28. Chemistry of transition elements

28.1 General physical and chemical properties of the first row of transition elements, titanium to copper

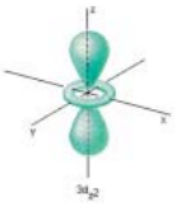
Paper 4

Marking Scheme

Q1.

(a)(i)	element which forms one or more stable ion with incomplete d orbitals	1
(a)(ii)	they have vacant d orbitals that are energetically accessible	1

Q2.

(a)(i)	the (3)d and (4)s (sub-shells/orbitals) are close/similar in energy	1
(a)(ii)		1

Q3.

(b)(i)	Any **two** from: • variable oxidation state • vacant / empty / unfilled d orbitals [1] • can form dative bonds / can accept electrons	1

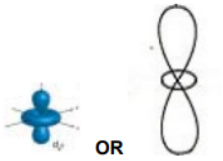
Q4.

(a)	*Any two from:* • they have variable / multiple oxidation states OWTTE • they behave as catalysts • they form complex ions / complexes • they form coloured compounds/ions	1

Q5.

(a)	more than one (stable) oxidation state [1] empty / vacant (d) orbitals are energetically accessible OR empty / vacant (d) orbitals can form dative bonds with ligands [1]	2

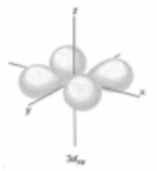
Q6.

(a)	forms one or more stable ions / compounds / oxidation states with incomplete / partially filled (3)d-orbital(s) / d-shell / d-subshell	1
(b)	 OR	1

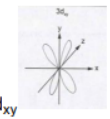
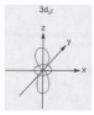
Q7.

(d)(i)	d orbitals that are energetically accessible **OR** empty / vacant d orbitals **AND** form dative bonds / accept a lone pair from a ligand	1

Q8.

(a)	the d and s sub-shells / orbitals are close / similar in energy	1
(b)		1

Q9.

(a)	 $3d_{xy}$  $3d_{z^2}$	1

Q10.

(a)	a d-block element that forms one or more stable ions with incomplete d-orbitals	1

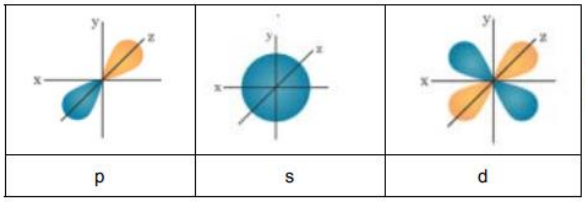
Q11.

(a)	+4 **and** any of +1, +2, +3	**1**
(b)	close similarity of energy of the 4s and 3d sub-shells	**1**

Q12.

(a)	(element forming) • one or more stable ions with **AND** • incomplete / partially filled d-orbitals / d-subshell [1]	**1**

Q13.

(a)	 p s d **All shapes required for mark**	**1**
(b)	both cadmium ions have full d subshells	**1**

Q14.

(b)	M1 (Cu^+/Ag^+) d-shell is full / complete **OR** d-orbitals are full [1] M2 no electrons can be promoted [1]	**2**

Q15.

(c)	FeO and +2 Fe_2O_3 and +3 all [1] **ALLOW** Fe_3O_4 and +3 and +2	**1**

Q16.

(a)	forms one or more stable ions with incomplete / partially filled d-orbitals / d-subshell	**1**