



James Ruse Agricultural High School

Theory and Data Processing

Chemistry Assessment Task 1 Term 4 2011

General Instructions

- **Reading Time:** 5 minutes
- **Working Time:** 90 minutes
- **Complete both Theory and Data Processing in the time, 90 minutes.**
- Write using black or blue pen
- Board approved calculators may be used
- Write your Student Number on the answer booklets
- A Periodic Table and Data Sheet are provided.

Total Marks 62

Theory Test

Total marks: 32

Take about 40 minutes
to do this section

Data Processing

Total marks: 30

Take about 50 minutes
to do this section

Multiple Choice: 10 marks
Attempt Questions 1-10

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

A  B  C  D 

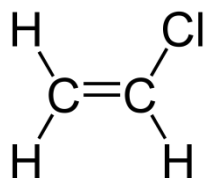
A  B  C  D 

correct

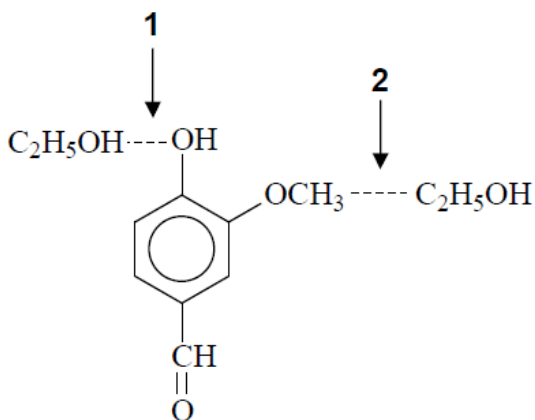
2011 Year 11 HSC Chemistry Assessment 1 Theory and Data Processing

Part A : Multiple Choice

1. What is the common name of this monomer?



- (A) chloroethene
- (B) styrene
- (C) polyvinyl chloride
- (D) vinyl chloride
2. A major use of ethanol is as a solvent in the perfume industry. The diagram below shows ethanol dissolving a molecule of vanillin.



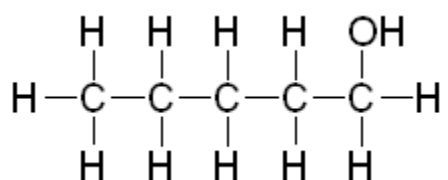
Identify the intermolecular forces acting at locations 1 and 2.

- | Location1 | Location 2 |
|-----------------------|-------------------|
| (A) dispersion forces | H-bonding |
| (B) dispersion forces | covalent bonding |
| (C) H-bonding | dispersion forces |
| (D) H-bonding | covalent bonding |

3. Identify the reagent used to distinguish between an alkane and an alkene.

- (A) bromine water
- (B) concentrated sulfuric acid
- (C) yeast
- (D) ethanol

4. What is the IUPAC name for the following compound?



- (A) 5-pentanol
- (B) 1-pentanol
- (C) 1-butanol
- (D) 1-propanol

5. Which equation best represents catalytic cracking of a petroleum fraction?

- (A) $\text{C}_{12}\text{H}_{26}(\text{l}) \rightarrow \text{C}_{12}\text{H}_{26}(\text{g})$
- (B) $\text{C}_{12}\text{H}_{26}(\text{l}) \rightarrow \text{C}_7\text{H}_{16}(\text{l}) + \text{C}_2\text{H}_4(\text{g}) + \text{C}_3\text{H}_6(\text{g})$
- (C) $n\text{C}_2\text{H}_4(\text{g}) \rightarrow -(\text{C}_2\text{H}_4)-n(\text{s})$
- (D) $\text{C}_7\text{H}_{16}(\text{l}) + \text{C}_2\text{H}_4(\text{g}) + \text{C}_3\text{H}_6(\text{g}) \rightarrow \text{C}_{12}\text{H}_{26}(\text{l})$

6. What is the oxidation number of manganese in potassium permanganate, KMnO_4 ?

- (A) +1
- (B) +3
- (C) +7
- (D) -3

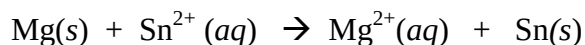
7. The police often use a device called a breath analyser to test drivers suspected of being drunk. The chemical basis for the test is shown by the equation:



Which is the oxidant in the reaction?

- (A) $\text{CH}_3\text{CH}_2\text{OH}$
- (B) $\text{K}_2\text{Cr}_2\text{O}_7$
- (C) H_2SO_4
- (D) K_2SO_4

8. Given the following cell reaction:



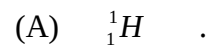
What is the standard cell potential for the reaction?

- (A) - 2.36 V
- (B) -0.14 V
- (C) 2.22 V
- (D) 2.50 V

9. Which of the following radiations is measured with a Geiger Counter ?

- (A) microwave
- (B) infrared
- (C) ultraviolet
- (D) beta

10. Which of the following isotopes is the most unstable?



Student Number

Theory Mark

Part A: Answer grid for multiple choice questions

- | | | | | |
|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| 1. | A ☐ | B ☐ | C ☐ | D ☐ |
| 2. | A ☐ | B ☐ | C ☐ | D ☐ |
| 3. | A ☐ | B ☐ | C ☐ | D ☐ |
| 4. | A ☐ | B ☐ | C ☐ | D ☐ |
| 5. | A ☐ | B ☐ | C ☐ | D ☐ |
| 6. | A ☐ | B ☐ | C ☐ | D ☐ |
| 7. | A ☐ | B ☐ | C ☐ | D ☐ |
| 8. | A ☐ | B ☐ | C ☐ | D ☐ |
| 9. | A ☐ | B ☐ | C ☐ | D ☐ |
| 10. | A ☐ | B ☐ | C ☐ | D ☐ |

Part B : Extended Response Questions (22 Marks)

Question 11 (5 marks)

You performed an experiment to carry out the fermentation of glucose.

- (a) Identify two conditions necessary for the successful fermentation of glucose. (2 marks)

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- (b) Give an equation for the fermentation of glucose. (1 mark)

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- (c) What volume of gas would be produced at 25⁰C when 90.0g of glucose undergoes fermentation? (2 marks)

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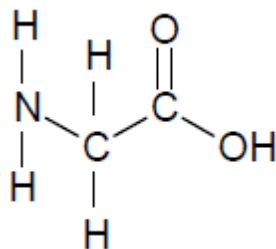
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Question 12 (2 marks)

Amino acids can undergo condensation polymerization to produce protein chains.

Use the following amino acid to draw the products of a condensation reaction between two amino acids.



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Question 13 (6 marks)

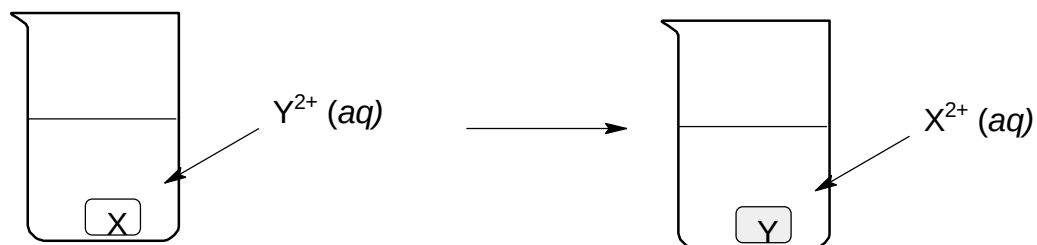
Cellulose has the potential to supply raw materials for the petrochemical and fuel industries.

Discuss this statement using relevant equations in your answer.

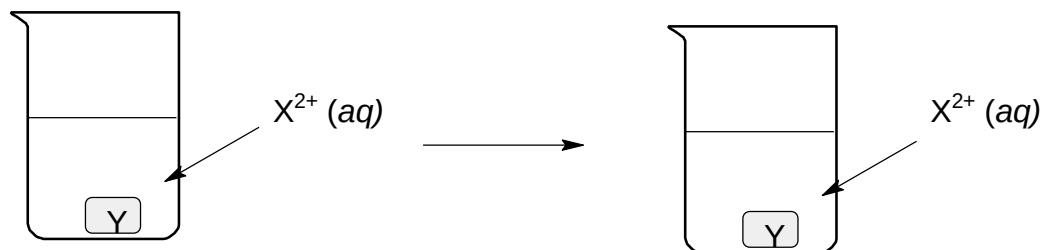
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Question 14 (5 marks)

A student tested two metals and their soluble salts using the following set-up:



Set-up 1



Set-up 2

On the basis of the student's results, draw a diagram of a working galvanic cell consisting of the two metal electrodes X and Y , and the solutions X^{2+} and Y^{2+} . Clearly label the anode, the positive electrode, the direction of electron flow and the direction of anion flow. (Place your labels very close to the part you are labelling)



Question 15 (4 marks)

(a) What are transuranic elements ? (1 mark)

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(b) Describe how transuranic elements are currently produced. (3 marks)

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End of Theory Paper, continue with Data Processing

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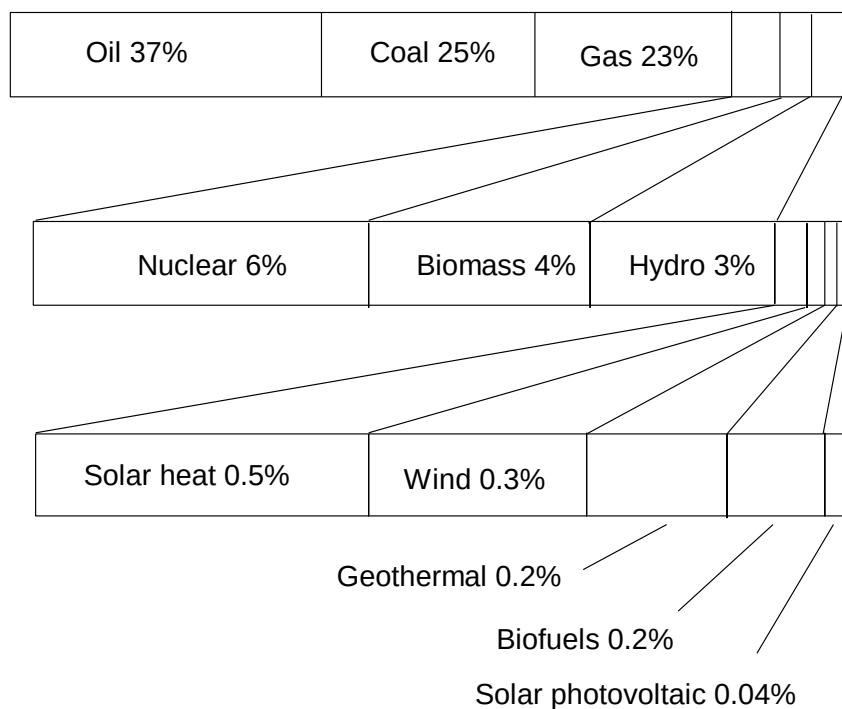
Student Number

Data Processing Mark

Data Processing

Question 1 (4 marks)

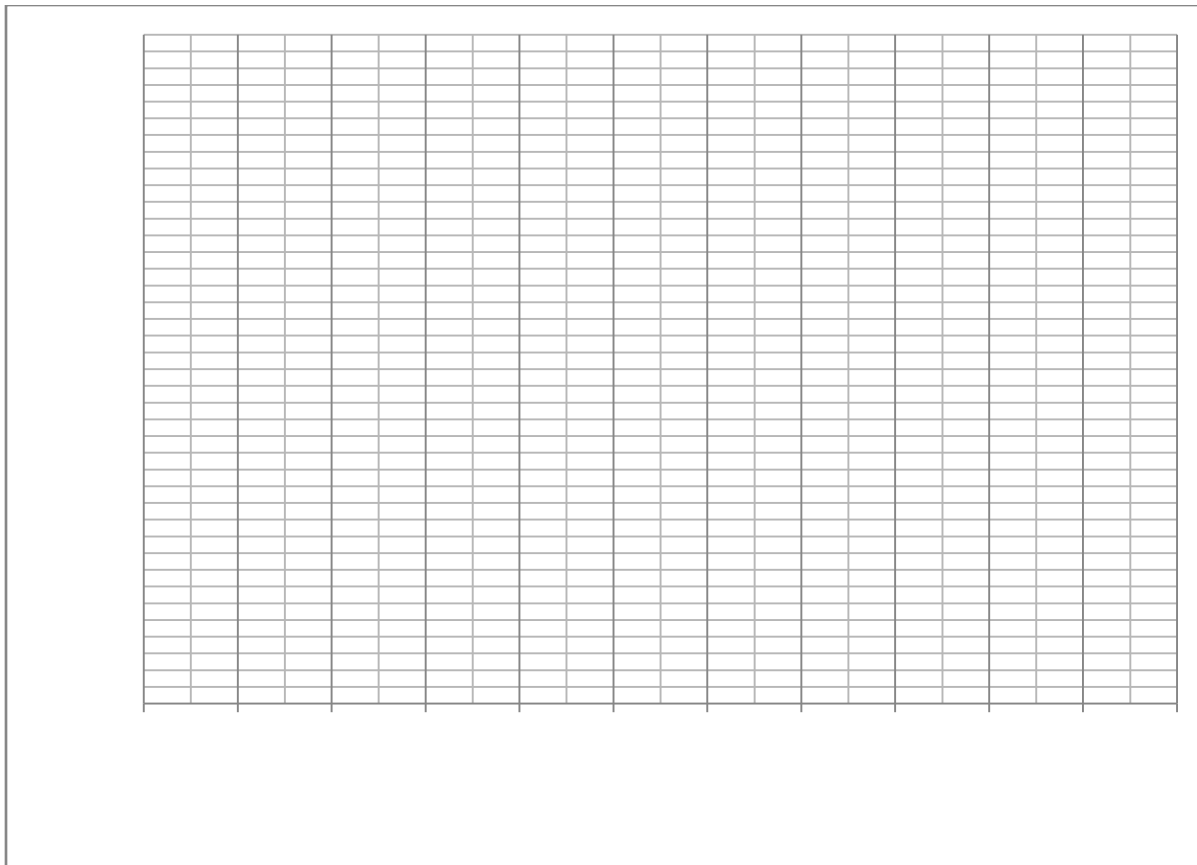
- (a) Shown below is information on world energy usage in successively increasing detail:
(2007) *BP Statistical Review of World Energy, June 2006(XLS) British Petroleum, as quoted by Wikipedia*



Convert the information into a table of data: (2 marks)

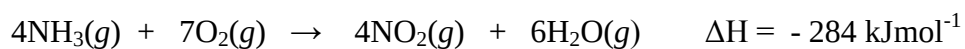
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- (b) Draw a column graph to show the relative magnitude of each energy source.
(2 marks)

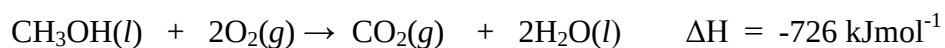


Question 2 (9 marks)

A farmer ran a generator from an engine he developed which was powered by ammonia produced from his farming activities. The reaction with ammonia was



The farmer then decided that it would be cheaper to run his engine from methanol rather than ammonia, with the following reaction.



The farmer could produce 1 kg of ammonia for 20 cents and 1 kg methanol for 30 cents.

(a) Calculate the heat of combustion for ammonia in kJ per kilogram. (2 marks)

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(b) Calculate the heat of combustion for methanol in kJ per kilogram. (2 marks)

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(c) Did the farmer make the correct decision on economic grounds ? Explain. (3 marks)

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(d) Outline one advantage and one disadvantage of using methanol as a fuel. (2 marks)

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Question 3 (6 marks)

Doctors often send patients for blood analysis in order to diagnose ailments. A 17 – year old male patient, suffering from fever with abdominal pain was advised by the doctor to have a blood test. Table 1 shows the blood test ordered by the doctor and what they indicate at increased or decreased level.

Table 1

<i>Test</i>	<i>Description</i>	<i>Indications of the level</i>	
		<i>increased</i>	<i>decreased</i>
sodium	sodium is one of the blood electrolytes, it is essential to maintaining the proper balance of fluid in the blood and cells	dehydration, adrenal gland disorder, kidney disease, heart disease, high blood pressure	diabetes, inadequate adrenal function
potassium	essential in maintaining the proper balance of fluids within body cells	kidney failure and liver disease	diabetes, vomiting and diarrhea
chloride	with sodium, potassium and hydrogen carbonate acts to balance the body's acid-base system and control water metabolism	kidney disease and dehydration	vomiting, diarrhea and excessive sweating
urea (BUN)	BUN (blood urea nitrogen) urea is produced in the liver and is the main nitrogen product of protein metabolism; it is eliminated by the kidneys to the urine	fever, starvation, kidney disease	liver disease and increased pituitary activity.
calcium	calcium is needed to maintain body processes such as muscle contraction and nerve transmission	certain bone tumour , when too much vitamin D or milk is taken,	when vitamin D cannot be absorbed because of kidney disease or nutritional factors as when insufficient calcium is taken
phosphate	phosphorus metabolism is directly related to calcium metabolism and is associated with many body functions	kidney disease, conditions of bone destruction	alcoholism, vitamin deficiency

The result of the blood analysis of the 17 – year old is given in Table 2

Table 2

<i>Test</i>	<i>Analysis result /(mmolL⁻¹)</i>	<i>Normal values/(mmolL⁻¹)</i>
sodium	134	135 – 145
potassium	4.4	3.5 – 5.6
chloride	98	99 - 109
bicarbonate	29	23 – 33
urea	4.0	2.1 – 9.0
calcium	2.65	2.10 – 2.60
phosphate	1.41	0.80 – 1.40

(a) Which of the tests gave abnormal values? (2 marks)

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(b) What possible health condition(s) could be indicated by the results? (3 marks)

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(c) What further tests or treatment may be advised to the patient? (1 mark)

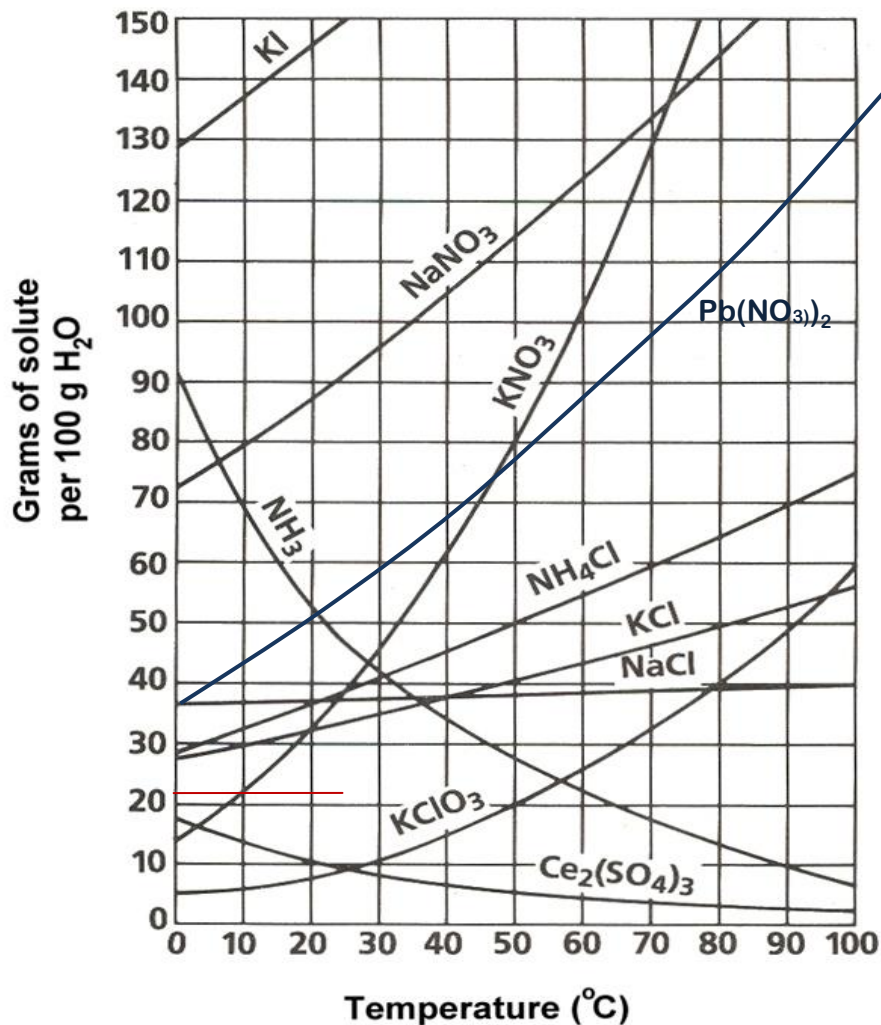
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Question 4 (11 marks)

Use the graph of “Solubility versus Temperature” to answer the following questions.



- (a) Name the most soluble material at 20°C. (1 mark)

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- (b) What mass of the following solutes could be dissolved in the volumes of water at the temperatures shown?

- (i) KNO₃ is added to 100 mL of water at 70°C. (1 mark)

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(ii) NaCl is added to 0.50 L of water at 90°C. (1 mark)

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(iii) NH₄Cl is added to 10.0 mL of water at 65°C . (1 mark)

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(c) Compare the solubility of the three solids, in (i), (ii) and (iii) above, if each were added to separate beakers containing 100 mL of water at 18°C. (2 marks)

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(d) A sample of 48.0 g of lead (II)nitrate solid is added to a small beaker containing 50.0 mL of water at 30⁰ C. This was then stirred vigorously for about 30 seconds. Identify the mass of lead(II) nitrate you would expect to remain as a solid in the beaker. Give a reason for your answer. (NB the temperature of the water did not change) (2 marks)

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- (e) A student is given an unknown solid and told that it is a pure ionic compound. The student is also given a graph of “Solubility versus Temperature” for some different materials (identical to the one in this test) and told that the unknown solid is one of the materials shown in the graph.
- The student carried out the following steps in an attempt to identify the unknown solid.
- The student
- (i) collected some deionised water and measured the temperature of the water to be 25°C .
 - (ii) carefully added 5.0 ml of the water to a large test tube.
 - (iii) used an electronic balance and measured the mass of the water and test tube to be 62.500g.
 - (iv) began to slowly add tiny amounts of the unknown solid while swirling the test tube and observing closely.
 - (v) continued to slowly add more of the solid and watched closely for any sign that the solid was not dissolving.
 - (vi) immediately stopped adding solid as soon as any undissolved solid was noticed.
 - (vii) reweighed the test tube and recorded a mass of 64.220g.
 - (viii) used their results and the graph of “Solubility versus Temperature” to identify the unknown solid.

Describe how the student would have used the information from their experiment, and the “Solubility versus Temperature” graph, to identify the unknown solid. Give the name of their likely answer. (3 marks)

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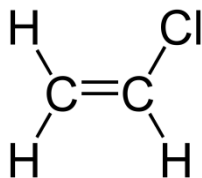
End of Data Processing

2011 Year11 Chemistry Term 4 Answers

Part A: Answer grid for multiple choice questions

- | | | | | |
|-----|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 1. | A ☐ | B ☐ | C ☐ | D ☒ |
| 2. | A ☐ | B ☐ | C ☒ | D ☐ |
| 3. | A ☒ | B ☐ | C ☐ | D ☐ |
| 4. | A ☐ | B ☒ | C ☐ | D ☐ |
| 5. | A ☐ | B ☒ | C ☐ | D ☐ |
| 6. | A ☐ | B ☐ | C ☒ | D ☐ |
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| 8. | A ☐ | B ☐ | C ☒ | D ☐ |
| 9. | A ☐ | B ☐ | C ☐ | D ☒ |
| 10. | A ☐ | B ☐ | C ☐ | D ☒ |

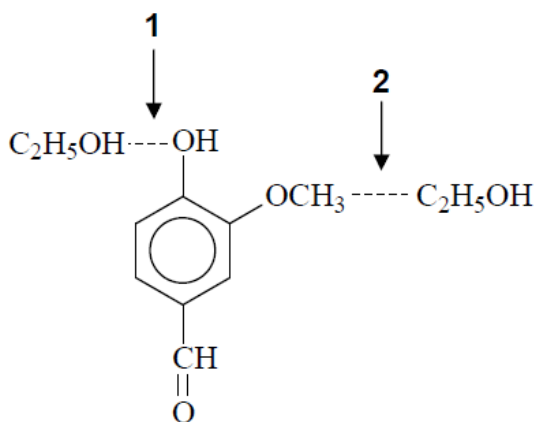
1. What is the common name of this monomer?



- (A) chloroethene
(B) styrene
(C) polyvinyl chloride
(D) **vinyl chloride**

Outcomes : H9

2. A major use of ethanol is as a solvent in the perfume industry. The diagram below shows ethanol dissolving a molecule of vanillin.



Identify the intermolecular forces acting at locations 1 and 2.

- | Location 1 | Location 2 |
|-----------------------|--------------------------|
| (A) dispersion forces | H-bonding |
| (B) dispersion forces | covalent bonding |
| (C) H-bonding | dispersion forces |
| (D) H-bonding | covalent bonding |

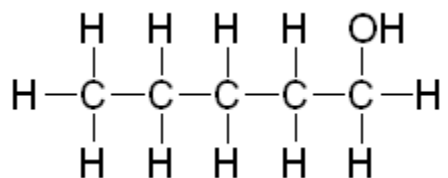
Outcomes : H9,6

3. Identify the reagent used to distinguish between an alkane and an alkene.

- (A) **bromine water**
- (B) concentrated sulfuric acid
- (C) yeast
- (D) ethanol

Outcomes : H9,8

4. What is the IUPAC name for the following compound?



- (A) 5-pentanol
(B) **1-pentanol**
(C) 1-butanol
(D) 1-propanol

Outcomes : H9

5. Which equation best represents catalytic cracking of a petroleum fraction?

- (A) $\text{C}_{12}\text{H}_{26} (l) \rightarrow \text{C}_{12}\text{H}_{26} (g)$
(B) **$\text{C}_{12}\text{H}_{26} (l) \rightarrow \text{C}_7\text{H}_{16}(l) + \text{C}_2\text{H}_4(g) + \text{C}_3\text{H}_6(g)$**
(C) $n\text{C}_2\text{H}_4 (g) \rightarrow -(\text{C}_2\text{H}_4)_n (s)$
(D) $\text{C}_7\text{H}_{16}(l) + \text{C}_2\text{H}_4(g) + \text{C}_3\text{H}_6(g) \rightarrow \text{C}_{12}\text{H}_{26} (l)$

Outcomes : H9,4,8

6. What is the oxidation number of manganese in potassium permanganate, KMnO_4 ?

- (A) +1
(B) +3
(C) **+7**
(D) -3

Outcomes : H8

7. The police often use a device called a breath analyser to test drivers suspected of being drunk. The chemical basis for the test is shown by the equation:

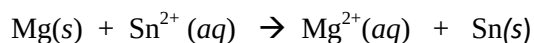


Which is the oxidant in the reaction?

- (A) $\text{CH}_3\text{CH}_2\text{OH}$
- (B) $\text{K}_2\text{Cr}_2\text{O}_7$**
- (C) H_2SO_4
- (D) K_2SO_4

Outcome(s): H13, H4, H8

8. Given the following cell reaction:



What is the standard cell potential for the reaction?

- (A) - 2.36 V
- (B) -0.14 V
- (C) 2.22 V**
- (D) 2.50 V

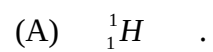
Outcome(s): H13

9. Which of the following radiations is measured with a Geiger Counter ?

- (A) microwave
- (B) infrared
- (C) ultraviolet
- (D) beta**

Outcome(s): H4, H6

10. Which of the following isotopes is the most unstable?



Outcome(s): H6, H10

Part B : Extended Response Questions (Marks)

Question 11 (5 marks)

You performed an experiment to carry out the fermentation of glucose.

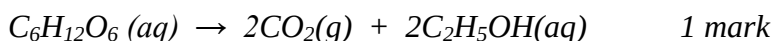
- (a) Identify two conditions necessary for the successful fermentation of glucose. (2 marks)

Sample answer

Yeast, Temperature between 25-35 degrees

Marking Criteria	Marks
• Two conditions	2
• One condition	1

- (b) Give an equation for the fermentation of glucose. (1 mark)



- (c) What volume of gas would be produced at 25°C when 90.0g of glucose undergoes fermentation? (2 marks)

Sample Answer

$$\text{Mol } C_6H_{12}O_6 = \text{mass}/f_w = 90.0/6 \times 12 + 12 \times 1 + 6 \times 16 = 0.5 \text{ mol} \quad (1 \text{ mark})$$

$$\text{Therefore mol } CO_2 \text{ is } 2 \times 0.5 = 1.0 \text{ mol}$$

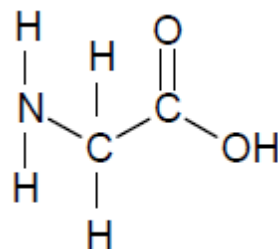
$$\text{Volume } CO_2 = \text{mol} \times 24.79 = 1.0 \times 24.79 = 24.79 \text{ L} \quad (1 \text{ mark})$$

Outcomes : H8,9,10,12

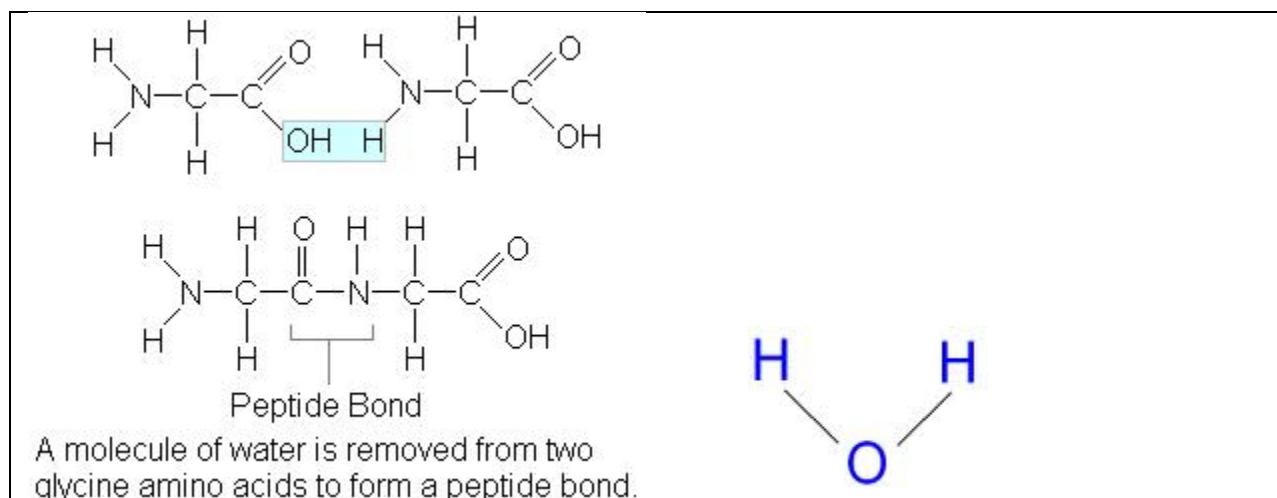
Question 12 (2 marks)

Amino acids can undergo condensation polymerization to produce protein chains.

Use the following monomer to draw the products of a condensation reaction between two amino acids.



Sample answer



Outcomes : H9,6,8

Question 13 (6 marks)

Cellulose has the potential to supply the raw materials for the petrochemical and fuel industries.

Discuss this statement using relevant equations in your answer.

Sample Answer

Cellulose is a condensation polymer made up of linked glucose molecules. When broken down into glucose, the glucose can be fermented to produce ethanol.

Ethanol can be dehydrated, using concentrated sulfuric acid, to ethene which can then be polymerised into polythene to make plastics in the petrochemical industry.



Ethanol can be used as a biofuel to supplement petrol and produce energy.



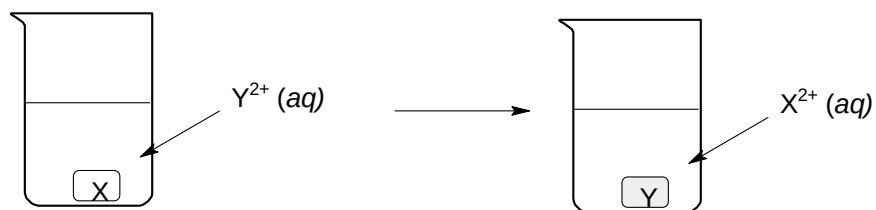
Marking Criteria	Marks
- Cellulose potential and ethanol from glucose - Dehydration of ethanol to ethene and link to petrochemicals - Combustion of ethanol to release heat as a fuel 2 relevant equations	6
5 of the above	5
4 of the above	4
3 of the above	3
2 of the above	2
1 of the above	1

eq eq pot pet g f

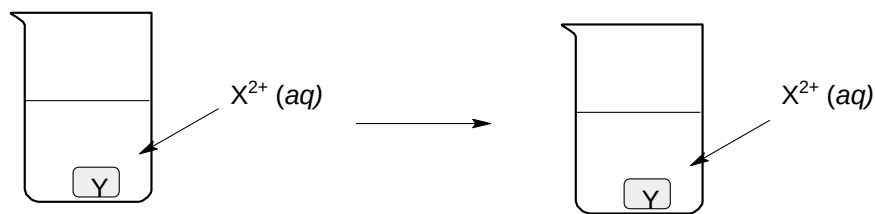
Outcomes : H3,4,7,8,9

Question14

A student tested two metals and their soluble salts using the following set-up:



Set-up 1



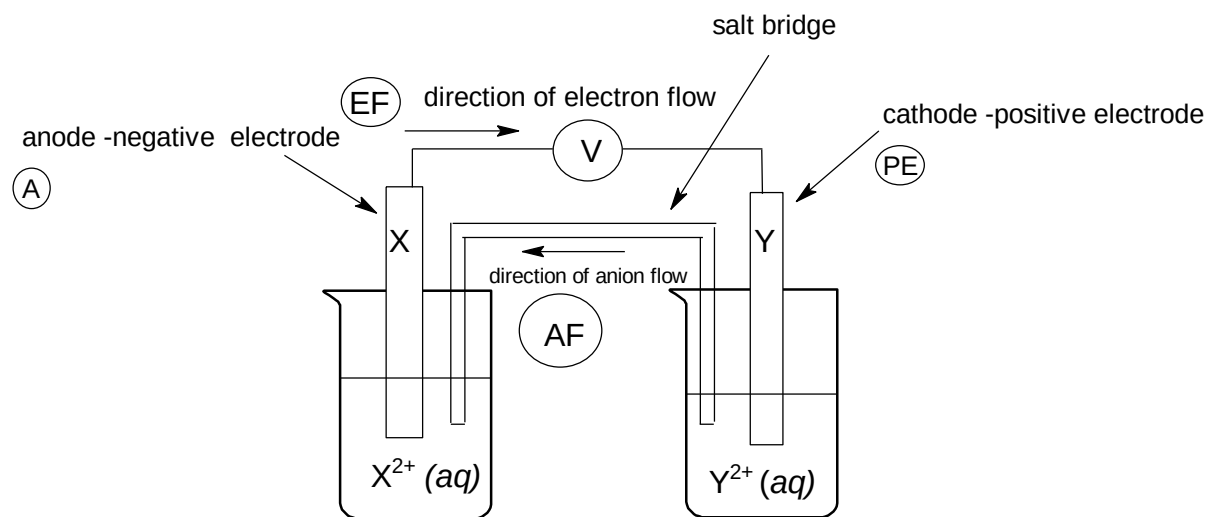
Set-up 2

On the basis of the student's results, draw a diagram of a working galvanic cell consisting of the two metal electrodes X and Y, and the solutions X^{2+} and Y^{2+} . Clearly label the anode, the positive electrode, the direction of electron flow and the direction of anion flow. (Place your labels very close to the part you are labelling)

Outcome(s): H6,H7, H13,H14

Sample answer:

The preliminary tests show that X is a more active metal than Y, therefore in a galvanic cell, X will be the anode:



CD = correct arrangement, salt bridge, solutions

Marking Guidelines

Criteria	Marks
correct diagram complete with salt bridge (voltmeter is optional)	1
correct labelling of parts: anode, A positive electrode, PE direction of electron flow, EF direction of anion flow, AF (1 mark each correct label)	4

Question 15 (4 marks)

a. What are transuranic elements ? (1 mark)

a. Sample answer : Transuranic elements are artificially created elements with atomic number greater than 92. They have too many protons and neutrons and hence are unstable.

a Marking Guidelines

Criteria	Mark
Correct definition of a transuranic element	1

b. Describe how transuranic elements are produced. (3 marks)

b Sample Answer : 1. A nuclear reactor can be used to bombard heavy nuclei with neutrons to produce transuranic elements eg bombarding uranium with neutrons results in the formation of neptunium which rapidly decays to plutonium or a linear accelerator can accelerate positive particles eg protons and small nuclei eh He or C to high speeds in a straight line and these can be fired at heavy elements eg uranium to create various transuranic elements.

Outcomes :H3, H5

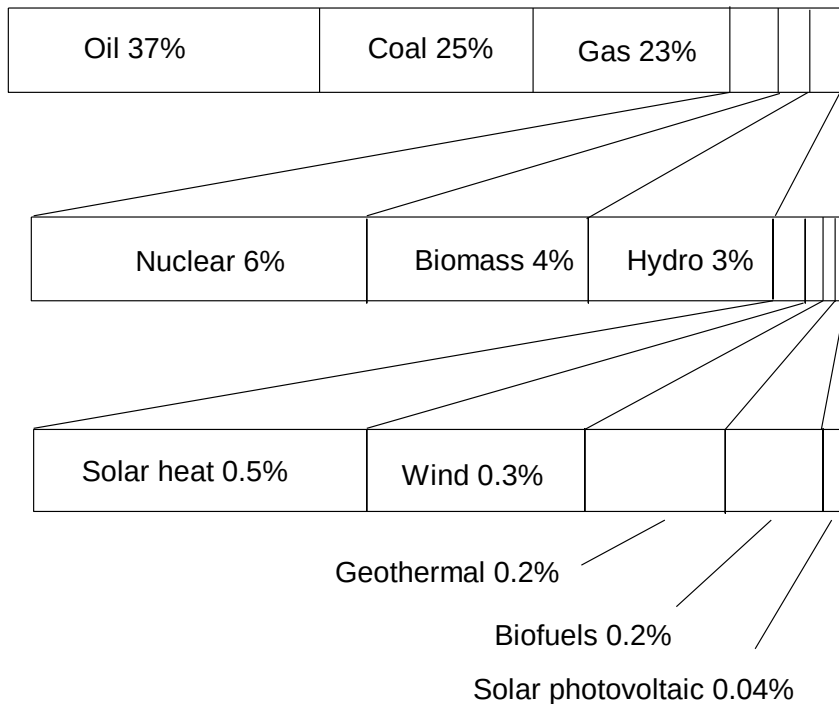
b Marking Guidelines

Criteria	Mark
Correct description of production of transuranic elements using nuclear reactors and linear accelerators.	3
Correct description of production of transuranic elements using nuclear reactors or linear accelerators	2
Identification of a process to produce transuranic elements	1

Data Processing

Question 1 (4 marks)

- (a) Shown below is information on world energy usage in successively increasing detail:
(2007) *BP Statistical Review of World Energy, June 2006(XLS)* British Petroleum, as quoted by Wikipedia



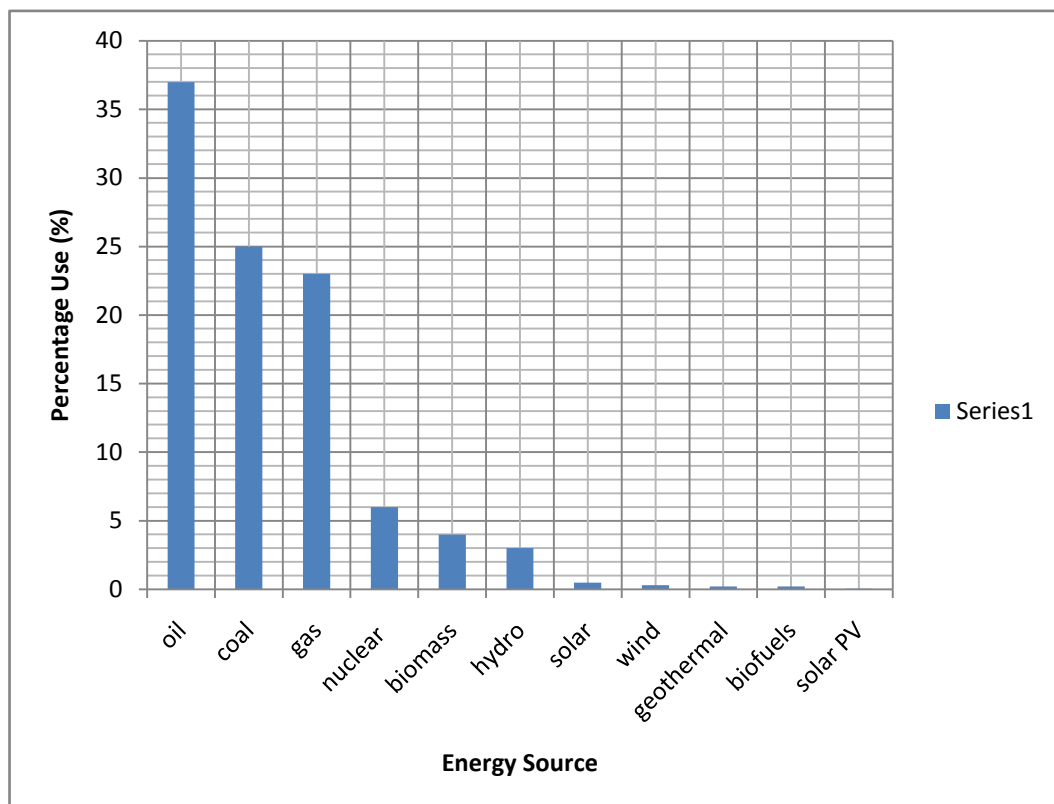
Convert the information into a table of data: (2 marks) **Outcome(s) H13, H12**
Sample answer

Energy Source	Percentage
oil	37
coal	25
gas	23
nuclear	6
biomass	4
hydro	3
solar	0.5
wind	0.3
geothermal	0.2
biofuels	0.2
solar PV	0.04

<i>Criteria</i>	<i>Mark(s)</i>
correct table set-up	1
correct data entered	1

- (b) Draw an appropriate graph to show the relative magnitude of each energy source.
(2 marks)

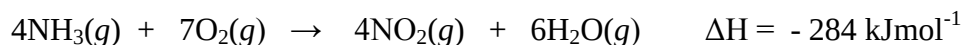
Sample answer:



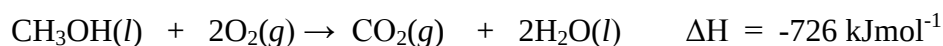
<i>Criteria</i>	<i>Mark(s)</i>
correct correct type of graph	1
correct data entered	1

Question 2 (9 marks)

A farmer ran a generator from an engine he developed which was powered by ammonia produced from his farming activities. The reaction with ammonia was



The farmer then decided that it would be cheaper to run his engine from methanol than ammonia, with the following reaction.



The farmer could produce 1 kg of ammonia for 20 cents and 1 kg methanol for 30 cents.

- (a) Calculate the heat of combustion for ammonia in kJ per kilogram. (2 marks)

$$\begin{aligned} a. \text{ Heat of combustion for ammonia} &= -284 \text{ kJmol}^{-1} / 17 \text{ gmol}^{-1} = -16.7 \text{ kJg}^{-1} \\ &= -16706 \text{ kJ kg}^{-1} \end{aligned}$$

Criteria	Marks
Correct calculation of heat of combustion of ammonia converted to kJkg^{-1}	2
Any one error in calculation or not converting to kJkg^{-1}	1

- (b) Calculate the heat of combustion for methanol in kJ per kilogram. (2 marks)

$$\begin{aligned} \text{Heat of combustion for methanol} &= -726 \text{ kJmol}^{-1} / 32 \text{ gmol}^{-1} = -22.6 \text{ kJg}^{-1} \\ &= -22625 \text{ kJ}^{-1}\text{kg} \end{aligned}$$

Criteria	Marks
Correct calculation of heat of combustion of methanol converted to kJkg^{-1}	2
Any one error in calculation or not converting to kJkg^{-1}	1

- (c) Did the farmer make the correct decision on economic grounds ? Explain. (3 marks)

$$\text{Cost NH}_3 = 16706 \text{ kJ} / 20c = 835.3 \text{ kJ} / c$$

$$\text{Cost } \text{CH}_3\text{OH} = 22625 \text{ kJ} / 30\text{c} = 754 \text{ kJ} / \text{c}$$

Thus NH_3 is a better fuel economically.

criteria	Marks
Correct calculation of cost per cent for each fuel and a statement indicating which is the more economic fuel	3
Any one of the above missing	2
Any two of the above missing	1

- (d) Suggest one advantage and disadvantage of using methanol as a fuel. (2 marks)

Liquid methanol is easier to store and trans port but produces $\text{CO}_{2(g)}$, a greenhouse gas.

Marking Guidelines

Criteria	Marks
Correct suggestions for the advantage and disadvantage of the use for methanol	2
One of the above missing	1

Outcomes : H8, H9, H10

Question 3 (6 marks)

Doctors often send patients for blood analysis in order to diagnose ailments. A patient, a 17 – year old male, suffering from fever with abdominal pain was advised by the doctor to have a blood test. Table 1 shows the blood test ordered by the doctor, what they indicate at increased or decreased level.

Table 1

<i>Test</i>	<i>Description</i>	<i>Indications of the level</i>	
		<i>increased</i>	<i>decreased</i>
sodium	sodium is one of the blood electrolytes, it is essential to maintaining the proper balance of fluid in the blood and cells	dehydration, adrenal gland disorder, kidney disease, heart disease, high blood pressure	diabetes, inadequate adrenal function
potassium	essential in maintaining the proper balance of fluids within body cells	kidney failure and liver disease	diabetes, vomiting and diarrhea
chloride	with sodium, potassium and hydrogen carbonate acts to balance the body's acid-base system and control water metabolism	kidney disease and dehydration	vomiting, diarrhea and excessive sweating
urea (BUN)	BUN (blood urea nitrogen) urea is produced in the liver and is the main nitrogen product of protein metabolism; it is eliminated by the kidneys to the urine	fever, starvation, kidney disease	liver disease and increased pituitary activity.
calcium	calcium is needed to maintain body processes such as muscle contraction and nerve transmission	certain bone tumour , when too much vitamin D or milk is taken,	when vitamin D cannot be absorbed because of kidney disease or nutritional factors as when insufficient calcium is taken
phosphate	phosphorus metabolism is directly related to calcium metabolism and is associated with many body functions	kidney disease, conditions of bone destruction	alcoholism, vitamin deficiency

The result of the blood analysis of the 17 – year old is given in Table 2
Table 2

Test	Analysis result /(mmolL ⁻¹)	Normal values/(mmolL ⁻¹)
sodium	134	135 – 145
potassium	4.4	3.5 – 5.6
chloride	98	99 - 109
bicarbonate	29	23 – 33
urea	4.0	2.1 – 9.0
calcium	2.65	2.10 – 2.60
phosphate	1.41	0.80 – 1.40

(a) Which of the tests gave abnormal values? (2 marks)

sample answer:

sodium, chloride, calcium and phosphate

Criteria	Marks
4 correct answers	2
3 correct answers	1
2 or less correct answers	0

(b) What possible health condition(s) could be indicated by the results? (3 marks)

Sample answer

A very slightly lower sodium ion level may indicate diabetes (1 mark) and parallel to that is the lower chloride value which can be due to excessive sweating due to the fever. (1 mark). The higher values for calcium may be indicative of vitamin D deficiency which prevents the proper metabolism of calcium and hence the higher values for calcium and phosphate. (1 mark)

Criteria	Marks
low sodium level may be due to diabetes	1
low chloride value may be due to excessive sweating	1
elevated calcium and phosphate may be due to Vitamin D deficiency	1
or	
All diagnoses referred to elevated phosphate and calcium and depressed sodium and chloride levels	3
Diagnoses only but no reference to levels of calcium, phosphate, sodium and chloride	2

(c) What further tests or treatment may be advised to the patient?

Sample answer:

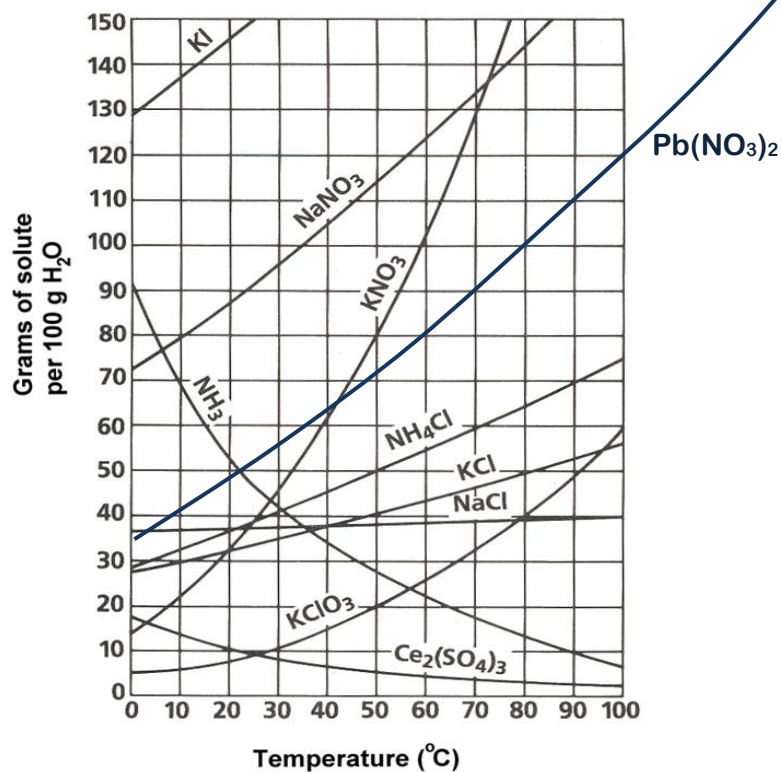
The doctor may advise the patient to do further test for diabetes or a supplement of vitamin D may be prescribed. (1 mark)

Criteria	Mark(s)
reasonable advise	1

Outcomes:H11, H13, H14

Question 4 (11 marks)

Use the following graph of “Solubility versus Temperature” to answer the following questions.



- (a) Name the most soluble material at 20⁰C. (1 mark)

Outcomes Assessed - H11.1 b, c, d: H12.3 b: H14.1.d

Most soluble is **KI** (potassium iodide)

Criteria	Mark
Correct identification of KI/potassium iodide	1

- (b) What mass of the following solutes could be dissolved in the volume of water at the temperatures shown?

- (i) KNO_3 is added to 100 mL of water at 70°C . (1 mark)

Outcomes Assessed – All parts – H11.1 b, c, d: H12.3.b, c: H12.4.b: H14.1.c, d: H14.2.a: H14.3.c.

KNO_3 in 100mL of water at 70°C , Maximum mass dissolving from graph equals ~ **130 g**

Criteria	Mark
Identifies mass of KNO_3 dissolving in 100mL at 70°C is 130 g (129 g accepted).	1

- (ii) NaCl is added to 0.50 L of water at 90°C . (1 mark)

NaCl in 0.50 L of water at 90°C , = $5 \times 40\text{g per } 100\text{mL} = \mathbf{200\text{ g}}$ in 0.50 L
(Can use 39g = **195 g** in 0.50 L)

Criteria	Mark
Identifies mass of NaCl dissolving in 0.50 L at $90^\circ\text{C} = \mathbf{200\text{ g}}$ or 195g if 39g used.	1

- (iii) NH_4Cl is added to 10.0 mL of water at 65°C . (1 mark)

NH_4Cl in 10.0 mL of water at 65°C , = $0.10 \times 58\text{g per } 100\text{mL} = \mathbf{5.8\text{ g}}$ in 10.0 mL
(Can use 57g = **5.7 g** in 10.0 mL)

Criteria	Mark
Identifies mass of NH_4Cl dissolving in 10.0 mL at $65^\circ\text{C} = \mathbf{5.8\text{ g}}$ or 5.7g if 57g used.	1

- (c) Compare the solubility of the three solids, in (a), (b) and (c) above, if each were added to separate beakers containing 100 mL of water at 18°C . (2 marks)

At 18°C , the NaCl (~37g dissolving) is marginally more soluble than the NH_4Cl (~36g dissolving), and both these are more soluble than the KNO_3 (~30-31g).

Criteria	Mark
Correct order for all three $\text{NaCl} \rightarrow \text{NH}_4\text{Cl} \rightarrow \text{KNO}_3$	1

- (d) A sample of 48.0 g of lead nitrate solid is added to a small beaker containing 50.0 mL of water at 300°C . This was then stirred vigorously for about 30 seconds.

Considering the temperature of the water did not change, including a brief explanation, what mass of lead nitrate would you expect to remain as a solid in the beaker?(2 marks)

Outcomes Assessed - H11.1 b, c, d: H12.3.b, c: H12.4.b: H14.1.c, d, e: H14.2.a,c: H14.3.a.b.c

*At 30⁰ C, from the graph 67g of PbNO₃ will dissolve in 100 mL, therefore in 50.0mL at 30⁰ C , 67/2 = **33.5 g** will dissolve. As 48.0 g was added then, 48 – 33.5 ~ **14.5 g** remains as solid in the beaker.*

Criteria	Mark
* Provides some explanation and indication of correct technique to obtain answer but has made an error with the result, Or // * Calculates correct answer but fails to provide sufficient detail to allow technique to be understood.	1
Correctly states 14.5 g (accept 14 g) will not dissolve and includes some explanation of technique.	2

Accept 34 g dissolving for students that are careful with significant figures.

- (e) A student is given an unknown solid and told that it is a pure ionic compound. They are also given a graph of “Solubility versus Temperature” for some different materials (identical to the one in this test) and told that the unknown solid is one of the materials shown in the graph.

The student carried out the following steps in an attempt to identify the unknown solid.

The student

- (i) collected some deionised water and measured the temperature of the water to be 25⁰C.
- (ii) carefully added 5.0 ml of the water to a large test tube.
- (iii) used an electronic balance and measured the mass of the water and test tube to be 62.500g.
- (iv) began to slowly add tiny amounts of the unknown solid while swirling the test tube and observing closely.
- (v) continued to slowly add more of the solid and watched closely for any sign that the solid was not dissolving.
- (vi) immediately stopped adding solid as soon as any undissolved solid was noticed.

- (vii) reweighed the test tube and recorded a mass of 64.220g.
- (viii) used their results and the graph of “Solubility versus Temperature” to identify the unknown solid.

Describe how the student would have used the information from their experiment, and the “Solubility versus Temperature” graph, to identify the unknown solid. Give the name of their likely answer. (3 marks)

Outcomes Assessed - H11.1 b, c, d: H12.3.b, c: H12.4.b, d: H14.1.c, d, e: H14.2.a,c: H14.3.a.b.c

The student can use the experiment to determine the mass dissolving in 5.0 mL and multiply it by 20. This gives the mass per 100 mL and allows the graph to be used to find the material that corresponds (or is closest to) the solubility from the experiment.

i.e. Mass of solid dissolving in 5.0 mL of water at 25 °C = 64.220 – 62.500 = 1.72 g

Mass dissolving in 100 mL = 20 x 1.72 = 34.4 g in 100mL.

From the graph the most likely material is KCl (potassium chloride).

Criteria	Mark
* Correctly determines that mass of solid dissolving is approx. 1.72 g, Or// * Shows that experimental mass must be multiplied by 20 to use graph, Or// * Suggests that experimental value can be converted and the graph used to find the material that corresponds.	1
* Correctly outlines the technique but has made errors in dealing with numbers or in reading off graph, Or// * Names potassium chloride but fails to clearly describe all steps to obtain the answer.	2
Provides clear description, completes all calculations and reads graph correctly, names potassium chloride as unknown.	3

