RIVER VALLEY HIGH SCHOOL
JC2 H1 CHEMISTRY 8873 PRELIMINARY EXAMINATION
SUGGESTED SOLUTIONS

Paper 1 worked solutions

1	D	**6**	C	**11**	D	**16**	A	**21**	A	**26**	C
2	B	**7**	B	**12**	C	**17**	A	**22**	B	**27**	B
3	D	**8**	D	**13**	A	**18**	B	**23**	A	**28**	B
4	C	**9**	D	**14**	B	**19**	A	**24**	B	**29**	B
5	D	**10**	A	**15**	C	**20**	D	**25**	C	**30**	C

1 **D**	Calculate the charge/mass ratio to each option and the one with the largest ratio will be deflected by the largest angle. A: q/m = 3/11 = 0.273 B: q/m = 2/9 = 0.222 C: q/m = 0/1 = 0 (i.e., won't be deflected) **D**: q/m = 2/4 = 0.5 (Answer)

2
B

Identify the elements in each option and choose the element that will have either ns^2 or $ns^2\ np^5$ after removing the first electron.

Element	Electronic configuration	Species after removal of 1st electron	Electronic configuration of new species
A: Mg	$1s^22s^22p^63s^2$	Mg^+	$1s^22s^22p^63s^1$
B: A*l*	$1s^22s^22p^63s^23p^1$	Al^+	$1s^22s^22p^63s^2$
C: Si	$1s^22s^22p^63s^23p^2$	Si^+	$1s^22s^22p^63s^23p^1$
D: P	$1s^22s^22p^63s^23p^3$	P^+	$1s^22s^22p^63s^23p^2$

For A*l*, it will have a higher 2nd IE than Mg (to its left) and Si (to its right).

For Al^+ vs Mg^+, Al^+ has a greater effective nuclear charge and smaller ionic radius, hence the IE to remove the next electron from Al^+ is higher.

For Al^+ vs Si^+, the 3p electron in Si^+ is higher in energy than the 3s electron in Al^+, so the IE to remove the next electron from Si^+ is lower, thus the IE to remove the next electron from Al^+ is higher.

3 **D**	In 1 cm^3 of air, there is 8.00×10^{-9} g of ozone. M_r of ozone is 16.0 × 3 = 48.0 Amount of ozone = 8.00×10^{-9} / 48 No. of ozone molecules = (8.00×10^{-9} / 48) × L

4 **C**	C_xH_y + $(x+\frac{y}{4})$ O_2 → xCO_2 + $\frac{y}{2}H_2O$ 20 cm³ 60 cm³ KOH absorbs CO_2 ⇒ V_{CO_2}=60 cm³. Thus, x=60/20=3 V_{CxHy} + $V_{initial\ O2}$ = 20 + 120cm³ = 140 cm³ After combustion, $V_{excess\ O2}$ + V_{CO_2} = 140 – 50 = 90 cm³ $V_{excess\ O2}$ = 90 – 60 = 30 cm³ $V_{O2\ consumed\ during\ combustion}$ = 120 – 30 = 90 cm³ $x+\frac{y}{4}$ = 90/ 20 = 4.5 y = 6 Answer: C

5 **D**	NH_3 + HCl → NH_4Cl Dative bond is formed in NH_4^+

6 **C**	Number of electrons in HS = 17; number of electrons in F_2 = 18 As HS has similar number of electrons in the molecules as F_2, and that HS is polar and F_2 is non-polar, the main reason for HS to have a higher boiling point will be due to the presence of an overall polarity of its molecules. Hence, more energy is required to overcome the stronger permanent dipole-permanent dipole interactions (and also instantaneous dipole-induced dipole interactions) between HS molecules than the weaker instantaneous dipole-induced dipole interactions between F_2 molecules.

7 **B**	The option that fits the characteristics of a simple molecular solid will be one with relatively low melting point, generally poor solubility in water (as compared to an ionic compound), and highly likely to have good solubility in organic solvents.

8 **D**	Amount of $CH_3CH_2OH = \frac{0.86}{46} = 0.0187$ mol Heat released from combustion of ethanol = $0.0187 \times 1367 = 25.56$ kJ Heat absorbed by water = $300 \times 4.18 \times 18 = 22570$J = 22.57 kJ Process efficiency = $\frac{22.57}{25.56} \times 100\% = 88.0\%$ Answer: D

9 **D**	Answer: D $\lvert\text{Lattice Energy}\rvert \quad \alpha \quad \left\lvert \frac{q_+ \times q_-}{r_+ + r_-} \right\rvert$ Between RbF and Rb_2O, O^{2-} has a bigger charge and hence, Rb_2O will have a more negative lattice energy. Between KF and K_2O, O^{2-} has a bigger charge and hence, K_2O will have a more negative lattice energy. Between Rb_2O and K_2O, K^+ has a smaller ionic radius and hence, K_2O will have a more negative lattice energy.

10 **A**	Answer: A (1) Neutralisation is exothermic. (2) Bond breaking requires energy hence it is endothermic. (3) Removal of electron needs energy to overcome attraction forces between electrons and nucleus. (4) Combustion of C is exothermic.

11 **D**	Let half-life of **Q** be T, and half-life of **P** be 2T. Let initial number of atoms of **P** = N_P and initial number of atoms of **Q** = N_Q = $4N_p$. After two half-lives of **P**, time elapsed = 4T -> this is equivalent to four half-lives of **Q** For **P**, number of atoms after 4T = $\underline{N_P / 4}$ For **Q**, number of atoms after 4T = $N_Q / 16 = 4N_P / 16 = \underline{N_P / 4}$ Hence the ratio of number of **P** to number of **Q** after two half-lives of **P** = **<u>1</u>**

12 **C**	Total number of molecules, at either T_1 or T_2, is represented by: **P + Q** Number of molecules with energy equal to or greater than activation energy at T_2: **Q + R** Therefore the fraction will be represented by $\frac{Q+R}{P+Q}$.

13 **A**	Statement 1: Correct A catalyst provides an alternative reaction pathway of a lower activation energy, which means altering the reaction mechanism. Statement 2: Correct With a lowered activation energy, the proportion of molecules with energies above the *lowered* activation energy increases. Statement 3: Incorrect Since temperature is not changed in this scenario, the average kinetic energy of the molecules stays the same.

14 **B**	Statement A: Incorrect. Adding a solid does not affect position of equilibrium. Statement B: Correct Reduce the temperature → shifts to the left Lowering temperature favours the exothermic direction (reverse reaction), so position of equilibrium shifts left. Statement C: Incorrect Adding more product shifts the position of equilibrium left to decrease the concentration of W, not right. Statement D: Incorrect. Increasing volume, decreases the pressure of the system→favours the direction which produces more moles of gas (left side, 2 Y vs. right side, 1 W) to counteract the decrease in pressure. so position of equilibrium shifts left.

15 **C**	Statement A: Incorrect. Low pressure (1 atm) *reduces* SO_3 yield as position of equilibrium shifts left (more gas moles on the left). 1–2 atm is used for practical/economic reasons, not to increase % of SO_3. Statement B: Incorrect. 450 °C increases rate of reaction. As the reaction is exothermic ($\Delta H < 0$), higher temperature actually shifts position of equilibrium to the left to absorb more heat, reducing the equilibrium SO_3 yield Statement D: Incorrect. A catalyst (V_2O_5) does not change equilibrium composition; it speeds up both forward and reverse reactions equally. Statement C: Correct.

16 **A**	Answer: A Reducing power: As the atomic size increases down the group, the attraction of nucleus for electrons decreases and hence the ease of losing electrons increases. Thus the reducing power increases. Ionic radius: Down the group, each element has 1 more principal quantum shell, and hence bigger ionic radius. Electronegativity: As the atomic size increases down the group, the attraction of nucleus for electrons decreases, and hence the electronegativity decreases.

17 **A**	Option A : Incorrect. The pH of the solutions of chlorides generally decrease across the period due to increasing extent of hydrolysis of the chlorides. Option B : Correct. Option C : Correct. The white fumes is the hydrogen chloride. Option D : Correct. The white ppt is $Al(OH)_3$ which dissolves in excess NaOH to form soluble $Al(OH)_4^-$.

18 **B**	Option A : Boiling and melting point overcome intermolecular forces of attraction.. Option B : $HCl \rightarrow H_2 + Cl_2$ H-Cl bond is broken. HCl has the highest bond energy, so it is most stable Option C : it is a covalent molecule. Not ionic compound. Option D : bond length to relate to bond strength.

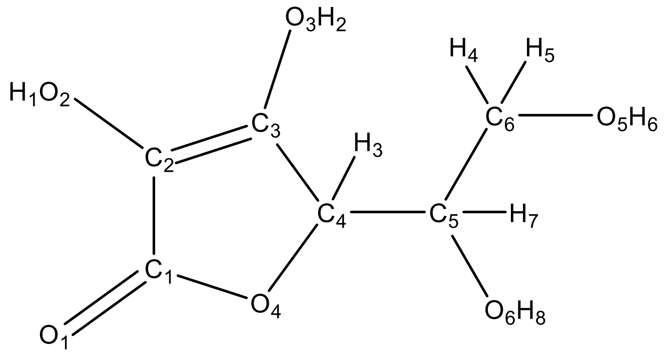
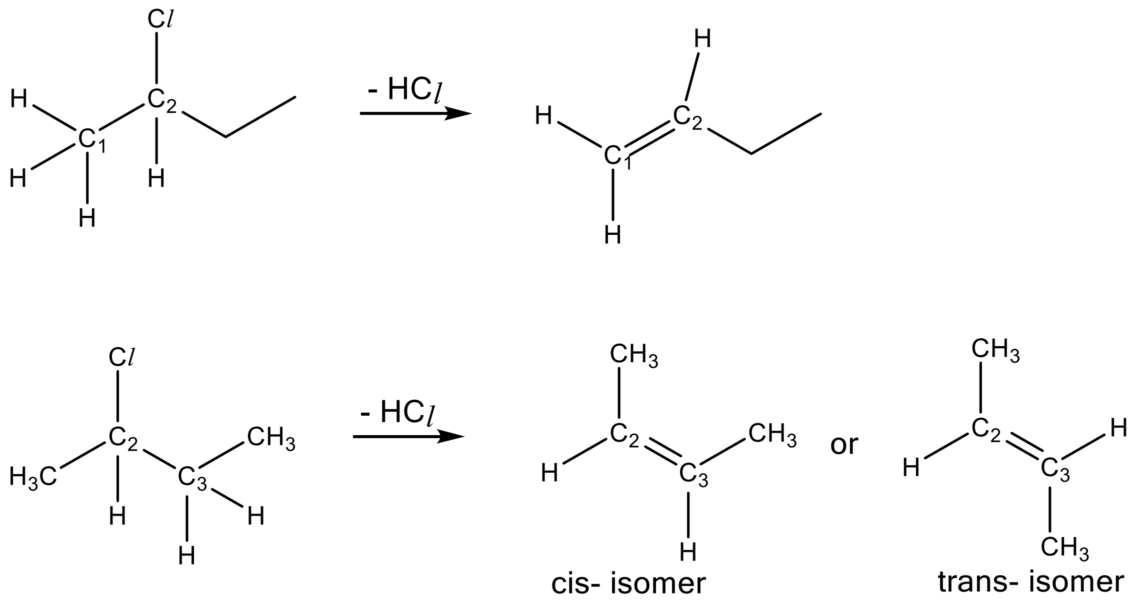
19 **A**	Option 1 correct: ionic radius of Na^+, Mg^{2+}, Al^{3+} decrease across the period. Option 2 correct: pH decreases across the period as pH of oxides become more acidic. Option 3 incorrect: electrical conductivity increases from Na to A*l* before it decreases. Hence, the statement is incorrect.

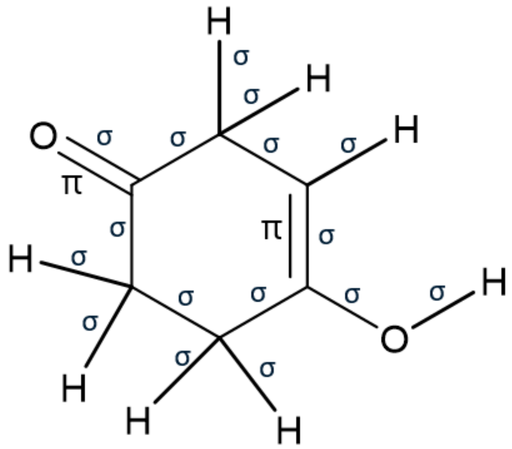
20 **D**	For this solution, the range of pH it can have will be between 5.5 (turning bromocresol-green blue) to 6.8 (turning phenol-red yellow). Hence this pH range is in the weakly acidic region.

21 **A**	1 (correct): Since HCl is a strong acid and HCl $\equiv$ H^+, pH = –lg(0.1) = 1 2 (incorrect): Since H_2SO_4 is a strong acid and $H_2SO_4 \equiv 2H^+$, pH = –lg(0.2) = 2 3 (incorrect): Since ethanoic acid is a weak acid, it will only be partially dissociated. $[H^+]$ does not equal 0.1 mol dm^{-3}.

22 **B**	Option A: incorrect. Both burn upon heating. Option B: Thermoplastic polymers can melt and remould into different shapes to be recycled. Thermosetting polymers once the shape is set will not be able to melt and remould. Hence, it cannot be recycled. Option C: Thermoplastic polymers are formed with little or no cross-linkages hence can melt. Thermosetting polymers are formed with many cross-linkages thus the shape is set. Option D: The main form of interactions between polymer chains in thermoplastic is instantaneous dipole-induced dipole interaction. The main form of interactions that give rise to cross-linking in thermoset is covalent bond.

23 **A**	Polymers with ester or amide bonds are usually polymers formed by condensation. In this kelvar polymer, carboxylic acid and amine formed the amide bonds. The amide bond will undergo hydrolysis in the presence of strong acids and strong alkali.

24 **B**	 Molecular formula: $C_6H_8O_6$ Empirical formula: $C_3H_4O_3$ (Option B)
25 **C**	Elimination of HC*l* will occur in 2-chlorobutane during the reaction with hot ethanolic KOH.  Option C is correct.

26 **C**	 C is the answer

27 **C**	Statement 1 is false. Counting atoms from the structure gives $C_{10}H_{16}O_4$ not $C_{10}H_{14}O_4$. (6-membered ketone ring + 4-carbon side chain with 2 OH and an aldehyde) Statement 2 is false. It has no carboxylic acid as a functional group. Aldehyde/ketone/alcohols react with $NaHCO_3$ to liberate CO_2. Statement 3 is correct. Hot acidified $K_2Cr_2O_7$ oxidises the aldehyde to form carboxylic acid (adds one O), while the two secondary alcohols form ketones (no net O increase). Total O atoms goes from 4 to 5. The remaining ketone will not be oxidised further.

28 **B**	Step R is correct. $C_2H_5Br \rightarrow C_2H_5OH$ is substitution reaction with aqueous NaOH Step S is incorrect. $C_2H_5OH \rightarrow CH_3COOH$ is oxidation reaction, not reduction. Step S reagent is incorrect. An oxidising agent on top of the acid medium is required (e.g., hot acidified $K_2Cr_2O_7$/$KMnO_4$ under reflux) Step T is correct. $CH_3COOH \rightarrow CH_3CONH_2$ can be done using DCC to react the carboxylic acid with NH_3 to form amide.

29 **B**	A: Their health risks are poorly understood. They may pose potential health risks. B: Nanomaterials can have a length of more than 100 nm as they just need at least one dimension in the size of 1 to 100 nm. C: Nanomaterials can be both man-made and exist biologically. D: Not all nanomaterials can stick onto surfaces (e.g. catalytic converter).

30 **C**	Geckos possess a hierarchical foot structure, where nanoscale spatulae on their toes maximise surface contact through deformation, creating vast collective contact areas. The resulting instantaneous dipole-induced dipole interactions generate exceptionally strong adhesive forces, allowing geckos to support many times their body weight.