Suggested Worked Solutions for 2012 JC2 Prelim Paper 1 (9647/01)

	1.	В	11.	Α	21.		21. B		Α		
	2.	С	12.	D	22.	22. C		32.	D		
	3.	D	13.	С	23. A		A Contraction of the second se	33.	В		
	4.	D	14.	D	24. C)	34.	Α		
	5.	В	15.	D	25.	25. C		35.	В		
	6.	В	16.	С	26.	C	;	36.	Α		
	7.	Α	17.	В	27.	C)	37.	В		
	8.	D	18.	Α	28.	A	4	38.	Α		
	9.	С	19.	Α	29.	C	;	39.	В		
	10.	В	20.	D	30.	C	;	40.	D		
a 3+					•		. ,				
Co° +	$e \rightarrow Co^{-}$				Z .		cnarge/ma	ass ∝	angle of defle	ection	
$Co \rightarrow 0$	20 ²¹ + 2e	3+	- 2+						charge/r	nass	
Overall	eqn: Co	+ $2\text{Co}^{3^+} \rightarrow 3$	BCo ²⁺	• • ³⁺ • ³⁺			""Gd		$\frac{1}{157} = 0.0$	00637	
For the must be	e resulting be in ex	g mixture to cess (more	contai than	double the			87.6 c r ²⁺		107		
amoun	t of Co). \	When x=1, y	=3,				31		$\frac{2}{87.6} = 0$.0228	
		Co + 2Co ³⁺	\rightarrow 3Co	0 ²⁺							
Initial a	mt/mol	1 3	0)		Angle of deflection for ${}^{87.6}Sr^{2+} = (\frac{0.0220}{0.00637} \times 2)$					
Final amt/mol 0 1 3						= 7.2°.					
Ans: B										Ar	າs: C
	I					П					
Α	CH ₃ CH ₂ CH ₂ F				CH ₃ CH ₂ CHF ₂						
	Polar molecule. Permanent dipole-				Polar molecule with larger dipole moment than						
	permanent dipole forces of attraction				CH ₃ CH ₂ CH ₂ F. Stronger permanent dipole-permanent dipole forces of attraction than that of I						
в	trans CH ₂ CC/=CC/CH ₂					cis CH ₂ CC/=CC/CH ₂					
0	Non-polar molecule, van der Waals'				Polar molecule Stronger permanent dipole-						
forces of attraction between				permanent dipole forces of attraction than weaker							
-	molecules.				VDW forces of attraction between I molecules.						
С	CH4				H ₂ O						
	van der Waals' forces of attraction between molecules				the weaker VDW forces of attraction between I						
0											
	between molecules as they exist as dimers (formation of more extensive										

hydrogen bonding between 2 RCO₂H

molecules) than that of II.

1.

3.

4.	Given,	5.	Using the formula,			
	2Y(g) + 6H(g) → Y ₂ H ₆ (g) ΔH = -2775 kJ mol ⁻¹		$\Delta H_{rxn} = \Sigma \Delta H_{f}(\text{products}) - \Sigma \Delta H_{f}(\text{reactants})$			
	$Y_2H_6(g) \rightarrow 2Y(g) + 6H(g) \Delta H = +2775 \text{ kJ mol}^{-1}$		$\Delta H_{\rm r} = 2\Delta H_{\rm f}({\rm H}_2{\rm O}) - 2\Delta H_{\rm f}({\rm H}_2{\rm O}_2)$			
	$\Delta H_{\rm r} = {\rm E}({\rm Y}-{\rm Y}) + 6{\rm E}({\rm Y}-{\rm H})$		= 2(–286) – 2(–188) = –196 kJ mol ^{–1}			
	E(Y–Y) = +2775 – 6(395) = + 405 kJ mol ⁻¹		Note: $\Delta H_{f}(O_2) = 0 \text{ kJ mol}^{-1} \text{ as } O_2 \text{ is an element.}$			
	Ans: D		Ans: B			
6.	Let x be the volume of NOC/(g) that reacted.					
	$NOCl(g) \rightleftharpoons NO(g) + \frac{1}{2} Cl_2(g)$					
	Eqm volume/cm ³ 100–x x $\frac{1}{2}x$					
	Total volume of gases at eqm = $(100+\frac{1}{2}x)$ cm ³					
	% of NO at eqm = $\frac{x}{100 + 1/2x} \times 100 \% = 40 \%$					
	Solving, x=50 cm ³					
	Hence, total volume of gases at eqm					
	$=100 + \frac{1}{2}(50) = 125 \text{ cm}^3$					
			Ans: B			
7.	$\begin{array}{rcl} HPO_4^{2^-}(aq) + H_2BO_3^-(aq) &\rightleftharpoons H_2PO_4^-(aq) + HBO_3^{2^-}(aq) \\ base & acid & conjugate \\ acid & of & base & of \\ HPO_4^{2^-} & H_2BO_2^{-} \end{array}$					
	$H_2PO_4^-$ and $H_2BO_3^-$ are acids and HBO_3^{2-} and HPO_4^{2-} are bases. Hence option C and D are wrong.					
	Since the equilibrium constant < 1.0, there will be a higher $[HPO_4^{2^-}(aq)]$ and $[H_2BO_3^{-}(aq)]$ and a lower $[H_2PO_4^{-}(aq)]$ and $[HBO_3^{2^-}(aq)]$ at equilibrium.					
	• Since $[H_2PO_4^-(aq)] < [H_2BO_3^-(aq)] \Rightarrow H_2PO_4^-$ ionises to a greater extent than $H_2BO_3^-$ to give H^+ . Hence $H_2PO_4^-$ is a stronger acid than $H_2BO_3^-$					
	• Since $[HBO_3^{2^-}(aq)] < [HPO_4^{2^-}(aq)] \Rightarrow HBO_3^{2^-}$ ionises to a greater extent than to give OH^- . Hence $HBO_3^{2^-}$ is a stronger base than $HPO_4^{2^-}$.					
	Strength of acids: $H_2PO_4^- > H_2BO_3^-$					
	Strength of bases: $HBO_3^{2^-} > HPO_4^{2^-}$					
		[Ans: A			
8.	$BaL_2(s) \rightleftharpoons Ba^{2+}(aq) + 2L^{-}(aq)$	9.	Given $t_{1/2} = 2.0$ hour			
	Given $K_{sp} = [Ba^{2+}(aq)][L^{-}(aq)]^2 = \boldsymbol{q} \text{ mol}^3 \text{ dm}^{-9}$		After first half-life,			
	Let [L ⁻] at equilibrium be x mol dm ⁻³		mass of X = $\frac{1}{2}(320) = 160 \text{ mg}$			
	$\therefore \ \mathcal{K}_{sp} = \frac{\mathbf{x}}{2} (\mathbf{x})^2 = \mathbf{q}$		After the second half-life,			
	2		mass of X = $\frac{1}{2}(160) = 80$ mg			
	$\Rightarrow \frac{X^3}{2} = q$		After the third half-life,			
	ک		mass of X = $\frac{1}{2}(80) = 40$ mg			
	\Rightarrow x = (2 q) ^{$\frac{1}{3}$} = [L ⁻] at equilibrium		Hence, drug X will still be effective after 3 half- lives (3 x 2.0 = 6.0 hour).			
	Ans: D		Ans: C			

10.	Rate = $k[H_2O_2][I^-]$,								
	For expt 1: Rate = $k'[H_2O_2]$ where $k' = k[I^-]$								
	The graph of $[H_2O_2]$ against time is a downward sloping curve with decreasing gradient.								
	For expt 2: Rate = I	k' where k	' = k[I [−]][H ₂ O ₂]						
	The graph of [H⁺] a	gainst time	e is a decreasing strai	ght line with a cons	tant gradient.				
		-	_	-	-	Ans: B			
11.	<i>E</i> [,] Ag ⁺ Ag = +0.80 V	, <i>E</i> ∘Zn²⁺∣Zn	= -0.76 V, <i>E</i> [·] Cu ²⁺ Cu	i = +0.34 V					
	A : (✓) <i>E</i> [·] (Ag ⁺ /Ag) i Ag. Hence, silver is	A : (\checkmark) $E(Ag^+/Ag)$ is more positive than $E(Cu^{2+}/Cu) \Rightarrow Cu$ has the greater tendency to be oxidised than Ag. Hence, silver is less electropositive (tendency to lose $e^- \Rightarrow$ undergoes oxidation) than copper.							
	B : (*) $E^{(Ag^{+}/Ag)}$ is more positive than $E^{(Zn^{2+}/Zn)} \Rightarrow Zn$ has the greater tendency to be oxidised than Ag. Hence, zinc displaces silver from a solution containing silver ions.								
	C : (*) $E(Zn^{2+}/Zn)$ is more negative than $E(Cu^{2+}/Cu) \Rightarrow Zn^{2+}$ has the lower tendency to be reduced than Cu^{2+} .								
	D : (*) $E(Ag^{+}/Ag)$ is more positive than $E(Zn^{2+}/Zn) \Rightarrow Zn$ has the greater tendency to be oxidised than Ag. Hence, zinc has a higher tendency than silver to form positively charged ions.								
				1		Ans: A			
12.		Result	Negative terminal	Positive terminal	Voltage (V)				
			(anode)	(cathode)					
		(1)	Pb	x	0.35				
		(2)	У	Pb	1.10				
		(3)	Z	Pb	2.60				
	Using (1), Pb undergoes oxidation and x undergoes reduction. \Rightarrow The reducing power of Pb is higher than that of x.								
	Using (2) and (3), both y and z undergo oxidation and Pb undergoes reduction. \Rightarrow The reducing power of y and z is higher than that of Pb.								
	Since the voltage recorded in (3) is higher than that in (2), the reducing power of z is higher than that of y . \therefore from weakest to strongest reducing power: x , Pb, y , z Ans: D								
13.	A : (x) Reactivity of Group II elements with cold water increases down the group. { <i>Mg reacts slowly; Ca reacts readily; Ba & Sr react vigorously.</i> }								
	$M(s) + 2H_2O(l) \rightarrow M(OH)_2(aq) + H_2(g)$, where M = Ca, Sr and Ba								
	B : (*) Solubility of Group II hydroxides and oxides increases down the group. As a result, the pH of the resulting hydroxide solutions increases { <i>from pH</i> 9 <i>in Mg</i> (OH) ₂ <i>to pH</i> 12 <i>in Ca</i> (OH) ₂ <i>to pH</i> 14 <i>in Ba</i> (OH) ₂ }.								
	MO(s) + H ₂ O(l) \rightarrow M(OH) ₂ (aq), where M = Ca, Sr and Ba								
	$MgO(s) + H_2O(l) = Mg(OH)_2(aq)$								
	C : (\checkmark) Second ionisation energy of elements decreases from Be to Ba. This is due to an increase in ionic radii of M ⁺ (g) and the increase in shielding effect which outweighs the effect of increasing nuclear charge.								
	D : (×) Down the gr	oup, thern	nal stability of Group I	I carbonates incre a	ases.				
			$MCO_3(s) \rightarrow 1$	$MO(s) + CO_2(g)$					
	As the ionic radius ability of M ²⁺ to pola	of the M ²⁺ arise the la	increases down the irge CO ₃ ²⁻ anion decre	Group, the charge eases down the gro	density of the loup.	M ²⁺ decreases. The			
				5		Ans: C			

14.	 A : (*) Atomic radius of At is larger than C/ and At-At bond is longer and weaker than Cl-Cl bond and so At₂ dissociates more readily than Cl₂. B : (*) It reacts explosively with hydrogen. X₂(g)+H₂(g) →2HX(g), ΔH_r (where X = Cl, Br and I) ΔH_r = E(X-X) + E(H-H) - 2E(H-X) As H-X bond energy decreases, ΔH_r becomes less exothermic(less energetically feasible). ⇒ Reactivity of X₂ with H₂ decreases down the group from Cl₂ to I₂. C : (*) Down the group, E'(X₂/X⁻) becomes less positive, indicating that the oxidising power decreases down the group. Thus At₂ will not be able to oxidise Γ to I₂. D : (✓) Volatility of halogens (X₂) decreases down group VII from Cl₂ to I₂. There is an increase in strength of van der Waals' forces between X₂ molecules as the no. of electrons per X₂ molecules as crystalline solid. 	15.	From the large drop in 1 st ionisation energy from M to N , we can deduce that M is the last element in the 2 nd Period (Ne) and N is the first element in the 3 rd Period (Na). A : (*) R is Si. It has the highest melting point. (Giant covalent structure, with strong Si–Si covalent bonds) B : (*) J is nitrogen and K is oxygen. Both N ³⁻ and O ²⁻ are isoelectronic, thus as nuclear charge increases from N ³⁻ and O ²⁻ , while the shielding effect by inner shell electrons remains relatively constant, the ionic radius of N ³⁻ (J) is larger than that of O ²⁻ (K). C : (*) Q is aluminium. A/ forms an insoluble hydroxide, which dissolves in excess dilute NaOH(aq). A/(OH) ₃ (s) + OH ⁻ (aq) \rightarrow [A/(OH) ₄] ⁻ (aq) [Note: Being amphoteric, A/(OH) ₃ reacts with both aqueous acids and alkalis. A/(OH) ₃ (s) + 3H ⁺ (aq) \rightarrow A/ ³⁺ (aq) + 3H ₂ O(/)] D : (\checkmark) Oxide of P (Mg) gives a lower pH than oxide of N (Na) when reacted with water. Na ₂ O(s) reacts vigorously with water to form a strongly alkaline NaOH(aq) solution with pH = 13-14. Na ₂ O(s) + H ₂ O(<i>l</i>) \rightarrow 2NaOH(aq) MgO(s) is sparingly soluble in water and hence dissolves with water to a small extent to form limited quantity of Mg(OH) ₂ (aq), a weakly alkaline solution with pH = 9.
			$MgO(s) + H_2O(l) = Mg(OH)_2(aq)$
			$Mg(OH)_2(aq) \rightarrow Mg^{2+}(aq) + 2OH^{-}(aq)$
40			Ans: D
16.	A : (*) A change in colour indicates either the reaction. $[Cr(H_2O)_6]^{3+} + 6NH_3 \longrightarrow [Cr(NH_3)_6]^{3+} + 6H_2O$ green purple B : (*) Since NH ₃ replaces the H ₂ O ligand, as thus a more stable complex ion than [Cr(H ₂ O) ₆]^{3+} C : (\checkmark) The yellow solution is CrO ₄ ²⁻ (Cr ₂ O ₇ ²⁻ is D D : (*) 2CrO ₄ ²⁻ + H ₂ O = Cr ₂ O ₇ ²⁻ + 2OH ⁻ CrO ₄ ²⁻ ionises in water, giving Cr ₂ O ₇ ²⁻ + 2OH ⁻ . T 2CrO ₄ ²⁻ + 2H ⁺ \longrightarrow Cr ₂ O ₇ ²⁻ + H ₂ O G H base conjugate acid	it forr t. orang	sibility of a redox reaction or a ligand exchange ns a stronger dative covalent bond with Cr^{3+} and e in colour). reacts with H ⁺ to give $Cr_2O_7^{2-}$ and H ₂ O.

17. $A: (*) \operatorname{Fe}(CN)_6^{3-} + e \rightleftharpoons \operatorname{Fe}(CN)_6^{4-} +0.36V$ $Br_2 + 2e \rightleftharpoons 2Br^-$ +1.07V E_{cell}^{9} = 0.36 – (+1.07) = -0.71 V < 0 (energetically not feasible). Hence $Fe(CN)_{6}^{3-}$ is not able to oxidise Br^{-} to Br_{2} . **B** : (\checkmark) "in atmosphere" indicates reaction in presence of O₂. $O_2 + 4H^+ + 4e \rightleftharpoons 2H_2O + 1.23V$ $Cr^{3+} + e \Rightarrow Cr^{2+} -0.41V$ E_{cell}° = 1.23 – (- 0.41) = +1.64V >0 (energetically feasible). Hence CrCl₂ is chemically unstable as it will be oxidised to CrCl₃. **C** : (**x**) MnO_4^- + 8H⁺ + 5e \Rightarrow Mn²⁺ + 2H₂O +1.52V $O_2 + 2H^+ + 2e \rightleftharpoons H_2O_2$ +0.68V E_{cell}° = 1.52 – 0.68 = +0.84V >0 (energetically feasible). On addition of H₂O₂ to acidified KMnO₄, the purple solution decolourises. **D**: (**x**) When NaOH(ag) and FeC $l_3(ag)$ is mixed, Fe(OH)₃(s) is formed. $Fe(OH)_3 + e \Rightarrow Fe(OH)_2 + OH^- - 0.56V$ $O_2 + 2H_2O + 4e \rightleftharpoons 4OH^-$ +0.40V E_{cell}^{\bullet} = -0.56 - (+0.40) = -0.96V <0(energetically not feasible). \therefore Fe(OH)₃ does not react with OH⁻ to give O_2 . Ans: B $AgCl + 2Na_2S_2O_3 \rightarrow 4Na^+ + Cl^- + [Ag(S_2O_3)_2]^{3-}$ 18. 19. **A** : (\checkmark) The reaction causes silver ions to dissolve through the formation of a silver complex, $[Ag(S_2O_3)_2]^{3-}$ which is soluble. B, C and D: (*) Silver is neither oxidised or free radical nucleophile electrophile reduced as the oxidation state of Ag remains at +1 in both AgCl and $[Ag(S_2O_3)_2]^{3-}$. No.of outershell e^- on C atom of $CH_3^+ = 2(3) = 6$ Ans: A No.of outershell e^- on C atom of $\bullet CH_3 = 2(3) + 1 = 7$ No.of outershell e⁻ on C atom of CH₃⁻ =2(3)+2=8 Ans: A 20. With cold, dilute acidified KMnO₄: H₂C After mild oxidation, there is an increase in two new chiral carbon atoms. (continue on next page





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30.	${f D}$: (*) To form covalent disulfide linkage with an	other	molecule, it has to be $-SH$, and not $-SCH_3$.
	-SCH ₃ cannot form disulfide linkage	nethion	NH ₂ COOH ine
		Γ	Answer : C
31.	 Gas particle Y has (n+1) protons and a charge of 2+. ⇒ no. of electrons = (n+1 - 2) = n - 1 Gas particle X has n protons and (n-1) electrons. ⇒ charge of X is 1+. (1): (✓) X has a smaller nuclear charge than Y, hence X has a larger radius than Y. (2): (✓) The electron removed is less tightly bound to the singly charged X than the doubly charged Y. Hence less energy is required to remove the electron. (3): (✓) The electron added is less tightly bound to the singly charged X than the doubly charged Y. Hence less energy is released when the electron is added to X. 	32.	 (1): (✓) ΔS<0. Decrease in disorder due to precipitation of PbSO₄(s). (2): (*)ΔS>0. Increase in disorder since kinetic energy of particles increases causing a broadening of the Boltzmann energy distribution. ⇒ more ways of arrangement of energy quanta. (3): (*)ΔS>0. Increase in disorder as reaction proceeds with an increase in number of gas particles from 0 to 1 mole. Answer : D
	Answer : A		
33.	 (1) and (2): (✓) The iron catalyst provides <u>an</u> <u>alternative reaction path</u> of <u>lower E_a</u> than that of the uncatalysed reaction. Thus, the number of molecules with energy greater than the lowered activation energy increases. Frequency of effective collisions between molecules increases and hence <u>rate</u> of reaction <u>increases</u> by the same extend for the forward and backward reaction. (3) : (×) Catalyst does not increase the kinetic energy of the reacting particles. 	34.	(1) : (✓) Solubility product, K_{sp} is only affected by temperature. (2) : (✓) The presence of the common ion F ⁻ , increases [F ⁻]. Equilibrium position of SrF ₂ (s) \Rightarrow Sr ²⁺ (aq) 2F ⁻ (aq) will shift to left, hence decreasing the solubility of strontium fluoride. (3) : (✓) Let solubility of SrCO ₃ be x. $x^2 = 8.7 \times 10^{-9}$ $x = (8.7 \times 10^{-9})^{1/2} = 9.33 \times 10^{-5} \text{ mol dm}^{-3}$ Let solubility of SrF ₂ be y. 4.0 x 10 ⁻¹¹ = (y)(2y) ² = 4y ³ $y = \left(\frac{4.0 \times 10^{-11}}{4}\right)^{\frac{1}{3}}$ $= 2.15 \times 10^{-4} \text{ mol dm}^{-3}$ \therefore SrF ₂ is more soluble than SrCO ₃ . Answer : A



