6, 7 elements.



What type of intermolecular force(s) exhibited by H_2O, HF and NH_3 specifically explains the elevated boiling points of these substances?

(A) dipole-dipole interaction
(B) hydrogen bonding
(C) dispersion forces
(D) dispersion forces and dipole-dipole interaction

Outcomes: P6 P13

6. Which of the following statements is true regarding a saturated solution of $Ca(OH)_2$ in water at 25^oC?

(A) $[Ca^{2+}] = 2 \times [OH^-]$
(B) solubility of $Ca(OH)_2$ in mol L^{-1} $25^oC = [Ca^{2+}]$
(C) solubility of $Ca(OH)_2$ in mol L^{-1} $25^oC = [OH^-]$
(D) $[Ca^{2+}] = [OH^-]$

Outcomes: P6 P10P13

7. Which of the following phenomena is explained by the comparatively large specific heat capacity of water?

(A) ice floating on water
(B) high viscosity of water
(C) cooling effect of evaporating perspiration
(D) the moderating effect of oceans on the Earth's temperature

Outcomes: P4 P7

8**.** Match the indicated measures of concentration with the appropriate substances

	% v/v	**% w/v**	**ppm**	**mol L^{-1}**
(A)	**alcohol in wine**	**vinegar (aq)**	**Se in soil**	**HCl (aq)**
(B)	vinegar (aq)	HCl (aq)	alcohol in wine	Se in soil
(C)	HCl (aq)	Se in soil	vinegar (aq)	alcohol in wine
(D)	alcohol in wine	HCl (aq)	Se in soil	vinegar (aq)

Outcomes: P13

9. What is a result of an increase in the temperature of a pure substance?

(A) An increase in the substance's chemical energy.
(B) A decrease in the substance's chemical energy.
(C) An increase in the average kinetic energy of the substance's particles.
(D) A decrease in the average kinetic energy of the substance's particles.

10.. Which condition determines whether a reaction is classified as spontaneous or explosive?

(A) release of heat energy
(B) the amount of oxygen available to react
(C) rapid rate of reaction
(D) heat absorbed

11. The ignition temperatures of various fuels are given in the table.

Fuel	Ignition temperature (^{o}C)
Butane	405
Petrol (octane)	390
Ethanol	392
Oil	350

Which type of fuel would most likely to spontaneously ignite without the need for a spark?

(A) butane
(B) petrol
(C) ethanol
(D) **oil**

12. Nitrogen may be formed from reacting oxygen with hydrazine.

$$H_2NNH_2\ (l) + O_2\ (g) \rightarrow 2N_2\ (g) + 2H_2O\ (l)$$

Which chemical bonds require energy to break and which bonds release energy when hydrazine reacts with oxygen?

	Bonds requiring energy to break	Bonds releasing energy when formed
(A)	N-N	H-N
(B)	H-N	N-N
(C)	H-O	O-O
(D)	O-O	H-N

13. Which equations represent complete combustion and incomplete combustion?

	complete combustion	incomplete combustion
(A)	$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + + 18H_2O(l)$	$CH_4(l) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
(B)	$2C_3H_8(g) + 7O_2(g) \rightarrow 6CO(g) + 8H_2O(l)$	$2C_3H_8(g) + 10O_2(g) \rightarrow 6CO_2(g) + 8H_2O(l)$
(C)	$2C_8H_{18}(l) + 17O_2(g) \rightarrow 16CO(g) + + 18H_2O(l)$	$2C(s) + O_2(g) \rightarrow 2CO(g)$
(D)	**$2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$**	**$2C_8H_{18}(l) + 8O_2(g) \rightarrow 7CO(g) + 9C(s) + 9H_2O(l)$**

Part A: Answer grid for multiple choice questions.

1.	A ✓	B O	C O	D O
2.	A O	B O	C ✓	D O
3.	A O	B O	C O	D ✓
4.	A O	B O	C ✓	D O
5.	A O	B ✓	C O	D O
6.	A O	B ✓	C O	D O
7.	A O	B O	C O	D ✓
8.	A ✓	B O	C O	D O
9.	A O	B O	C ✓	D O
10.	A O	B O	C ✓	D O
11.	A O	B O	C O	D ✓
12.	A O	B ✓	C O	D O
13.	A O	B O	C O	D ✓

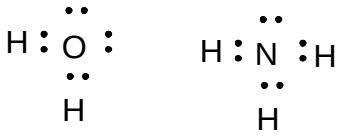
Extended Response Questions:

Question 14 (3 marks)

The electron dot structure of a substance shows the electron distribution in that substance.

(a) Draw the electron dot structure for H_2O and for NH_3. (1 mark)

Outcome: P13
Answer:



Criteria	**Mark(s)**
correct electron dot structures for the two compounds	1

(b) Explain the shape of the water molecule. (2 marks)

Outcome: P6

Sample Answer:

Water is V-shaped. It does not have a linear structure despite the presence of only two hydrogens because of the two other pairs of electrons around oxygen, which despite being non-bonding, still occupy space and affect the positioning of the bonded pairs of electrons.

Criteria	**Mark(s)**
Correct explanation which involves the use of the effect of the lone pair of electrons on shape of water.	2
Correct explanation but does not give the correct shape of water	1

Question 15 (4 marks)

Water has a number of unusual properties which can be traced to its molecular properties.

(a) Discuss the implications, in terms of physical properties of water, if the water molecule was *linear*. (2 marks)

Outcome: P6

Sample Answer

A linear water molecule will be non-polar. therefore, it will have a very low melting and boiling point. It will not exist as liquid at room temperature. Polar substances will not dissolve in water and possibly, living organisms will not have as much water in their bodies as they have at present.

Criteria	**Mark(s)**
Any two correct implications	2

(b) Discuss the environmental implications for aquatic invertebrates of the unusually high surface
tension. of water (2 marks)

Outcome: P6

Sample Answer

The unusually high surface tension of water contributes to life diversity in ponds and lakes by serving as a habitat for water striders and water lilies. Surface tension is also the cause of the rising of water in narrow tubes so vital to the survival of plant life.

Criteria	**Mark(s)**
Any two correct implication	2

Question 16 (3 marks)

$Ba(OH)_2$ reacts with H_2SO_4 to produce a precipitate of $BaSO_4$ and water

(a) Write a balanced net ionic equation for this reaction. Include the states of the substances (1 mark)

Outcome: P6

Answer:

$Ba^{2+}(aq) + 2\ OH^-(aq) + 2\ H^+(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + H_2O(l)$

Criteria	**Mark(s)**
Correct equation	1

(b) Calculate the mass of solid $BaSO_4$ produced if 20.0 mL of 0.20 $molL^{-1}$ $Ba(OH)_2$ is mixed with 40.0 mL of 0.20 $molL^{-1}$ H_2SO_4..(2 marks)

Outcome: P10

Sample Answer

Determine the limiting reagent: moles of $Ba(OH)_2$: 4.0×10^{-3} (1 mark)
moles of H_2SO_4 : 8.0×10^{-3}

Therefore: limiting reagent is $Ba(OH)_2$: 4.0×10^{-3} mole
mole of $BaSO_4 = 4.0 \times 10^{-3}$

Mass of $BaSO_4$ = moles $BaSO_4$ x molar mass $BaSO_4$

$= 4.0 \times 10^{-3} \times (137.3 + 32.07 + 4(16.00) = 0.93$ g (1 mark)

Criteria	**Mark(s)**
Correct calculation of limiting reagent	1
correct calculation of mass	1

Question 17 (3 marks)

An unscrupulous factory owner dumped about 6.0 kg of solid NaOH in a 75,000 L pond. If the heat of solution of NaOH is 44.2 kJ mol^{-1},

(a) Calculate how much heat is released with the complete dissolution of the NaOH in the pond? (1 mark)

Outcome: P10
Sample Answer:

q= heat released = ΔH x n = 44.2 kJ/mol x $\frac{6000}{22.99+16.00+1.008} = 6630\ kJ$

(b) What will be the final temperature of the pond if the original temperature was 10^0C (1 mark)

Outcome: P10
Sample Answer

$q = mc\Delta T = 75{,}000{,}000g \times 4.20 \times \Delta t$

$\Delta t = \frac{6630000}{75000000\ x\ 4.2} = 0.02\ ^oC$

(c) Does this constitute thermal pollution of the pond? Explain your answer.

Outcome: P4

Sample Answer

No, this does not constitute thermal pollution since the increase in temperature is not very high. However, this constitutes chemical pollution of the pond.

Criteria	**Mark(s)**
Correct calculations	1 each
recognition of the absence of thermal pollution and the criterion used	1

18. The equation for the production of phosgene is

$$CO\ (g) + Cl_2\ (g) \rightarrow COCl_2\ (g)$$

(a) State one variable that would need to be controlled when investigating the effect of concentration on the rate of the reaction for the production of phosgene. (1 mark)

Temperature

(b) Explain the effect of increasing the concentration of the reactants on the rate of the reaction. (2 marks)

An increase in the concentration of reactants would increase the rate of the reaction due to the greater number of effective collisions that may arise from having a greater number of particles per unit volume.

(1): stating an increase in the rate of the reaction
(1): stating a greater number of effective collisions.

(e) State one other factor that may influence the rate of the reaction. (1 mark)

Temperature, pressure, volume

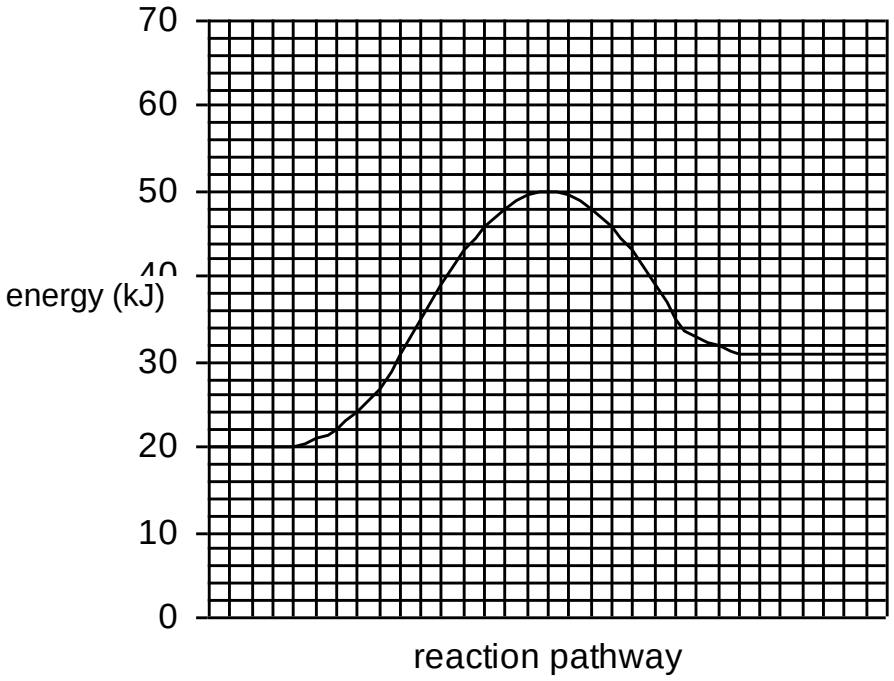
19. Describe one condition in work environments that may contribute to the formation of an explosion. (1 mark)

Particle size: the smaller the size of particles the greater the chance of an explosion.

-20. The energy pathway for the reaction

$2AB\ (g) \rightarrow A_2\ (g) + B_2\ (g)$

is shown in the graph.



(a) Identify the reaction as endothermic or exothermic. (1 mark)

Endothermic

(b) Give a reason for your answer to (a). (1 mark)

The total chemical energy of the products is greater than the total chemical energy of the reactants.

(c) State the activation energy for the reaction. (1 mark)

30 kJ

(d) On the graph in your answer book, construct a graph for the reaction to show the effect of using a catalyst on the reaction pathway. (1 mark)

Must show: (i) lower activation energy, and (ii) chemical energy of products is attained quicker.

(e) Describe the effect of using a catalyst on this reaction. (1 mark)

Catalyst increases the rate of the reaction.

21. Fluorine gas was passed over solid tin(II)sulfide at 500^0C and the products were sulfur hexafluoride gas and a solid. The solid contained 61% by mass of tin and 39% by mass of fluorine.

(a) Determine the empirical formula of the solid produced. (1 mark)

Answer

Sn	61%/118.7	0.5139	0.5139/0.5139	1
F	39%/19	2.0526	2.0526/0.5139	4

Emperical formula is SnF_4 (1)

(b) Name the solid (1 mark)

Tin (IV) fluoride (1)

Outcomes : P10

22. 2.25g scandium metal reacts with excess hydrochloric acid to give 1.86L hydrogen gas at 25^0C and 100 kPa.

(a) How many moles of scandium reacted? (1 mark)

Answer

$$Mol\ Sc = \frac{mass}{Molar\ mass} = \frac{2.25}{44.96} = 0.05\ mol \quad (1)$$

(b) How many moles of hydrogen were produced? (1 mark)

Answer

$$Mol\ H_2 = \frac{V}{24.79} = \frac{1.86}{24.79} = 0.075\ mol \quad (1)$$

(c) Use your answers in (a) and (b) to write down an equation for this reaction. (1 mark)

Answer

$2Sc + 6HCl \rightarrow 2ScCl_3 + 3H_2$ (no subscripts required) (1)

Outcomes : P10

23. Dimethyl hydrazine, $(CH_3)_2N.NH_2$, together with the oxidant nitrogen dioxide is the fuel mixture sometimes used in rockets. The combustion equation is

$$6NO_2\ (g) + 2(CH_3)_2N.NH_2\ (g) \rightarrow 4CO\ (g) + 8H_2O(g) + 5N_2(g)$$

At the temperature of the reaction, all reactants and products are gaseous.

(a) How many litres of nitrogen dioxide gas would have to be supplied to produce 85L of gaseous product in this reaction? Assume all gases were measured at the same temperature and pressure (500^0C and 350kPa). (2 marks)

Answer

6 L NO_2 → 17L gaseous product

x L NO_2 → 85L gaseous product

$x = \frac{85 \times 6}{17} = 30\ L\ NO_2$ (Answer with working 2 marks, without working, 1 mark)

(b) Whose Law of Combining Volumes of Gases is used to determine the answer in (a)? (1 mark)

Answer : Guy Lussac

Outcomes : P10