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Tasmanian Certificate of Education**CHEMISTRY****Senior Secondary 5C***Subject Code: CHM5C***External Assessment****2007****Part 1****Time: approximately 45 minutes**

On the basis of your performance in this examination, the examiners will provide a result on the following criteria taken from the syllabus statement:

Criterion 4 Develop and evaluate experiments.

Criterion 7 Demonstrate an understanding of the fundamental principles and theories of electrochemistry.

Criterion	Mark
7	/32
4	/8

Pages: 12
Questions: 8

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CANDIDATE INSTRUCTIONS

Candidates **MUST** ensure that they have addressed **ALL** of the externally assessed criteria on this examination paper.

Answer **ALL** questions (making sure you answer all parts within each question so that the criteria can be assessed). Answers must be written in the spaces provided on the examination paper.

The 2007 Chemistry Information Sheet can be used throughout the examination.

No other printed material is allowed into the examination.

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Each booklet is of equal value (40 marks) and it is recommended that you spend no more than 45 minutes on any one of the **FOUR** parts to this examination.

In calculations no credit can be given for incorrect answers unless they are accompanied by details of the working. Some credit will be given for unsimplified answers. Appropriate units must be included.

NOTE: 1 litre (L) = 1000 millilitres (mL) = 1dm^3 = 1000 cm^3 .

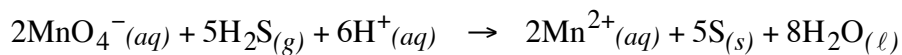
The last question in each part is used in the assessment of Criterion 4.

All written responses must be in English.

Question 1**For
Marker
Use
Only**

This question assesses Criterion 7.

When gaseous hydrogen sulfide, H_2S , is bubbled through an acidified aqueous solution of potassium permanganate, KMnO_4 , the following reaction occurs:



- (a) What is the oxidation number of Mn in MnO_4^- ion? (1 mark)

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- (b) Which substance was oxidised? (1 mark)

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- (c) Explain why this is an oxidation-reduction reaction. (1 mark)

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Question 2**For
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This question assesses Criterion 7.

The green manganate ion, $\text{MnO}_4^{2-}(\text{aq})$, in acidic solution spontaneously undergoes auto oxidation-reduction forming the pink-purple permanganate ion, $\text{MnO}_4^{-}(\text{aq})$, and colourless manganese(II) ions, $\text{Mn}^{2+}(\text{aq})$.

- (a) Write a balanced half equation for the oxidation of manganate to permanganate in acidic conditions. (1 mark)

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- (b) Write a balanced half equation for the reduction of manganate to manganese(II) in acidic conditions. (1 mark)

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- (c) Hence write the net oxidation-reduction equation. (1 mark)

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Question 3**For
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Use
Only**

This question assesses Criterion 7.

Predict whether a reaction will occur when an iron nail is placed in an aqueous solution of tin(II) chloride. Assume standard conditions.

If yes, write the equation for the reaction. If no, give reason. (2 marks)

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Question 4

This question assesses Criterion 7.

A typical Hall-Heroult cell used for the electrolytic extraction of aluminium from alumina, Al_2O_3 , operates at 5.00 volts with a current of 150 000 amperes.

(a) Write the half equation for the reduction of the aluminium ion in the alumina. (1 mark)

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(b) Determine the mass of aluminium produced by such a cell over a 24-hour period. (3 marks)

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Question 5**For
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This question assesses Criterion 7.

Calcium is produced by the electrolysis of molten calcium chloride, CaCl_2 , using inert electrodes.

(a) Write an equation showing the products at: (2 marks)

(i) the anode:

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(ii) the cathode:

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(b) If a solution of calcium chloride were electrolysed with inert electrodes, indicate (using an equation) the products expected at each electrode. (2 marks)

(i) the anode:

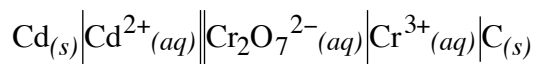
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(ii) the cathode:

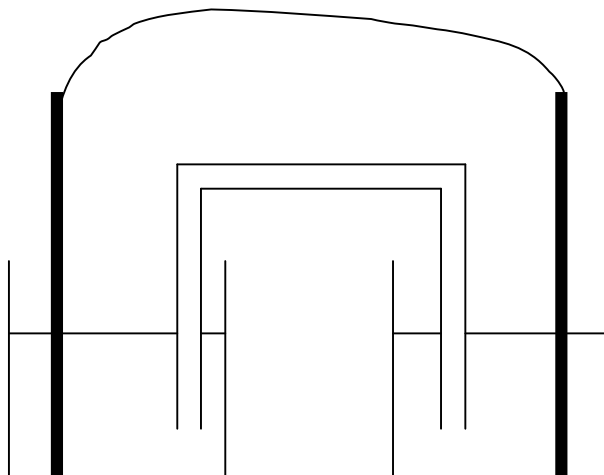
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Question 6**For
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Only***This question assesses Criterion 7.*

Complete the diagram below to illustrate the electrochemical cell:



- (a) On the diagram label the electrodes, solutions, anode and anode reaction, cathode and cathode reaction, salt bridge and show the direction of electron flow in the external circuit, and the ion flow through the salt bridge. (5 marks)



- (b) Calculate the maximum net E° for this cell. (1 mark)

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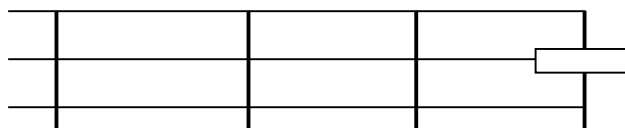
- (c) Outline the main requirements for a salt bridge chemical and suggest a suitable chemical for the salt bridge in this cell. (2 marks)

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Question 7**For
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Use
Only**

This question assesses Criterion 7.

A farm fence is made of wooden posts with three strands of galvanised wire between the posts. The corner post has a steel sign nailed to it.



- (a) After a particularly wet winter the sign fell off because the iron nails had rusted. Explain why the iron nails had more rust on the part that had been inside the post. Include relevant equations and a diagram. (3 marks)

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- (b) The farmer repaired the fence and replaced the steel sign using copper nails thinking that they would not corrode in the post. However, the sign fell off again a few months later. Explain why. (3 marks)

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- (c) The next summer the fence was burned in a bush fire. Explain why the wire strands rusted very quickly after the fire. (2 marks)

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Question 8**For
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Only***This question assesses Criterion 4.*

(a) In an experiment to determine where germanium and titanium would be placed in the electrochemical series the following results were obtained. (Standard solutions were used.)

- Germanium, Ge, reacted slowly with copper(II) ions in solution to produce germanium(II) ions and copper metal.
- Germanium did not react with dilute acids or with solutions of tin(II) ions.
- Aluminium, with the oxide layer removed, reacted with a solution of titanium(II) ions to produce aluminium ions and titanium metal.
- Manganese metal did not react with a solution of titanium(II) ions.

(i) Where would $\text{Ge}^{2+}_{(aq)} + 2e^{-} \rightarrow \text{Ge}_{(s)}$ be placed in the series? (1 mark)

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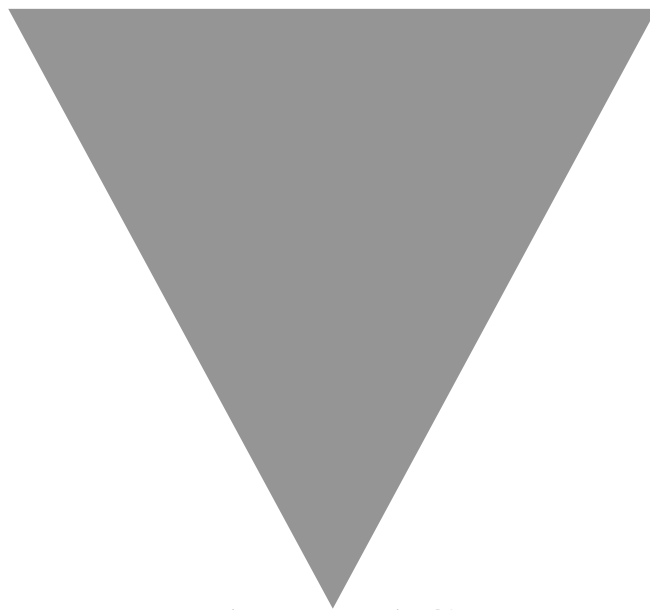
(ii) Where would $\text{Ti}^{2+}_{(aq)} + 2e^{-} \rightarrow \text{Ti}_{(s)}$ be placed in the series? (1 mark)

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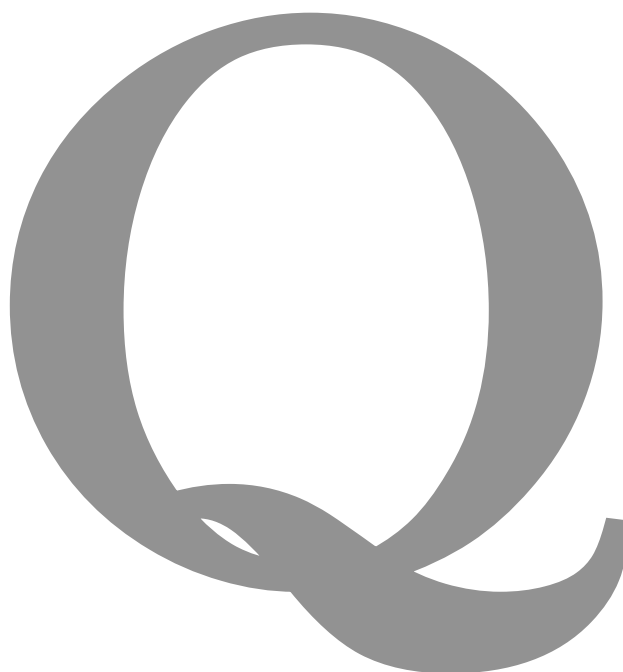
(iii) Predict whether a reaction would occur between titanium metal and a 1.00 mol L^{-1} solution of hydrochloric acid. Explain your answer. (2 marks)

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Question 8 continues opposite.



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Tasmanian Certificate of Education**CHEMISTRY****Senior Secondary 5C***Subject Code: CHM5C***External Assessment****2007****Part 2****Time: approximately 45 minutes**

On the basis of your performance in this examination, the examiners will provide a result on the following criteria taken from the syllabus statement:

Criterion 4 Develop and evaluate experiments.

Criterion 8 Demonstrate knowledge and understanding of the principles and theories of thermochemistry, kinetics and equilibrium.

Criterion	Mark
8	/32
4	/8

Pages: 16
Questions: 8

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CANDIDATE INSTRUCTIONS

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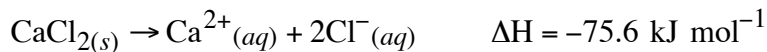
The last question in each part is used in the assessment of Criterion 4.

All written responses must be in English.

Question 9

This question assesses Criterion 8.

The dissolving of calcium chloride in water is represented by:



- (a) (i) Explain what ΔH represents. (1 mark)

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- (ii) State whether this is an exothermic or endothermic reaction. (1 mark)

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- (b) If 50.0 g of calcium chloride were dissolved in excess water what would be the energy change resulting from the reaction? (2 marks)

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Only****Question 10**

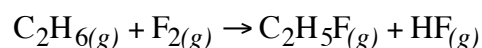
This question assesses Criterion 8.

The **bond energy** of a chemical bond is the energy required to overcome the forces operating between atoms that hold them together.

Some bond energies for bonds in gaseous molecules are listed below:

Bond type	Bond energy (kJ mol ⁻¹)
C–H	416
C–C	346
F–F	172
H–F	565
C–F	485

The reaction of ethane with fluorine gas is given by the equation:



Use the bond energies in the table (and your knowledge of chemical structures) to calculate ΔH for the reaction. Clearly show your calculations. (3 marks)

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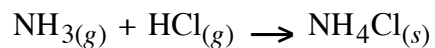
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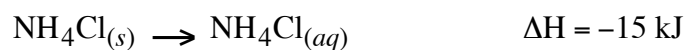
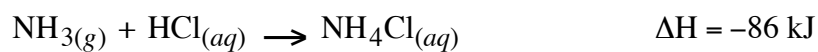
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Only****Question 11***This question assesses Criterion 8.*Calculate ΔH for the reaction:

Using the information:

(2 marks)



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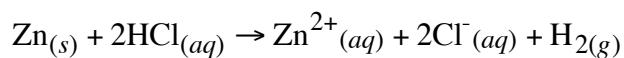
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Question 12**For
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This question assesses Criterion 8.

Zinc and dilute hydrochloric acid react according to the equation:



The reaction starts slowly at room temperatures and gradually speeds up. The beaker containing the reaction becomes warmer as the reaction proceeds.

- (a) Is the reaction exothermic or endothermic? Give a reason. (2 marks)

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- (b) What is the relative size of the activation energy? Explain. (2 marks)

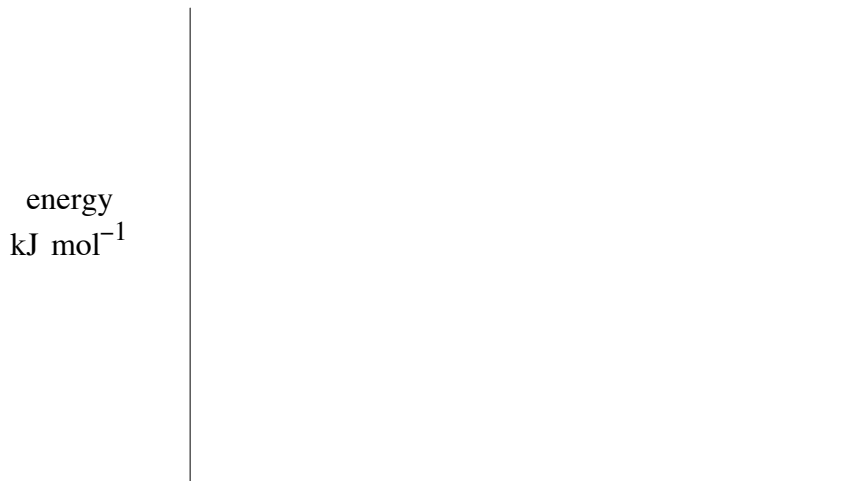
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- (c) On the axes below draw an energy diagram for this reaction indicating reactants, products, ΔH and activation energy. (2 marks)

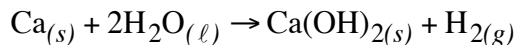


- (d) A piece of copper wire wound around the zinc catalyses the reaction. Show the effect of the catalyst on the graph above with a dotted line. (1 mark)

Question 13

This question assesses Criterion 8.

The reaction between calcium and water is represented by:



A student conducts an experiment and has three beakers containing the following:

- Beaker A: 2.00 g lump of calcium, 2.00 L of water at 15°C temperature;
- Beaker B: 2.00 g lump of calcium, 2.00 L of water at 25°C temperature;
- Beaker C: 2.00 g of small calcium pieces, 2.00 L of water at 25°C temperature.

(a) Which beaker will have the fastest reaction rate? (1 mark)

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(b) Give reasons in terms of Collision Theory for your answer in (a). (3 marks)

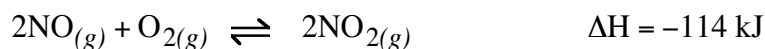
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Question 14**For
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This question assesses Criterion 8.

One step in the synthesis of nitric acid involves the following reversible reaction:



Assume this reaction has reached equilibrium in a closed container at constant temperature and pressure.

What happens (increase, no change, or decrease) to the equilibrium yield of $\text{NO}_{2(g)}$ if the following occur?

- (a) The volume of the container is increased at constant temperature. (1 mark)

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- (b) More oxygen is added to the container at constant volume and temperature. (1 mark)

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- (c) A suitable catalyst is added. (1 mark)

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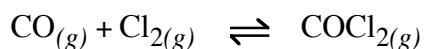
- (d) Some helium is added at constant volume and temperature. (1 mark)

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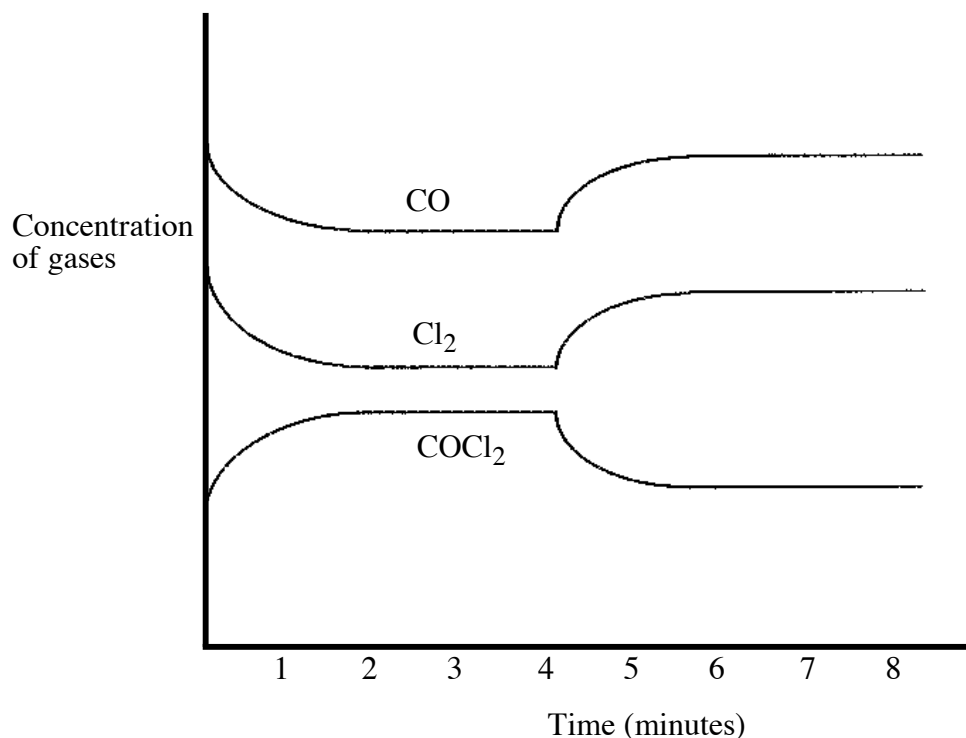
Question 15

This question assesses Criterion 8.

Phosgene gas, COCl_2 , is prepared according to the following reversible reaction:



A mixture containing these three gases is introduced into a closed system in the presence of a charcoal catalyst. The following graph shows how the concentration of these gases varies with time.



- (a) Describe the system three minutes after mixing. (1 mark)

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- (b) Four minutes after mixing, the temperature was increased by 25°C . From the system's response shown on the graph above, deduce whether the reaction as written is endothermic or exothermic. Explain. (2 marks)

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Question 15 continues opposite.

Question 15 (continued)

(c) Write an expression for the equilibrium constant of this reaction.

(1 mark)

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(d) 0.100 mole of $\text{COCl}_{2(g)}$ is put into a 2.00 L closed vessel and allowed to come to equilibrium at 25°C . When equilibrium reached the $\text{COCl}_{2(g)}$ concentration is measured as $0.0447 \text{ mol L}^{-1}$.

Calculate the equilibrium constant at a temperature of 25°C .

(4 marks)

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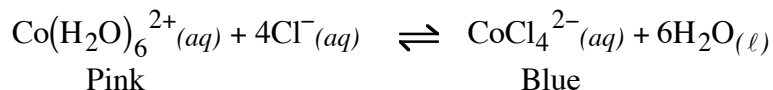
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Question 16**For
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Only***This question assesses Criterion 4.*

- (a) An equilibrium system involving an aqueous solution of cobalt(II) chloride acidified with hydrochloric acid is observed. The equation for the system is:



Two tests are carried out on the system.

Test 1: Solution is boiled, removing most of the water

Test 2: Silver ions, Ag^+ , are added to the solution

- (i) What is the expected observation for test 1? (1 mark)

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- (ii) What is the expected observation for test 2? (1 mark)

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- (b) 40.0 mL of 1.00 mol L⁻¹ hydrochloric acid, HCl, were added to 20.0 g of marble chips (a large excess), CaCO₃, in a conical flask. The flask and contents were immediately weighed and a stop watch started. The mass of the flask and contents were noted as the reaction proceeded. The following table indicates the loss in mass at various times.

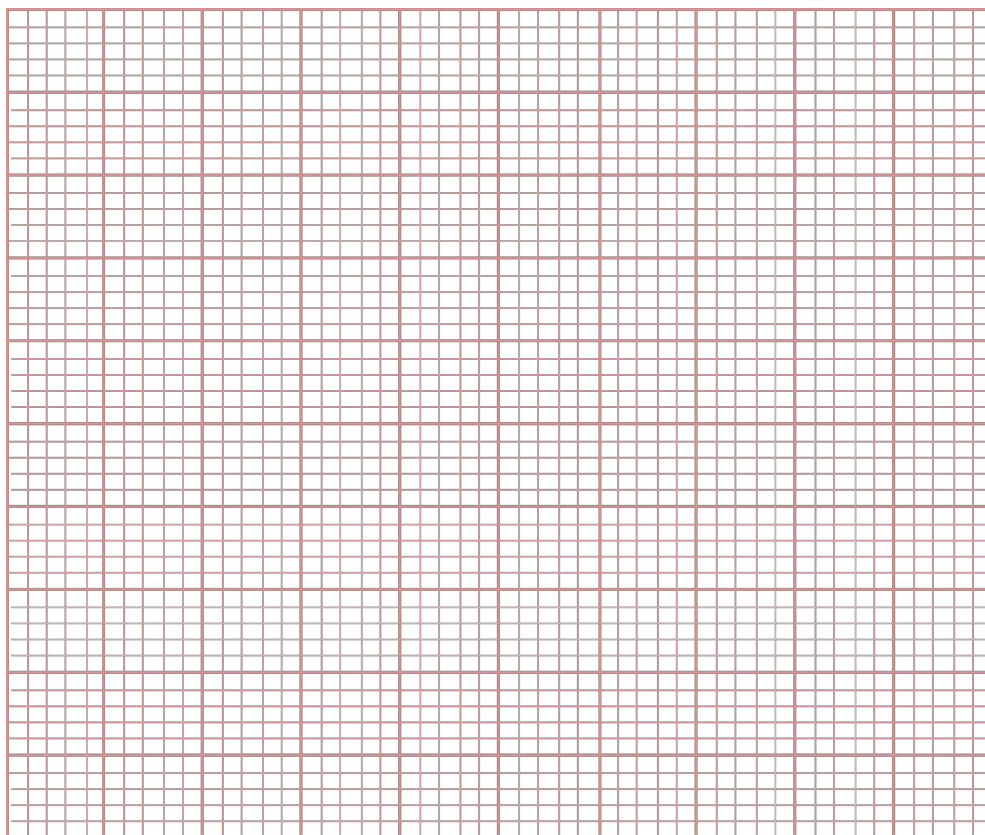
Time (min)	0	0.5	1.0	1.5	2.0	3.0	5.0	7.0	8.0	10.0
Loss in mass (g)	0	0.19	0.35	0.47	0.56	0.69	0.82	0.86	0.88	0.88

- (i) Plot a graph of 'loss in mass' against time, on the grid on page 13. (3 marks)

Question 16 continues opposite.

Question 16 (continued)

Graph Grid

**For
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Use the graph to answer the following questions:

- (ii) How long did it take for half the acid to be used up? (1 mark)

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- (iii) How long did it take for all of the acid to be used up? (1 mark)

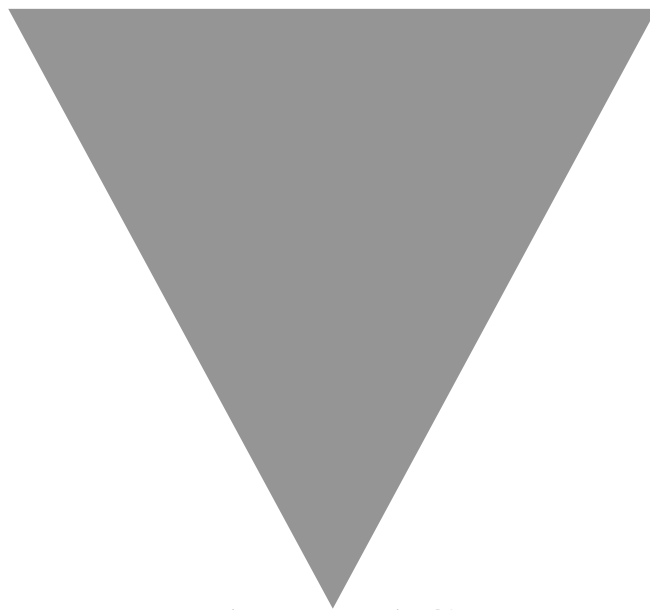
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- (iv) Why did the second half of the reaction take longer than the first? (1 mark)

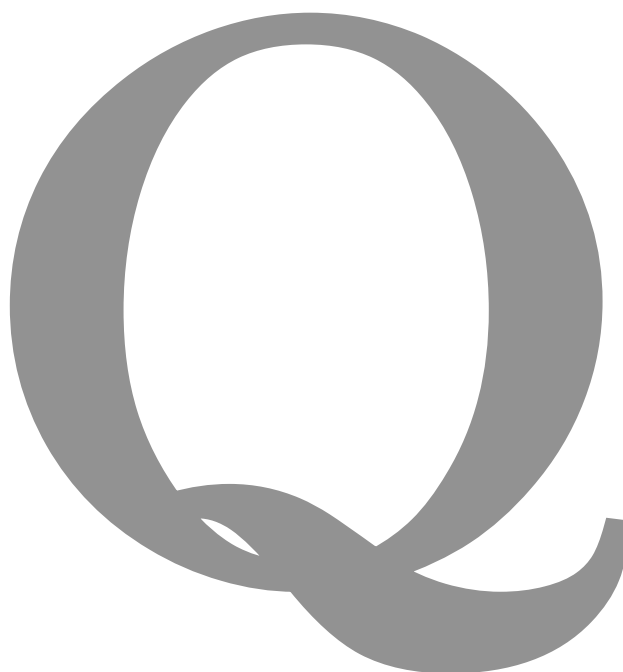
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Tasmanian Certificate of Education**CHEMISTRY****Senior Secondary 5C***Subject Code: CHM5C***External Assessment****2007****Part 3****Time: approximately 45 minutes**

On the basis of your performance in this examination, the examiners will provide a result on the following criteria taken from the syllabus statement:

- Criterion 4** Develop and evaluate experiments.
- Criterion 9** Demonstrate knowledge and understanding of the properties and reactions of organic and inorganic matter.

Criterion	Mark
9	/32
4	/8

Pages: 16
Questions: 9

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**For
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Use
Only**

Question 17

This question assesses Criterion 9.

(a) Zinc has an atomic number of 30.

(i) Give the most stable electronic configuration of zinc. (1 mark)

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(ii) Which electrons does zinc lose to form its positive ion? (1 mark)

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(b) The electronic configurations of three elements are.

Element	Electron configuration
A	$1s^2 2s^2 2p^6 3s^2 3p^1$
B	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$
C	$1s^2 2s^2 2p^6 3s^2 3p^3$

(i) A and B form a compound. What is its formula in terms of A and B? (1 mark)

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(ii) B and C also form a compound. Describe the bonding present in a solid sample of this compound. (2 marks)

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Question 17 continues opposite.

**For
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Only****Question 17 (continued)**

(c) The ions Cl^- and K^+ have the same electron configuration as Ar.

(i) List the three entities (Ar, Cl^- , and K^+) in order of increasing radii. (1 mark)

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(ii) Explain the trend. (2 marks)

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Only****Question 18***This question assesses Criterion 9.*

- (a) Consider the **main groups** in the Periodic Table.
- (i) Explain why elements within a group react similarly. (1 mark)
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- (ii) Give a reason why caesium is more reactive than the lower atomic mass alkali metals. (1 mark)
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- (iii) Give a reason why fluorine is the most reactive halogen. (1 mark)
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Question 18 continues opposite.

Question 18 (continued)**For
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- (b) The table below lists the oxides of the elements of the third period.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Oxide	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₃	Cl ₂ O ₇	

- (i) Explain the trend in reactivity of the elements across the period. (3 marks)

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- (ii) How does the acid/base behaviour of the oxides change across the period? (1 mark)

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Question 19

This question assesses Criterion 9.

Complete the following table:

(4 marks)

Name	Semi-Structural formula	Functional group present
3,4-dimethylpentan-1-ol		
	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{CH}_2 - \text{C} = \text{O} \end{array}$	
	$\begin{array}{c} \text{OH} \\ \\ \text{CH}_3 - \text{CH}_2 - \text{C} = \text{O} \end{array}$	
1,2-dibromobenzene		

**For
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Only****Question 20**

This question assesses Criterion 9.

Write a chemical equation for the reaction between 2-chloropropane and sodium hydroxide showing the **structural** formulae of all organic molecules. (1 mark)

Question 21

This question assesses Criterion 9.

Boiling points of some organic compounds are listed in the table below.

Compound	Propan-1-ol	Propanal	Propanone	Propanoic acid
Boiling points, °C	92.7	47.9	56.1	140.8

- (a) Why are the boiling points of propan-1-ol and propanoic acid higher than the boiling points of propanal and propanone? (1 mark)

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- (b) Which of these compounds would be expected to be most soluble in water? Give reasons. (2 marks)

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Only****Question 22**

This question assesses Criterion 9.

There are two alcohols with the formula C_3H_8O , one a primary alcohol and the other a secondary alcohol.

One of these isomers was treated with acidified potassium permanganate. The resulting organic product was isolated and when tested with sodium metal did not react.

- (a) Which isomer was tested? (1 mark)

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- (b) What was the product that was formed? (1 mark)

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- (c) The other isomer was also treated with acidified potassium permanganate. The resulting organic product was isolated and tested with sodium metal.

Write the equation for the reaction that was expected between the product and sodium. (2 marks)

**For
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Use
Only****Question 23**

This question assesses Criterion 9.

The aroma of rockmelon (cantaloupe) is largely due to the ester methyl butanoate.

- (a) What are the names of the two organic chemicals needed to produce this ester? (1 mark)

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- (b) Write the equation for this reaction. Show the structural formulae of all organic molecules. (1 mark)

**For
Marker
Use
Only****Question 25**

This question assesses Criterion 4.

- (a) The successive ionisation energies, in kJ mol^{-1} , of an unknown element are listed in the table below.

1 st	2 nd	3 rd	4 th	5 th	6 th	7 th
588	1 143	4 903	6 463	8 130	10 477	12 300

From this data predict the following:

- (i) The charge on the ion that the element normally forms. (1 mark)

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- (ii) Given that the element is in Period 4, write the balanced equations for its reactions with oxygen, hydrogen and water? (3 marks)

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Question 25 continues over the page.

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Only****Question 25 (continued)**

- (b) A liquid organic compound was qualitatively analysed and found to contain carbon, hydrogen and oxygen.

Various tests and reactions were undertaken and the observations are shown in the table below.

Test or Reaction	Observations
Tested with pH paper	The pH = 7
Acidified potassium permanganate	The colour of the potassium permanganate remained
Small amount of sodium added	No reaction
Odour	Pleasant
Sodium hydroxide solution added	The pleasant odour disappeared after some time

Suggest the likely type of organic compound, giving reasons for your choice.

(4 marks)

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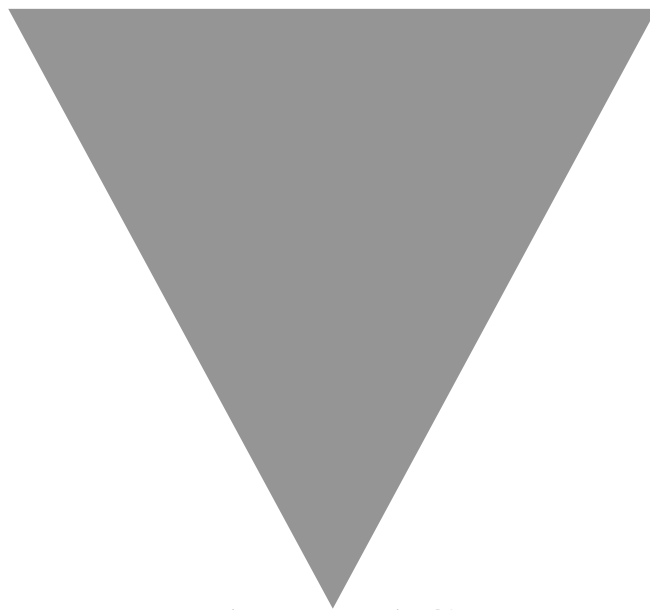
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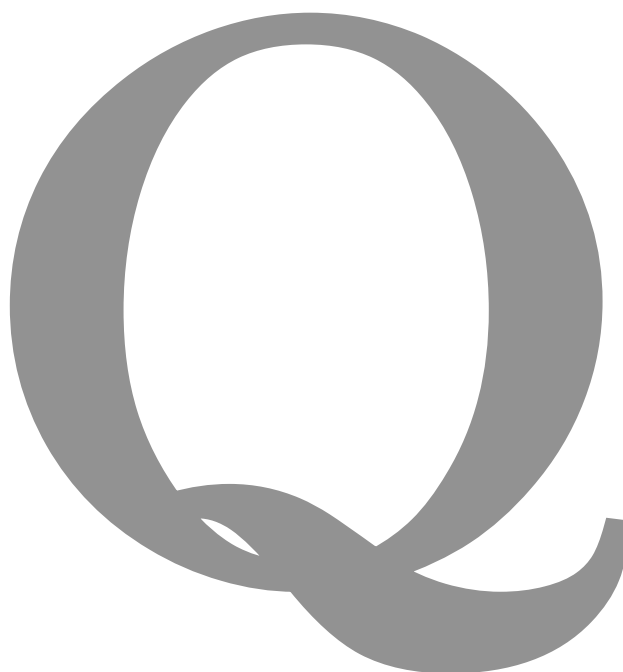
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PLACE LABEL HERE

Tasmanian Certificate of Education**CHEMISTRY****Senior Secondary 5C***Subject Code: CHM5C***External Assessment****2007****Part 4****Time: approximately 45 minutes**

On the basis of your performance in this examination, the examiners will provide a result on the following criteria taken from the syllabus statement:

Criterion 4 Develop and evaluate experiments.

Criterion 10 Apply logical processes to solve quantitative chemical problems.

Criterion	Mark
10	/32
4	/8

Pages: 12
Questions: 7

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CANDIDATE INSTRUCTIONS

Candidates **MUST** ensure that they have addressed **ALL** of the externally assessed criteria on this examination paper.

Answer **ALL** questions (making sure you answer all parts within each question so that the criteria can be assessed). Answers must be written in the spaces provided on the examination paper.

The 2007 Chemistry Information Sheet can be used throughout the examination.

No other printed material is allowed into the examination.

TQA approved graphics calculators can be used throughout the examination.

Each booklet is of equal value (40 marks) and it is recommended that you spend no more than 45 minutes on any one of the **FOUR** parts to this examination.

In calculations no credit can be given for incorrect answers unless they are accompanied by details of the working. Some credit will be given for unsimplified answers. Appropriate units must be included.

NOTE: 1 litre (L) = 1000 millilitres (mL) = 1dm³ = 1000 cm³.

The last question in each part is used in the assessment of Criterion 4.

All written responses must be in English.

**For
Marker
Use
Only****Question 26**

This question assesses Criterion 10.

A research worker analysed a sample of iron and obtained the following results.

Isotope	Relative isotopic mass	% Abundance
^{54}Fe	53.94	5.9
^{56}Fe	55.94	91.8
^{57}Fe	56.93	2.3

Calculate the relative atomic mass of iron based on the results obtained. (3 marks)

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**For
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Use
Only****Question 27***This question assesses Criterion 10.*

- (a) Given the following two compounds, Na_3PO_4 and NaPO_3 , which one contains the higher percentage of oxygen? Show calculations to support your answer. (3 marks)

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- (b) Analysis of a 2.48 g sample of an organic compound showed it to contain 0.602 g of carbon and 1.78 g of chlorine, with the remainder being hydrogen.

What is the empirical formula of the compound? (3 marks)

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Question 28**For
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Use
Only**

This question assesses Criterion 10.

- (a) A meteorological balloon is filled with helium, He, at 0°C and 100 kPa pressure. Its volume at these conditions is 1500 L. What would its volume be at a region where the temperature was -91°C and the pressure was 10.0 kPa? (3 marks)

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- (b) A 36.0 L container is filled with 16.0 g of methane, CH_4 , and some hydrogen, H_2 , at a temperature of 27°C and a total pressure of 500 kPa. Assume that no chemical reaction takes place between the two gases.

- (i) Calculate the partial pressure of the methane in the mixture. (2 marks)

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- (ii) Calculate the amount (in mol) of hydrogen in the container. (2 marks)

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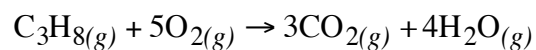
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**For
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Use
Only****Question 29**

This question assesses Criterion 10.

Propane gas, C₃H₈, is commonly used for gas barbeques. A cylinder of propane contains 4.50 kg of usable propane. Calculate the mass of the greenhouse gas carbon dioxide, CO₂, produced from the complete combustion of the usable propane.



(4 marks)

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**For
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Use
Only****Question 31***This question assesses Criterion 10.*

- (a) Determine the pH of a $0.0155 \text{ mol L}^{-1}$ aqueous solution of the strong base barium hydroxide, $\text{Ba}(\text{OH})_2$. (2 marks)

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- (b) The K_a for ethanoic acid, CH_3COOH , is 1.80×10^{-5} . Calculate the pH of a 0.150 mol L^{-1} aqueous solution of ethanoic acid. (4 marks)

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Question 32**For
Marker
Use
Only**

This question assesses Criterion 4.

- (a) An experiment was conducted to determine the Molar mass of a volatile organic liquid. A sample of the liquid was vaporised and the volume, temperature and pressure of the gas formed were measured.

Results from the experiment:

mass of liquid/vapour	0.708 g
temperature of vapour	151°C
pressure of vapour	104 kPa
volume of the vapour	0.323 L

- (i) Calculate the molar mass of the vapour. (2 marks)

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- (ii) The same mass of a sample of a different organic liquid was analysed using the same technique, and a pressure of 147 kPa was obtained under the same conditions.

How does the molar mass compare to that calculated in (i)? Give your reason. (2 marks)

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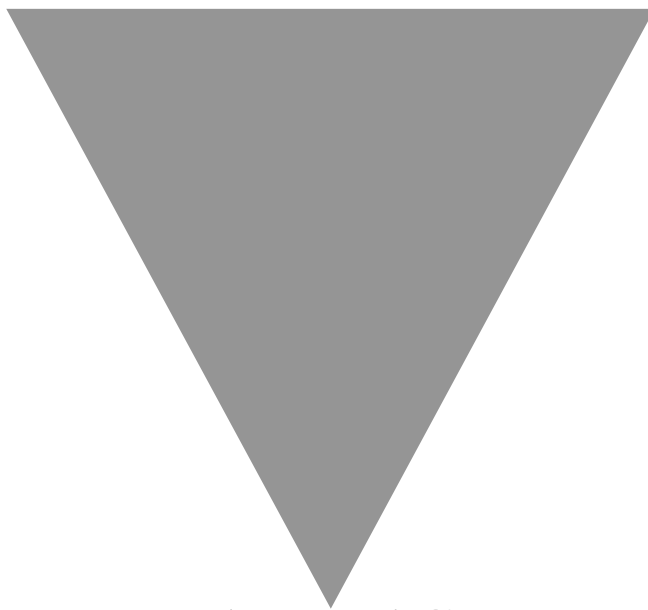
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Question 32 continues opposite.



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