An Introduction to the Chemistry of the Transition Elements

Question Paper 2

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 2

Time Allowed: 71 minutes

Score: /59

Percentage: /100

Grade Boundaries:

A*	Α	В	С	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

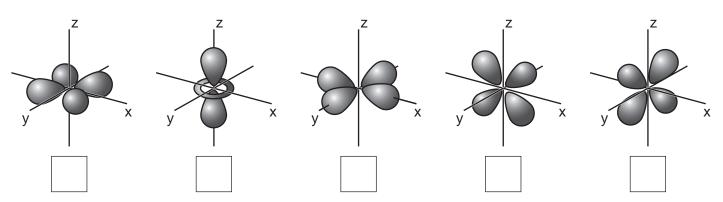
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1 Transition elements have characteristic properties due to their partially-filleddorbitals.

(a)	(i)	Which two elements in the first row of the d-block have only one electron in the 4s orbital of their neutral atoms?
	(ii)	The d orbitals in an isolated transition metal atom or ion are described as being degenerate.
		What is meant by the term degenerate?
	(iii)	Sketches of the shapes of the atomic orbitals from the d subshell are shown.
		In an octahedral complex, the d orbitals are split into two groups at different energy levels.

On the diagram below, write an 'H' in the box under each of the orbitals at the higher energy level.

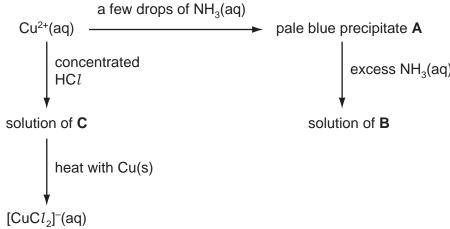


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(b) The following scheme shows some reactions of Cu²⁺(aq).

(c)

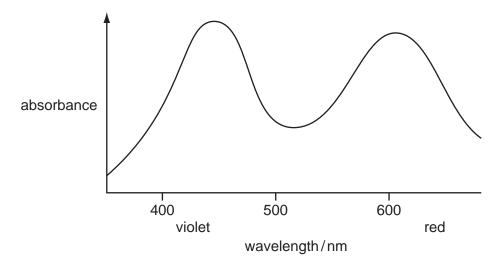


♦
[CuCl ₂] ⁻ (aq)
Suggest the formula of each of the following.
A
В
c
State the colour of the following solutions.
solution of B
solution of C
Name the type of reaction that occurs when C is heated with copper.
Deduce the role of the copper metal in this reaction.
[6]
en the solution containing the complex $[CuCl_2]^-$ is poured into water, a precipitate of $CuCl_2$ ormed. $CuCl_2$ is white because it does not absorb visible light.
plain why CuC <i>l</i> does not absorb visible light.
[O]

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(d) The complex ion $[Cr(H_2O)_6]^{3+}$ is coloured because it **absorbs** visible light. The absorption spectrum for $[Cr(H_2O)_6]^{3+}$ is shown below.



Suggest the colour of this complex ion. Explain your answer.
[2]

[Total: 14]

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

		Н						He				
Li	Вє		В	С	Ν	0	F	Ne				
Na	Mg	9	Αl	Si	Р	S	Cl	Ar				
K	Ca	a transition elements	Ga	Ge	As	Se	Br	Kr				
(a) From this list of elements, identify in each case one element that has the prodescribed. Give the symbol of the element.												
	(i) An element that floats on cold water and reacts readily with it.											
	(ii) An element that forms an oxide that is a reducing agent.											
	(iii)	The element that has the smallest first ionisati	on en	ergy.								
1	(iv)	The element which has a giant molecular structure.	cture	and fo	orms a	an oxic	le whi	ch has a				
	(v)	The element in Period 3 (Na to Ar) that has the	e sma	ıllest a	nion.							
1	(vi)	The element in Period 3 (Na to Ar) which form and an oxide with a very high melting point.	ns a d	chlorid	e with	n a low	/ melt	ing point				
								[6]				

(b)	ider	the elements in Period 3 (Na to Ar) in the section of the Periodic Table opposite to ntify the oxide(s) referred to below. ach case, give the formula of the oxide(s).										
	(i)	An oxide which when placed in water for a long time has no reaction with it.										
	(ii)	An oxide which o	lissolves readily in v	water to g	jive a str	ongly alkaline solution.						
((iii)	Two acidic oxides formed by the same element.										
		and										
((iv)	An oxide which is amphoteric.										
						[5]						
(c)			ther elements in Gross and their boiling point/°C	•		umber of different compounds. the table.						
	(i)		es have similar elec ectrons only, draw a			ons. iagram of the bonding in $\mathrm{C}l\mathrm{F}_3$.						
	(ii)		es have the same s boiling points are s	•	ly differe	ent.						
						[4]						

[Total: 15]

3

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

	н						He					
Li B	e	В	С	N	0	F	Ne					
Na M		Αl	Si	Р	S	C1	Ar					
K C		Ga	Ge	As	Se	ات Br	Kr					
K C	a transition elements	Ga	Ge	Α3	36	ы	IXI					
(a) From this list of elements, identify in each case one element that has the prince described. Give the symbol of the element.												
(i)	(i) An element that when placed in cold water sinks and reacts readily.											
(ii)	An element whose molecules contain $\boldsymbol{\pi}$ bondi	ing.										
(iii)	An element that forms a gaseous toxic oxide.											
(iv)	The element which has a giant molecular structure.	ucture	and	forms	an ox	ide w	hich also					
(v)	An element that forms a covalent chloride conducting solution.	whic	h diss	olves	in wa	ater t	o give a					
(vi)	The element in Period 3 (Na to Ar) with the gr	eates	t elect	rical c	onduc	ctivity.						
							[6]					
							L - ,					

			(Na to Ar) burn w	ith a col	oured flame v	when heated in			
(i)	Give the symbol of one such element, the formula of the oxide formed, and state the flame colour that would be seen.									
	symbol of element									
	formula of oxide									
	flame colour									
(ii)										
	formula of chlo	oride								
	nH of solution									
	pri or solution						[4]			
						-	•			
THE	mening points	or chionine and	the two t	riionaes	are sno	wii iii tile tab	ie.			
		substance	Cl ₂	BrC1	IC1					
		m.p./°C	-101	-66	24					
(i)	Showing outer	electrons only	draw a 'd	ot-and-c	ross' dia	gram of the b	oonding in IC1.			
/::\	Cuggoot why t	ha malting nain	to increas	o from C	1 to 10	1				
(11)	Suggest why to	ne meiting poin	is increas	se irom C	<i>ι</i> ₂ ιο το	ι.				
(iii)	~ ~		molecule	s has the	e largest	permanent o	dipole.			
							[5]			
	oxy (i) (ii) (ii)	(i) Give the symbol flame colour the symbol of elementary formula of oxide flame colour flame colour flame colour formula of chical photosolution formula of c	(i) Give the symbol of one such e flame colour that would be set symbol of element	oxygen or chlorine. (i) Give the symbol of one such element, the flame colour that would be seen. symbol of element	oxygen or chlorine. (i) Give the symbol of one such element, the formula flame colour that would be seen. symbol of element formula of oxide flame colour (ii) For the element you have used in (i), give the state the pH of the solution produced when this formula of chloride pH of solution Chlorine reacts with both bromine and iodine to form The melting points of chlorine and the two chlorides substance cl ₂ m.p./°C -101 -66 (i) Showing outer electrons only draw a 'dot-and-coloride substance coloride and the two chlorides Substance Substance Cl ₂ BrCl m.p./°C -101 -66 (ii) Suggest why the melting points increase from Coloride substance coloride and the two chlorides substance colorides Substance Substance Substance Substance Cl ₂ BrCl The melting points increase from Colorides Substance colorides	oxygen or chlorine. (i) Give the symbol of one such element, the formula of the flame colour that would be seen. symbol of element	(ii) Give the symbol of one such element, the formula of the oxide former flame colour that would be seen. symbol of element			

[Total: 15]

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

		Н						He					
Li	Be)	В	С	N	0	F	Ne					
Na	Μç	9	Αl	Si	Р	S	Cl	Ar					
K	Ca	transition elements	Ga	Ge	As	Se	Br	Kr					
(a)	 (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. 												
	(1)	An element that has molecules which consist of single atoms.											
	(ii)	An element that has a molecule which contain	ıs exa	ctly fo	ur ato	ms.							
	(iii)	The element that is a liquid at room temperature and pressure.											
	(iv)	The element in Period 3 (Na to Ar) that has the	e larg	est ato	omic r	adius.							
	()	The alement is Deviced O (No. 15 An) the other th	- 1-11-	1	- 100								
	(v)	The element in Period 3 (Na to Ar) that has the	e nigr	iest m	eiting	point.							
	(vi)	The element in Period 3 (Na to Ar) that forms	the la	rgest a	anion.								
(vii)	An element that reacts with water to give a sol agent.	lution	that c	an bel	have a	as an o	oxidising					

(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_2O_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)		rmula of one for a long tin		e oxides	that will	give no r	eaction with	wate	r wh	nen
(iii)	Give the for	rmula of the	product f	ormed w	hen MgC) is reacte	ed with SO ₂	•		
										[4]
(c) The	e melting poi	nts of the ele	ements S	i to C <i>l</i> ar	e given iı	n the tabl	e.			
		element	Si	Р	S	Cl				
		m.p./°C	1414	44	115	-102				
(i)	Explain why elements.	y the melting	point of S	Si is very	much gr	eater thai	n those of th	e othe	er thi	ree
(ii)	Suggest w	why the me	elting po	ints of	the oth	er three	elements	are	in 1	the
										 [4]

[Total: 15]