

An Introduction to the Chemistry of the Transition Elements

Question Paper 7

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	An Introduction to the Chemistry of the Transition Elements
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 7

Time Allowed: 32 minutes

Score: /26

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

1 This question refers to the elements in the section of the Periodic Table shown below.

			H						He	
Li	Be			B	C	N	O	F	Ne	
Na	Mg			Al	Si	P	S	Cl	Ar	
K	Ca	transition elements	Ga	Ge	As	Se	Br	Kr

(a) From this list of elements, identify in **each** case **one** element that has the property described. Give the **symbol** of the element.

(i) An element that has molecules which consist of single atoms.

.....

(ii) An element that has a molecule which contains exactly four atoms.

.....

(iii) The element that is a liquid at room temperature and pressure.

.....

(iv) The element in Period 3 (Na to Ar) that has the largest atomic radius.

.....

(v) The element in Period 3 (Na to Ar) that has the highest melting point.

.....

(vi) The element in Period 3 (Na to Ar) that forms the largest anion.

.....

(vii) An element that reacts with water to give a solution that can behave as an oxidising agent.

.....

[7]

- (b) The formulae and melting points of some of the oxides of the elements in Period 3, Na to Cl, are given in the table.

formula of oxide	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₆	SO ₂	Cl ₂ O ₇
m.p./°C	1132	2830	2054	1710	24	-73	-92

- (i) Give the formulae of **two** of these oxides that have simple molecular structures.

..... and

- (ii) Give the formula of one of these oxides that will give no reaction with water when placed in it for a long time.

.....

- (iii) Give the formula of the product formed when MgO is reacted with SO₂.

.....

[4]

- (c) The melting points of the elements Si to Cl are given in the table.

element	Si	P	S	Cl
m.p./°C	1414	44	115	-102

- (i) Explain why the melting point of Si is very much greater than those of the other three elements.

.....

- (ii) Suggest why the melting points of the other three elements are in the order S > P > Cl.

.....

[4]

[Total: 15]

- 2 (a) (i) What is meant by the term *ligand* as applied to the chemistry of the transition elements?

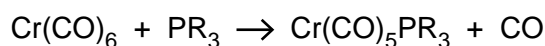
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- (ii) Describe the type of bonding that occurs between a ligand and a transition element.

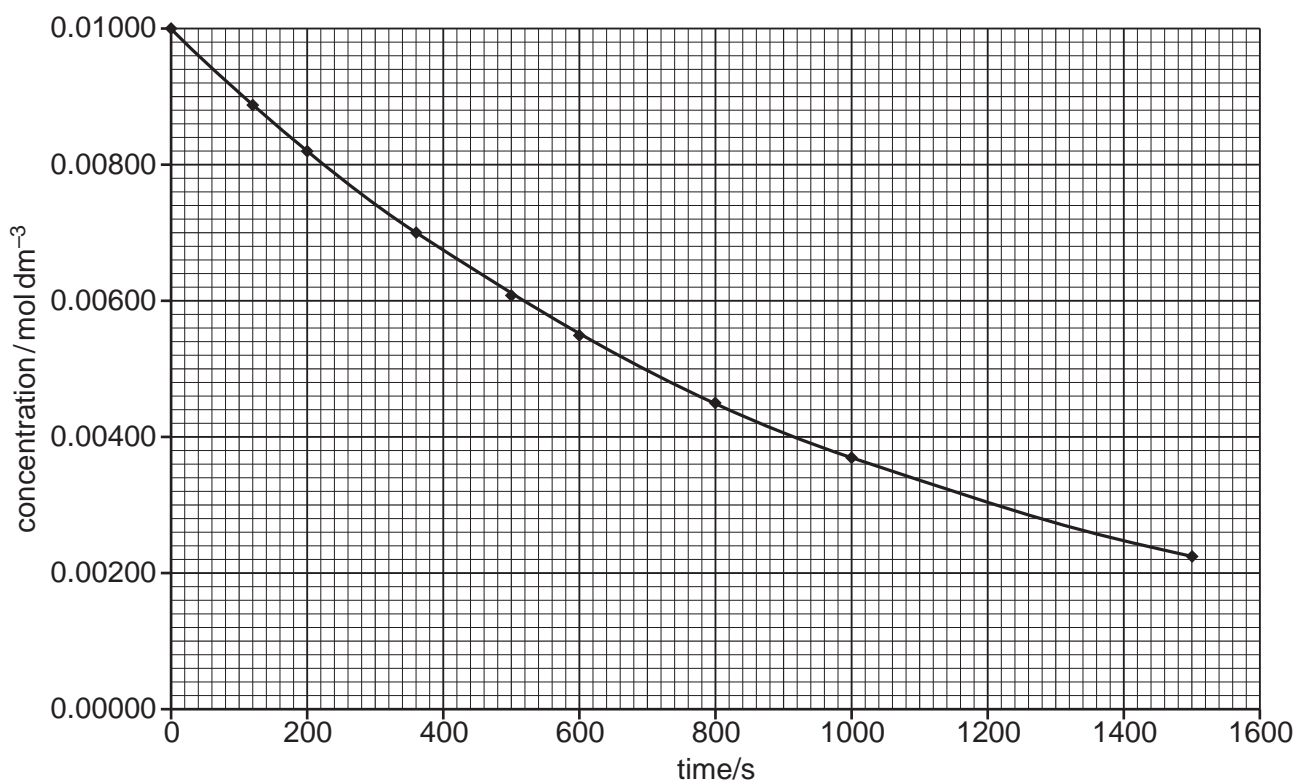
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[2]

- (b) Chromium hexacarbonyl undergoes the following ligand replacement reaction.



Two separate experiments were carried out to study the rate of this reaction. In the first experiment, the ligand PR_3 was in a large excess and $[\text{Cr(CO)}_6]$ was measured with time. The results are shown on the graph below.



In the second experiment, Cr(CO)_6 was in a large excess, and $[\text{PR}_3]$ was measured with time. The following results were obtained.

time/s	$[\text{PR}_3]/\text{mol dm}^{-3}$
0	0.0100
120	0.0076
200	0.0060
360	0.0028

- (i) Plot the data in the table on the graph above, using the same axis scales, and draw

- (ii) Use the graphs to determine the order of reaction with respect to $\text{Cr}(\text{CO})_6$ and PR_3 . In each case explain how you arrived at your answer.

$\text{Cr}(\text{CO})_6$

.....

PR_3

.....

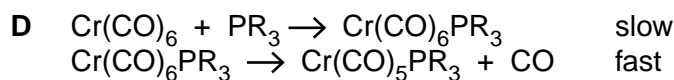
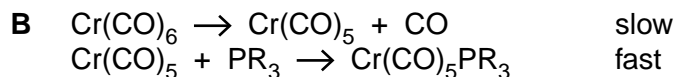
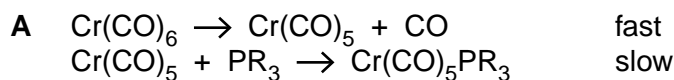
- (iii) Write the rate equation for the reaction, and calculate a value for the rate constant, using the method of initial rates, or any other method you prefer.

.....

- (iv) State the units of the rate constant.

.....

- (v) Four possible mechanisms for this reaction are given below. Draw a **circle** around the letter next to the **one** mechanism which is consistent with the rate equation you have written in (iii).



Explain your answer.

.....

[9]

[Total: 11]