

THE D-AND F-BLOCK ELEMENTS

Q.No	Question	Marks
Multiple Choice Question		
Q.61	<p>Two elements X and Y have electronic configurations as follows:</p> <p style="text-align: center;">$X = 3d^5 4s^1$; $Y = 5d^{10} 6s^2$</p> <p>Which of the following statements is correct about X and Y?</p> <p>A. They both have a high enthalpy of atomization. B. X is a misch metal but Y is not. C. Both are transition elements. D. X is a hard metal but Y is not.</p>	1
Q.62	<p>Pt is used as a catalyst in the preparation of SO_3 by direct combination of SO_2 and O_2 at $450^\circ C$. In the reaction Pt is used as catalyst which _____</p> <p>A. Increases the yield of SO_3 B. Absorbs the SO_2 and O_2 molecules C. Decreases the activation energy D. Adsorbs the SO_2 molecule selectively</p>	1
Q.63	<p>In which of the following oxometal anions does the metal NOT exhibit an oxidation state equal to its group number?</p> <p>A. CrO_4^{2-} B. MnO_4^- C. $Cr_2O_7^{2-}$ D. MnO_4^{2-}</p>	1
Q.64	<p>Manav poured some potassium chromate in a test tube for qualitative analysis. The yellow solution of potassium chromate soon turned orange in colour. Manav realised that this happened because the test tube was not clean and contained a few drops of some liquid.</p> <p>Which of the following were the liquid drops most likely to be?</p> <p>A. Drops of hydrochloric acid B. Drops of methyl orange C. Drops of naoh solution D. Drops of water.</p>	1



Q.65	<p>A transition element 'X' is placed in the first series of transition elements. It has the following characteristics:</p> <p>i) It is a coinage metal.</p> <p>ii) It has a positive reduction potential.</p> <p>ii) It does not react with HCl but reacts with Nitric acid.</p> <p>Which of the following is element X likely to be?</p> <p>A. Zinc B. Iron C. Copper D. Chromium</p>	1
Q.66	<p>Which of the following characteristics make transition elements good catalysts?</p> <p>P) their tendency to form reaction intermediates with the reactants, thereby reducing the activation energy</p> <p>Q) their ability to have multiple oxidation states</p> <p>R) their ability to form complex compounds</p> <p>A. only P B. only Q C. only Q and R D. all - P, Q and R</p>	1
Q.67	<p>Given below is an image showing a specific property of transition metals.</p> <div data-bbox="529 1384 1046 1697" data-label="Chemical-Block"> </div> <p>Which property of transition metals is shown in the image?</p> <p>A. Catalytic action B. Formation of alloy C. Coloured complex formation D. Interstitial compound formation</p>	1

Q.68	<p>Priya listed 4 uses of KMnO_4 as follows:</p> <p>P) It is used in volumetric analysis.</p> <p>Q) It is used in the Chromyl Chloride test to detect Cl^- ion.</p> <p>R) It is used as a germicide.</p> <p>S) It is used in Baeyer's test, the test for unsaturated hydrocarbon.</p> <p>Which of the uses are CORRECTLY listed by Priya?</p> <p>A. Only P, R, and S B. Only Q, R, and S C. Only S and R D. Only P and Q</p>	1															
Q.69	<p>Two important compounds of transition element Chromium are $\text{K}_2\text{Cr}_2\text{O}_7$ and K_2CrO_4. Compound $\text{K}_2\text{Cr}_2\text{O}_7$ is orange in colour and K_2CrO_4 is yellow in colour. The colour observed is because Chromium ion in these compounds;</p> <p>A. Contain completely filled d-orbitals. B. Contain empty d-orbitals C. Undergo d-d transition of electrons. D. Undergo charge transfer between oxide ion and itself.</p>	1															
Q.70	<p>The bond angle between the atoms of a chromate ion is</p> <p>A. 109.5° B. 108° C. 110° D. 94°</p>	1															
Q.71	<p>The following reactions occur in an acidic medium. Which of the following options gives the correct pOH value?</p> <p>Reaction 1: $\text{MnO}_4^- \rightarrow \text{MnO}_2$</p> <p>Reaction 2: $\text{MnO}_4^- \rightarrow \text{Mn}^{+2}$</p> <table border="1"> <thead> <tr> <th></th><th>Reaction 1</th><th>Reaction 2</th></tr> </thead> <tbody> <tr> <td>L</td><td>High</td><td>High</td></tr> <tr> <td>M</td><td>Low</td><td>High</td></tr> <tr> <td>N</td><td>Low</td><td>Low</td></tr> <tr> <td>O</td><td>High</td><td>Low</td></tr> </tbody> </table>		Reaction 1	Reaction 2	L	High	High	M	Low	High	N	Low	Low	O	High	Low	1
	Reaction 1	Reaction 2															
L	High	High															
M	Low	High															
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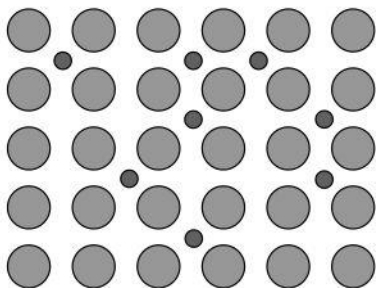
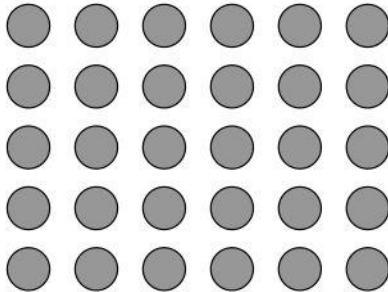


	<p>A. L B. M C. N D. O</p>	
Q.72	<p>Which of the given options gives the correct magnetic properties of the given ions?</p> <p>[At no. of: La = 57 Ce = 58 Yb = 70 Lu = 71]</p> <p>A. Both La and La^{+3} is paramagnetic in nature. B. Both La^{+3} and Lu^{+3} are repelled by the applied magnetic field. C. Ce^{+2} is diamagnetic in nature. D. Yb^{+2} has a magnetic moment of 2.76 BM.</p>	1
Q.73	<p>Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R).</p> <p>Assertion (A): Ce^{4+} ion is a good analytical reagent.</p> <p>Reason (R): Ce^{4+} has a stable electronic configuration.</p> <p>Which of the following is correct?</p> <p>A. Both (A) and (R) are correct and (R) is the correct explanation of (A) B. Both (A) and (R) are correct and (R) is not the correct explanation of (A) C. (A) is true but (R) is false D. (A) is false but (R) is true.</p>	1
Q.74	<p>Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R).</p> <p>Assertion (A): The atomic density of copper is less than that of chromium.</p> <p>Reason (R): The atomic mass of copper is more than that of chromium.</p> <p>Which of the following is correct?</p> <p>A. Both (A) and (R) are correct and (R) is the correct explanation of (A) B. Both (A) and (R) are correct and (R) is not the correct explanation of (A) C. (A) is true but (R) is false</p>	1



	D. (A) is false but (R) is true.							
Free Response Questions/Subjective Questions								
Q.75	<p>The standard electrode potential E^0 (M^{2+}/M) for three metals X, Y, and Z are as follows:</p> <table border="1"> <thead> <tr> <th>X</th><th>Y</th><th>Z</th></tr> </thead> <tbody> <tr> <td>-1.18 V</td><td>-0.91V</td><td>-0.44V</td></tr> </tbody> </table> <p>Which metal out of X, Y, and Z will be the most stable in the M^{2+} state? Give reason.</p>	X	Y	Z	-1.18 V	-0.91V	-0.44V	2
X	Y	Z						
-1.18 V	-0.91V	-0.44V						
Q.76	<p>The preparation of potassium dichromate is a stepwise process, as shown below.</p> <p>Step I - $4FeCr_2O_4 + 16NaOH + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8H_2O$</p> <p>Step II - $2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$</p> <p>Step III - $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$</p> <p>(a) What process should be used to remove impurities from sodium chromate solution, after step I?</p> <p>(b) What makes the reaction in step III possible?</p>	2						
Q.77	Why is mercury liquid at room temperature even though it is a metal? Give reasons.	2						
Q.78	<p>A bottle contains compound 'A', which is the ammonical solution of nitrate salt of a transition element. A chemical compound 'B', containing carbonyl functional group is taken in a test tube. When compound 'A' is added in test tube containing compound 'B' in basic medium. the wall of test tube B develops a shiny coating on it. Based on this information, answer the following questions;</p> <p>i) Write the formula and name of the compound present in bottle A.</p> <p>ii) Which carbonyl compound in test tube B gives a silver mirror formation on heating with compound A.</p> <p>iii) Write a general chemical reaction taking place between chemical A and B.</p>	3						
Q.79	<p>The melting points of three elements J, K, and L were recorded. These three elements are from 1st, 2nd, and 3rd transition series (not necessarily in the order). All of them have half-filled d orbital.</p> <p>The melting point of J is more than K and melting point of K is more than L.</p> <p>Which element is expected to have valence electrons in 5f orbitals and why?</p>	2						
Q.80	<p>a) Complete the table given below.</p> <p>[Note: X (At. No.: 48) and Y(At. No.: 40)]</p>	5						



	<table><tr><th>Element</th><th>Electronic configuration of only the valence shell in the atomic state</th><th>Tensile strength (High/Low)</th><th>Shows colour in aqueous solution(yes/No)</th></tr><tr><td>X</td><td></td><td></td><td></td></tr><tr><td>Y</td><td></td><td></td><td></td></tr></table>	Element	Electronic configuration of only the valence shell in the atomic state	Tensile strength (High/Low)	Shows colour in aqueous solution(yes/No)	X				Y				
Element	Electronic configuration of only the valence shell in the atomic state	Tensile strength (High/Low)	Shows colour in aqueous solution(yes/No)											
X														
Y														
	b) Give a reason for your choice of tensile strength and colour in aq. solution.													
Q.81	Complete the table given below: <table><tr><th>Properties</th><th>Actinoids</th><th>Lanthanoids</th></tr><tr><td>Magnetic properties (Higher/Lower)</td><td></td><td></td></tr><tr><td>The action of boiling water</td><td></td><td></td></tr></table>			Properties	Actinoids	Lanthanoids	Magnetic properties (Higher/Lower)			The action of boiling water			2	
Properties	Actinoids	Lanthanoids												
Magnetic properties (Higher/Lower)														
The action of boiling water														
Q.82	The ionic radii of certain elements of the 3 rd transition series are tabulated below: <table><tr><th>Element</th><th>Ionic radii</th></tr><tr><td>X⁺³</td><td>87 pm</td></tr><tr><td>Y⁺³</td><td>106 pm</td></tr><tr><td>Z⁺³</td><td>95 pm</td></tr></table> <p>a) Arrange the elements in the decreasing order of atomic number.</p> <p>b) Define the phenomenon seen in this table.</p>			Element	Ionic radii	X ⁺³	87 pm	Y ⁺³	106 pm	Z ⁺³	95 pm	2		
Element	Ionic radii													
X ⁺³	87 pm													
Y ⁺³	106 pm													
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Q.83	The structure of two different samples of the same metal is shown below: <div><div><p>Sample I</p></div><div><p>Sample II</p></div></div> <p>Complete the table with respect to the samples given above with the given information:</p>			2										

	<p>[1668°C, 3160°C, chemically reactive, chemically inert]</p> <table border="1"> <thead> <tr> <th></th><th>Sample I</th><th>Sample II</th></tr> </thead> <tbody> <tr> <td>Melting point</td><td></td><td></td></tr> <tr> <td>Chemical reactivity</td><td></td><td></td></tr> </tbody> </table>		Sample I	Sample II	Melting point			Chemical reactivity			
	Sample I	Sample II									
Melting point											
Chemical reactivity											
Q.84	<p>Substance D is used for the bleaching of wool, cotton, silk and other textile fibres and for the decolourisation of oils. It is dark purple in colour and is almost insoluble in water. The shape of the molecule is tetrahedral.</p> <p>a) Calculate the magnetic moment of this substance.</p> <p>b) What is the magnetic nature of the compound D?</p> <p>c) What is the bond angle of the central metal atom with the other atoms?</p>	2									
Q.85	<p>Look at the image given below and answer the questions that follow:</p> <div style="text-align: center;"> <p>Substance P Substance Q</p> </div> <p>a) Define the process seen here.</p> <p>b) If the melting point of substance P is 1023°C, the melting point of Q should be more or less than 1023°C?</p>	2									
Q.86	<p>Oxide of a metal D in the lanthanoid series is used as phosphors in television screens and similar fluorescing surfaces.</p> <p>a) State the valency of element D and the formula of its oxide in terms of 'D'.</p> <p>b) What will the pH range of its aqueous solution be?</p> <p>c) What role does it play in the petroleum industry?</p>	4									
Q.87	<p>The graph below shows the first, second and third ionisation energies of a set of elements.</p>	2									

	<p>In the graph, we can see a deviation in the fifth element in the trend for second ionisation energy and a deviation in the sixth element in the trend for third ionisation energy. Identify the elements and explain why the deviation occurs.</p>	
Q.88	<p>Read the information given below on a transition metal M and answer the question that follows.</p> <p>P) The M^{2+} state has d^4 configuration, where $n = 4$.</p> <p>Q) The crystal field splitting for M ion is given below</p> <p>(a) Is M^{2+} ion reducing or oxidising in nature? Explain.</p> <p>(b) Identify the metal ion.</p>	3
Q.89	<p>Shown below is a step-wise process for the formation of an orange-coloured crystalline compound C. Identify the compound C and write the chemical reactions to show the formation of compounds A, B, and C.</p> <div style="display: flex; align-items: center; justify-content: space-around;"> <div style="border: 1px solid gray; padding: 10px; background-color: #f0f0f0;"> Chromate ore fused with NaOH in presence of air forms a yellow coloured compound A </div> <div>→</div> <div style="border: 1px solid gray; padding: 10px; background-color: #f0f0f0;"> Yellow coloured compound A on acidification with dil. Sulphuric acid gives compound B </div> <div>→</div> <div style="border: 1px solid gray; padding: 10px; background-color: #f0f0f0;"> Compound B on reaction with KCl forms an orange coloured crystalline compound C </div> </div>	4

Answer Key and Marking Scheme

Q.No	Answers	Marks
Q.61	D. X is a hard metal but Y is not.	1
Q.62	C. Decreases the activation energy	1
Q.63	D. MnO_4^{2-}	1
Q.64	A. Drops of hydrochloric acid	1
Q.65	D. Chromium	1
Q.66	D. All - P, Q and R	1
Q.67	B. formation of alloy	1
Q.68	A. Only P, R, and S	1
Q.69	D. Undergo charge transfer between oxide ion and itself.	1
Q.70	A. 109.5°	1
Q.71	B. M	1
Q.72	B. Both La^{+3} and Lu^{+3} are repelled by the applied magnetic field.	1
Q.73	B. Both (A) and (R) are correct and (R) is not the correct explanation of (A)	1
Q.74	D. (A) is false but (R) is true.	1
Q.75	<p>- Metal X will be most stable in M^{2+} state. [1]</p> <p>- The given electrode potential of metal X is</p> <p style="text-align: center;">$\text{M}^{2+}/\text{M} = -1.18 \text{ V}$</p> <p>which is the least reduction potential among the three metals. It suggests metal X will undergo the reduction process very slowly hence it will show more stability at X^{2+} state or M^{2+} state. [1]</p>	2
Q.76	<p>(a) Filtration</p> <p>(b) Sodium dichromate is more soluble than potassium dichromate</p>	2
Q.77	<ul style="list-style-type: none"> The hardness of metals depends upon the strength of metallic bonds in it which in turn depends upon the number of unpaired electrons, which overlap to form covalent bonds. 	2



	<ul style="list-style-type: none">• The greater the number of unpaired d-electrons, the greater the number of covalent bonds, and hence greater the strength of bonds.• Mercury is in group 12, period 6. Its electronic configuration is $[\text{Xe}]4f^{14}5d^{10}6s^2$. Due to the absence of unpaired electrons and covalent bonds, mercury is very soft and is a liquid.•• <i>[Give 0.5 marks for the first two points. Give 0.5 marks each for the correct position of mercury in the periodic table and its correct electronic configuration respectively. Students may write the answer in their own words.]</i>													
Q.78	<p>i)</p> <p>formula of compound present in bottle A is $[\text{Ag}(\text{NH}_3)_2] \text{NO}_3$</p> <p>Name of the compound is diammine silvernitrate or Tollen's reagent</p> <p>ii) Compound present in test tube B containing Aldehyde functional group gives silver mirror formation.</p> <p>iii) $\text{RCHO} + [\text{Ag}(\text{NH}_3)_2] \text{NO}_3 + \text{NaOH}$</p> <p>---heat--- $\text{RCOO}^- + \text{Ag(s)} + \text{NH}_3 + \text{H}_2\text{O}$</p>	3												
Q.79	<p>Element J is expected to valence electrons in the 5f orbitals. The melting point of the element J is the highest among the three. So, it is expected to belong to the 3rd transition series with the valence electrons in 5f orbitals.</p> <p>[1 marks for correctly identifying the element + 1 mark for the correct reason]</p>	2												
Q.80	<p>a)</p> <table><tr><th>Element</th><th>Electronic configuration of only the valence shell in the atomic state</th><th>Tensile strength (High/Low)</th><th>Shows colour in aqueous solution(yes/No)</th></tr><tr><td>X</td><td>$5s^2, 4d^{10}$</td><td>Low</td><td>No</td></tr><tr><td>Y</td><td>$5s^2, 4d^2$</td><td>High</td><td>Yes</td></tr></table> <p>[Give 0.5 marks for each correctly filled blank]</p> <p>b) The presence of unpaired electrons leads to strong metallic bonds in the transition elements. Element U has no unpaired electron in it so it has low tensile strength.Element V can form metallic bonds due to the presence of unpaired electrons.</p>	Element	Electronic configuration of only the valence shell in the atomic state	Tensile strength (High/Low)	Shows colour in aqueous solution(yes/No)	X	$5s^2, 4d^{10}$	Low	No	Y	$5s^2, 4d^2$	High	Yes	5
Element	Electronic configuration of only the valence shell in the atomic state	Tensile strength (High/Low)	Shows colour in aqueous solution(yes/No)											
X	$5s^2, 4d^{10}$	Low	No											
Y	$5s^2, 4d^2$	High	Yes											



	The elements with completely filled or completely empty d-orbitals are colourless. So, aqueous solutions of element U are expected to be colourless while that of element V is expected to show some colour. [1+1 for each reason]				
Q.81	Properties	Actinoids	Lanthanoids	2	
	Magnetic properties (Higher/Lower)	Lower	Higher		
	The action of boiling water	gives a mixture of oxide and hydride	gives a mixture of hydroxides and hydrogen gas		
	[0.5 marks for each correct answer]				
Q.82	a) The elements in decreasing order of atomic number are: $X > Z > Y$ b) The overall decrease in atomic and ionic radii from lanthanum to lutetium (the lanthanoid contraction) is a unique feature in the chemistry of the lanthanoids. This is called 'Lanthanoid contraction.'			2	
Q.83			Sample I	Sample II	2
		Melting point	3160°C	1668°C	
		Chemical reactivity	chemically inert	chemically reactive	
	[0.5 marks for each correct answer]				
Q.84	a) The central atom in this compound is Mn^{+2} and the compound is D is $KMnO_4$. The number of valence electrons in Mn in $KMnO_4$ is 0 as its electronic configuration is $[Ar]4s^03d^0$. So, its magnetic moment is 0. [1] b) The magnetic moment of D is diamagnetic in nature. [0.5] c) The bond angle of the central metal atom with the other atoms is 109° [0.5]			2	
Q.85	a) The process seen here is alloying. The process of formation of homogeneous solid solutions in which the atoms of one metal are distributed randomly among the atoms of the other is called alloying. [1]			2	
	b) The melting point of Q will be more than P. [1]				



Q.86	<p>a)</p> <ul style="list-style-type: none"> - The valency of element D is 3. [1] - The formula of its oxide is D_2O_3. [1] <p>b) The range of pH of the aqueous solution of this element D is from 7 to 14.</p> <p>c) The element is employed as a catalyst in petroleum cracking.</p>	4
Q.87	<p>The element that shows deviation in the trend for the second ionisation energy is Manganese.</p> <p>The element that shows deviation in the trend for the third ionisation energy is Iron. [0.5+0.5]</p> <p>The deviation occurs because Mn^{2+} ion and Fe^{3+} have $3d^5$ configuration which is more stable than the configuration of Cr^{2+} and Mn^{3+} ions. [1]</p>	2
Q.88	<p>(a) It is evident from the crystal field splitting that the configuration of M changes from d^4 to t_{2g}^3 and e_g^1. (1)</p> <p>Since the half-filled t_{2g}^3 level is more stable, the M^{2+} ion will furnish one electron and will act as a reducing agent. (1)</p> <p>(b) Metal ion M has $n=4$ and d^4 configuration. Its electronic configuration will be $[Ar]4s^03d^4$.</p> <p>As its oxidation state is +2, therefore metal ion is likely to be Cr^{2+}.</p>	3
Q.89	<p>The above given process is depicting the preparation of potassium dichromate.</p> <p>The unknown compound 'C' is Potassium dichromate ($K_2Cr_2O_7$)</p> <p>Stepwise chemical equations involved are as follows</p> $4FeCr_2O_4 + 16NaOH + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8H_2O$ <p>Compound A is Na_2CrO_4</p> $2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$ <p>Compound B is $Na_2Cr_2O_7$</p> $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$ <p>Compound C is $K_2Cr_2O_7$</p>	4