VICTORIA JUNIOR COLLEGE
2024 JC2 H1 CHEMISTRY PRELIMINARY EXAMINATION PAPER 1 ANSWERS

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

1 A

	particle	electronic configuration
A	C^-	$1s^2 2s^2 2p^3$
B	N^{2-}	$1s^2 2s^2 2p^5$
C	F^+	$1s^2 2s^2 2p^4$
D	Ne	$1s^2 2s^2 2p^6$

Hence, C^- has a half-filled set of p orbitals.

2 B

Element X has the highest 6th ionisation energy, it means that the sixth electron removed from X is from its next inner shell. Hence, X has five valence electrons and X is in Group 15. As W, X, Y and Z are four consecutive elements in the Periodic Table, W is in group 14. Hence, the formula of the fluoride of W is WF_4.

3 C (1 and 3 only)

Option 1: Correct

A dative bond is formed when the lone pair on O in CH_3OCH_3 is donated to the vacant orbital of B in BF_3.

Option 2: Incorrect

The bond angle around B changes from 120° in BF_3 (3 bond pairs, trigonal planar), to 109.5° in Q (4 bond pairs, tetrahedral).

Option 3: Correct

In CH_3OCH_3, there are 2 bond pairs and 2 lone pairs around O (bent). In Q, there are 3 bond pairs and 1 lone pair around O (trigonal pyramidal).

4 B

Option A: Incorrect

NH_3: Trigonal pyramidal
All dipole moments are not cancelled out, so the molecule is polar.
CCl_4: Tetrahedral
All dipole moments are cancelled out, so molecule is non-polar.

Option B: Correct

CO and HF: linear
Since electronegativity difference is greater between H and F than between C and O, so HF is more polar than CO.

Option C: Incorrect

H_2O and H_2S: bent.
Since O is more electronegative than S, so H_2O is more polar than H_2S since O-H bond is more polar than S-H bond.

Option D: Incorrect

CO_2: linear; BF_3: trigonal planar
Dipole moments in these two molecules cancel out and so these molecules are non-polar.

5 D

$(CH_3)_2CHOH$ and $CH_3CH_2CH_2OH$ form hydrogen bonds between molecules. However, $CH_3CH_2CH_2OH$, with its straight-chain structure, has greater surface area for molecular interaction, leading to greater extent and stronger instantaneous dipole–induced dipole interactions than $(CH_3)_2CHOH$, which is a branched molecule having smaller area for molecular interaction. Hence, more energy is required to overcome the stronger id-id interactions between $CH_3CH_2CH_2OH$ and $CH_3CH_2CH_2OH$ has a higher boiling point than $(CH_3)_2CHOH$.
There are only weaker permanent dipole-permanent dipole interactions between CH_3CH_2CHO molecules, hence, CH_3CH_2CHO has the lowest boing point among three molecules.

6 C (2 and 3 only)

Bronsted-Lowry base is a proton acceptor.

Option 1: Incorrect

NH_3 donated a lone pair to CH_3Cl to form CH_3NH_2. There is no transfer of proton in this reaction.

Option 2: Correct

HNO_3 accepted a proton to form $H_2NO_3^+$

Option 3: Correct

H_2O accepted a proton to form H_3O^+

7 A

Since K_w increases when temperature increases, the dissociation of water is endothermic. Hence, at higher temperature, more H^+ and OH^- are formed in equal amounts. So, $[H^+] = [OH^-]$ but pH decreases due to higher $[H^+]$.

8 C

Concentration of dilute HNO_3
$= (10.0 \times 0.010) \div 100$
$= 0.00100$ mol dm^{-3}

HNO_3, being a strong acid, will fully dissociate in water. Hence, $[H^+] = [HNO_3]$.

$pH = -\log[H^+] = -\log(0.00100) = 3$

9 D

Option A: Incorrect

Solution B is a monoprotic base which its initial pH (before adding acid solution A) is 11.10.
$pOH = 14 - 11.10 = 2.90$
$[OH^-] = 10^{-2.90}$
$= 1.26 \times 10^{-3}$ mol $dm^{-3} < 0.125$ mol dm^{-3}
Hence, solution B is a weak base.

Option B: Incorrect

Since solution B is a weak base, given that pH at equivalence point is 5.22 (less than 7), solution A must be a strong acid.

Option C: Incorrect
Since monoprotic base (solution B) reacts with monobasic acid (solution A), 1 mol of A will react with 1 mol of B at the equivalence point.

Amount of B reacted
= $(25.0 \times 10^{-3}) \times 0.125$
= 3.13×10^{-3} mol

Hence, amount of A reacted at the equivalence point
= 3.13×10^{-3}
= 12.50×10^{-3} × Concentration of A
Concentration of A = 0.250 mol dm^{-3}

Option D: Correct
From graph, equivalence point has pH 5.22 which falls within the working range of bromocresol green (pH range 3.8 – 5.4). Hence, bromocresol green is a suitable indicator to detect the endpoint of this titration.

10 A
Option A: Incorrect statement
pH of blood will remain relatively constant only when a small amount of H^+ or OH^- is added to it. However, when a large amount of H^+ is added, there is insufficient HCO_3^- in the buffer and the pH decreases significantly.

Option B: Correct statement
A decrease in $[H^+]$ of blood will shift equilibrium position of $H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$ to the right, resulting in more hydrogencarbonate ions to be formed.

Options C and D: Correct statement
A mixture of H_2CO_3 and HCO_3^- is a buffer present in blood to control its pH.

11 C
Option A: Incorrect
Electronegativity of the Period 3 elements increases across the period. Hence, the difference in the electronegativities of Period 3 elements and oxygen becomes smaller, causing the bonds formed in the oxides to be more covalent.

Option B: Incorrect
Sulfur can also form more than one oxide, which are SO_2 and SO_3.

Option C: Correct
Electronegativity of the Period 3 elements increases across the period. Hence, the difference in the electronegativities of Period 3 elements and chlorine becomes smaller, causing the bonds formed in the chlorides to be more covalent.

Option D: Incorrect
NaCl dissolves in water to give a neutral aqueous solution which will not turn blue litmus red.

12 B (1 and 2 only)
Options 1 and 2: Correct
The reducing power of Group 1 elements increases down the group. With increasing number of electronic shells, the valence electrons are further away from nucleus. Hence, the nuclear attractions between nucleus and valence electrons get weaker down the group, enabling valence electrons to be given out more easily.
As such, rubidium reduces water more readily than sodium and caesium loses electrons more easily than potassium.

Option 3: Incorrect
Group 1 element such as caesium is not an oxidising agent, it is a reducing agent.

13 D
Option A: Correct
Down Group 17, the halogen molecules have greater number of electrons, which results in stronger instantaneous dipole-induced dipole attractions between molecules. Hence, melting point of Group 17 elements increases down the group. Since iodine is a solid, Singaporium should be a solid at r.t.p. too.

Option B: Correct
Increase in atomic radius of halogen (X) down the group leads to poorer extent of overlap between the orbitals of halogen atoms in the halogen molecules, this leads to weakening of X–X bond. Hence, the bond energy of Sg–Sg is less endothermic than that of I–I.

Option C: Correct
Oxidising power of halogens decreases down the group. Hence, Sg_2 being a weaker oxidising agent than I_2, is unable to oxidise iodide to iodine.

Option D: Incorrect
Increase in atomic radius of halogen (X) down the group leads to poorer extent of overlap between the orbital of H and the orbital of the halogen, this leads to weakening of H–X bond and HX becomes less stable to heat. Since HI can decompose when heated with red-hot steel, HSg can therefore decompose when heated with red-hot steel.

14 A (1, 2 and 3)
If the third element is O

	C	H	O
Mass in 100 g	54.5	9.1	36.4
Amt in 100g	4.54	9.1	2.275
Ratio	2	4	1

The empirical formula of the organic compound is C_2H_4O.

Option 1: Correct
The molecular formula of $CH_3CH_2CH_2CO_2H$ is $C_4H_8O_2$ so the empirical formula is C_2H_4O.

Option 2: Correct
The molecular formula of $CH_2(CHO)CH_2CH_2OH$ is $C_4H_8O_2$ so the empirical formula is C_2H_4O.

Option 3: Correct
If the third element is S

	C	H	S
Mass in 100 g	54.5	9.1	36.4
Amt in 100g	4.54	9.1	1.13
Ratio	4	8	1

The molecular formula of $CH_3CH{=}CHCH_2SH$ is C_4H_8S so the empirical formula is C_4H_8S.

15 C

In the acidic solution, H_2O_2 is oxidised to form O_2 as the oxidation number of O changes from –1 in H_2O_2 to 0 in O_2.
In the alkaline solution, H_2O_2 is reduced to form H_2O as the oxidation number of O changes from –1 in H_2O_2 to –2 in H_2O.
Hence, oxygen gas is formed only in the acidic solution.

16 C
Amount of Au = 10000 ÷ 197 = 50.76 mol
Amount of O_2 required = 50.76 ÷ 4 = 12.69 mol
Volume of O_2 required = 12.69 × 24 = 304.6 dm^3
Volume of air required = 304.6 ÷ 20% = 1520 dm^3

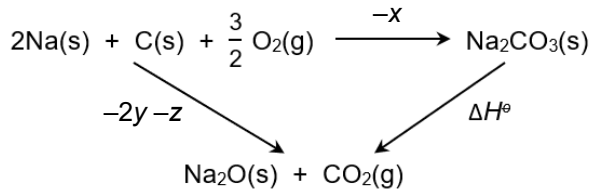
17 D (3 only)
Standard enthalpy change of formation is defined as the enthalpy change when one mole of the substance in their specific state is formed from its constituent elements in their standard states under standard conditions of 298 K and 1 bar.

Option 1: Incorrect
For the standard enthalpy change of formation LiC*l*(s), 1 mol of LiC*l*(s) should be formed from 1 mol of Li(s) and ½ mol of Cl_2(g).

Option 2: Incorrect
2 mol of H_2O is formed from their constituent elements. Hence, the equation $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ represents $2 \times \Delta H_f^{\ominus}(H_2O)$.

Option 3: Correct
1 mol of NaC*l*(s) is formed from their constituent elements.

18 D



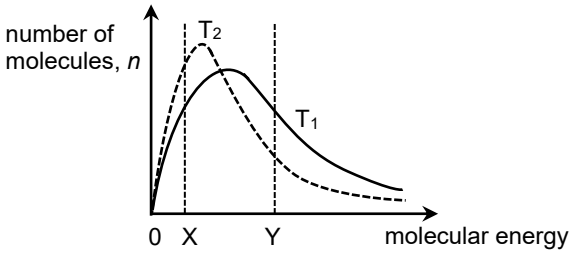
By Hess's Law:
$-x + \Delta H^{\ominus} = -2y - z$
$\Delta H^{\ominus} = (x - 2y - z)$ kJ mol^{-1}

19 A (1, 2 and 3)
Let rate equation be rate = $k[BrO_3^-]^a[Br^-]^b[H^+]^c$

Comparing experiments 1 and 3:
$(\frac{0.10}{0.20})^b = \frac{7.20 \times 10^{-3}}{1.44 \times 10^{-2}} = \frac{1}{2}$
b = 1
Comparing experiments 3 and 4:
$(\frac{0.10}{0.20})^a = \frac{1.44 \times 10^{-2}}{2.88 \times 10^{-2}} = \frac{1}{2}$
a = 1
Comparing experiments 2 and 3:
$(\frac{0.30}{0.15})^c = \frac{1.44 \times 10^{-2}}{3.60 \times 10^{-3}} = 4$
c = 2
Hence, rate equation is rate = $k[BrO_3^-][Br^-][H^+]^2$
Option 1: Correct
The reaction is second order with respect to H^+.
Option 2: Correct
Since rate = $k[BrO_3^-][Br^-][H^+]^2$, overall order of reaction is four.

Option 3: Correct
Substitute the concentration of each reagent in experiment 1 into the rate equation.
rate = $k[BrO_3^-][Br^-][H^+]^2$
$7.20 \times 10^{-3} = k(0.10)(0.10)(0.30)^2$
$k = 8.00\ mol^{-3}\ dm^9\ s^{-1}$

20 B



With a decrease in the temperature, the Boltzmann distribution curve will shift to the left (as seen by the dotted line). There is a smaller number of molecules with higher energy so *n* at Y will be lower, while there is a greater number of molecules with lower energy so value of *n* at X will be higher.

21 A
Enzymes as biological catalysts which have specific activity on their reactants (substrates).

22 B
Option A: Correct statement
Since H_3O^+ is formed during hydrolysis, the solution is acidic. It will turn blue litmus red.

Option B: Incorrect statement
At equilibrium, the concentrations of $[Al(H_2O)_6]^{3+}(aq)$ and $[Al(H_2O)_5(OH)]^{2+}(aq)$ remain constant but they may not be equal to each other.

Option C: Correct statement
The rates of forward and reverse reactions are equal at equilibrium.

Option D: Correct statement
When HCl is added, $[H_3O^+]$ increases. By Le Chatelier's Principle, increasing the concentration of H_3O^+ will shift the equilibrium position to the left, leading to formation of more $[Al(H_2O)_6]^{3+}$ ions.

23 C

	$CO(g)$ +	$2H_2(g)$ ⇌	$CH_3OH(g)$
I / mol	1.00	1.50	0
C / mol	−0.30/2 = −0.15	−(0.20)1.50 = −0.30	+0.30/2 = +0.15
E / mol	0.85	1.20	0.15

At equilibrium,
$[CO] = 0.85 \div 2 = 0.425\ mol\ dm^{-3}$
$[H_2] = 1.20 \div 2 = 0.60\ mol\ dm^{-3}$
$[CH_3OH] = 0.15 \div 2 = 0.075\ mol\ dm^{-3}$

$K_c = [CH_3OH] / ([CO][H_2]^2)$
$= 0.075 \div (0.425 \times 0.60^2)$
$= 0.490\ mol^{-2}\ dm^6$

24 A

Option A: Incorrect
Due to the giant molecular structure of graphene, there is a network of strong covalent bonds where each C atom is covalently bonded to three other C atoms, this will require a large amount of energy to break the covalent bonds. Therefore, the high tensile strength of graphene is due to its giant molecular structure with a network of strong covalent bonds and not surface area of the material.

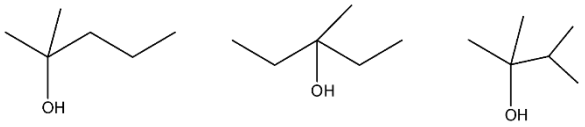
Option B: Correct
The tiny hairs on the gecko's feet (100 nm in diameter) produces a large surface area, allowing the molecules on the gecko's feet to come very close to the molecules of the surfaces. This causes the instantaneous dipole–induced dipole interactions between the gecko's feet and surface to become strong enough to support the weight of the gecko and hence allows it to "stick" onto the surface.

Option C: Correct
The catalytic converter consists of a ceramic support fashioned into a honeycomb structure, and the surfaces are coated with platinum (Pt) nanoparticles. The use of the honeycomb structure together with platinum nanoparticles which have a high surface area to volume ratio, serves to maximise the surface area so as to increase the rate of catalysis and hence increasing the rate of reaction.

Option D: Correct
The high surface area to volume ratio of silver nanoparticles enables it to remove impurities from pre-treated water efficiently.

25 D
Graphene is a giant molecule. The carbon atoms in graphene are arranged in a hexagonal network, with each C atom covalently bonded to three other C atoms, resulting in a network of strong covalent bonds. The remaining valence electron (π electron) on each C atom is located in a p-orbital. This p-orbital overlaps with p-orbitals of adjacent C atoms, forming a continuous π electron cloud, allowing electrons to be delocalised along the graphene layer (similar to graphite). Hence graphene is a good conductor of electricity.

26 C
Three tertiary alcohols of the following structures could be formed.



27 C
2-chloropropane undergoes elimination to form propene.

Option 1: Incorrect
Only propene is formed. It does not exhibit cis-trans isomerism. Thus, the products do not exist as two isomers.

Option 2: Correct
The formula of propene is $CH_2{=}CHCH_3$. It does not contain oxygen atom.

Option 3: Correct
Propene has an alkene functional group and it will undergo addition reaction with Br_2 in CCl_4 to form 1,2-dibromopropane.

28 A
$CH_3CH_2CH{=}CHCH_2CHO$ has both alkene and aldehyde functional groups.

reducing agent	alkene	aldehyde
H_2 + Pt	√	√
$NaBH_4$	×	√

Option A: Correct and Option B: Incorrect
Both alkene and aldehyde are reduced by H_2 + Pt to form alkane and primary alcohol respectively. Hence, the product should be $CH_3CH_2CH_2CH_2CH_2CH_2OH$.

Option C and Option D: Incorrect
$NaBH_4$ can reduce aldehyde to form primary alcohol but cannot reduce alkene to alkane. Hence, the product should be $CH_3CH_2CH{=}CHCH_2CH_2OH$.

29 B
Option A: Correct statement
HDPE has less degree of branching so that polymer chains are closer to each other with a higher density.

Option B: Incorrect statement
HDPE is a much stiffer and less flexible material than LDPE due to more extensive instantaneous dipole-induced dipole (id-id) interactions between the polymer chains. Thus, HDPE is not suitable to make plastic bags.

Option C: Correct statement
Since there is stronger id–id interactions between polymer chains of HDPE, greater amount of energy is needed to overcome stronger id–id interactions. Hence, HDPE has a higher melting point than LDPE.

Option D: Correct statement
Each polymer chain in HDPE has less branching, so more polymer chains can be packed closer and there will be more extensive id-id interactions between polymer chains which results in HDPE a harder material than LDPE.

30 D
Only side chain of polymer D contains non-polar group which does not form hydrogen bonds with water. Hence, polymer D is not able to absorb water and it is not a suitable material for making contact lens.