Guangyang Secondary School
Chemistry 6092
Secondary Four Express
Preliminary Examination

MARK SCHEME

Paper 1

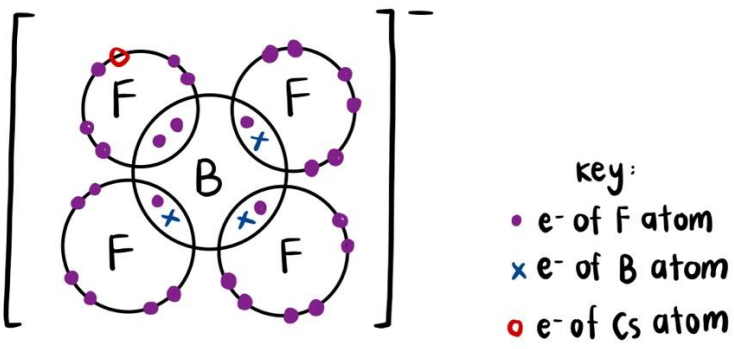
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
D	D	B	C	B	D	A	B	C	C
Q11	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**
D	B	A	C	A	A	C	D	B	D
Q21	**Q22**	**Q23**	**Q24**	**Q25**	**Q26**	**Q27**	**Q28**	**Q29**	**Q30**
C	A	C	D	D	D	A	C	A	B
Q31	**Q32**	**Q33**	**Q34**	**Q35**	**Q36**	**Q37**	**Q38**	**Q39**	**Q40**
D	C	B	C	D	A	B	D	D	C

Paper 2

SECTION A

Question	Solutions	Marks	Remarks
1 (a)	barium chloride, zinc sulfate	1	*both answer for 1m*
(b)	sulfur dioxide	1	
(c)	silver chloride, zinc carbonate	1	*both answer for 1m*
(d)	ammonium carbonate	1	

Question	Solutions	Marks	Remarks
2 (a) (i)	*Labelled arrow of electron highly deflected towards positive plate*	1	
(ii)	Electron is **negatively charged** with a **very small / negligible mass**	1	*both points 1m*
(b) (i)	Unlike neutrons, protons are **positively-charged** and **will be repelled by the positively-charged nucleus**.	1	*both points 1m*
(ii)	**No change in chemical properties** as the new isotope / atom formed has **the same electronic configuration** (or same number of valence electrons) **as the original element**. *Reject no change in chemical properties as they are isotopes.*	1	*award marks even if the term isotope is not used*

Question	Solutions	Marks	Remarks
3 (a)	Typical: Bonding in the compound is **covalent and involves the sharing of electrons** which is expected as boron and fluorine are **both non-metals**. Not typical: The valence electron shell of boron **only has 6 valence electrons**, **instead of a complete octet electronic configuration**.	1 1	
(b)	 *1m for correct electronic structure* *1m for square brackets and charge number* *Accept if donation of electron pair includes electron from caesium atom.*	2	*deduct 1m if key not included*
(c)	Boron trifluoride has a **simple molecular structure** while caesium tetrafluoroborate has a **giant ionic crystal lattice structure**. There are **weak intermolecular forces of attraction between boron trifluoride molecules**, which only require a small amount of energy to overcome. There are **strong electrostatic forces of attraction between caesium cations and tetrafluoroborate anions**. Thus, a **larger amount of energy is required** to overcome these forces of attraction within the ionic compound. Hence, boron trifluoride exists as a gas and caesium tetrafluoroborate exists as a solid at rtp.	3	*1m: both structures* *1m: bonding present in both substances* *1m: comparison of energy required*

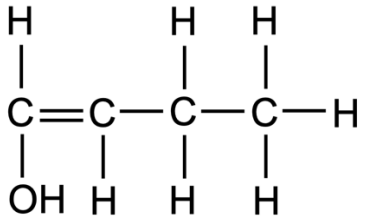
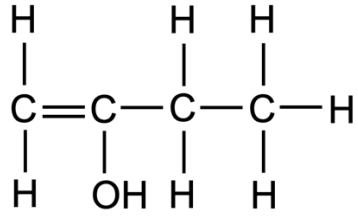
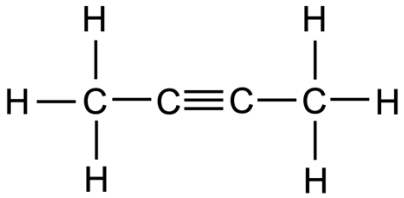
Question	Solutions	Marks	Remarks
4 (a)	$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O$ $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$ no. of moles of KOH = $\frac{25.00}{1000} \times 0.320$ = 0.00800 mol mole ratio of KOH : H_2SO_4 2 : 1 no. of moles of excess H_2SO_4 = 0.008 ÷ 2 = 0.00400 mol total no. of moles of H_2SO_4 = $\frac{50.00}{1000} \times 0.200$ = 0.0100 mol no. of moles of H_2SO_4 reacted with $CaCO_3$ = 0.0100 – 0.00400 = 0.00600 mol mole ratio of H_2SO_4 : $CaCO_3$ 1 : 1 no. of moles of $CaCO_3$ = 0.00600 mol mass of $CaCO_3$ = 0.00600 × (40 + 12 + 48) = 0.6 g % purity of $CaCO_3$ = $\frac{0.6}{0.835} \times 100\%$ = **71.9 %** (3sf)	1 1 1 1	*1m for excess H_2SO_4 that reacted with KOH* *1m for amount of H_2SO_4 that reacted with $CaCO_3$* *1m for mass of $CaCO_3$* *1m for percentage purity of $CaCO_3$*
(b) (i)	Point **Q** was the equivalence point where nitric acid was completely neutralised by sodium hydroxide. At **R**, sodium hydroxide is in excess. The presence of **<u>free moving Na^+ and OH^- ions from excess sodium hydroxide act as mobile charge carriers</u>** to conduct electricity. Thus, electrical conductivity of solution increases.	1	*To state the presence of ions from EXCESS sodium hydroxide*

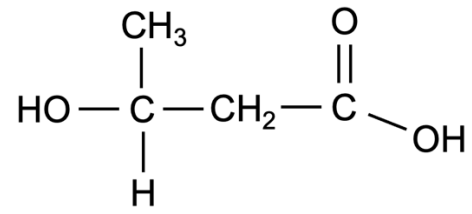
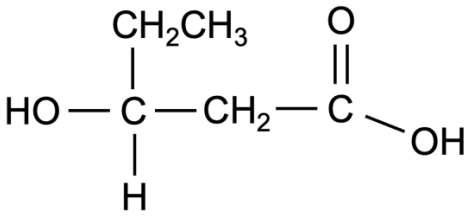
(ii)	*Similar to curve for experiment, except for an initial pH value of 4. Same volume of NaOH used and same height at end of reaction.*	1	
(iii)	As ethanoic acid is a **<u>weak acid</u>**, it **ionises partially** in water to produce hydrogen ions. Nitric acid, on the other hand, is a **<u>strong acid</u>** which **ionises completely** to produce hydrogen ions. Since ethanoic acid has a **<u>lower concentration of hydrogen ions, it has a higher pH</u>**	1 1	*1m for difference in strength of acids* *1m pH value to concentration of hydrogen ions*

Question	Solutions	Marks	Remarks
5 (a)	Iron(II) ion is a **catalyst** as it is **chemically unchanged in the overall reaction** / is regenerated at the end of step 2.	1	
(b) (i)	**Aqueous sodium hydroxide could be added** to the mixture of iron(II) ions and aqueous iodine, to form insoluble iron(II) hydroxide. Aqueous sodium hydroxide is **added in excess until no further change is seen.** **Filtration** can be carried out to remove the solid from the mixture.	1 1	*Accept use of aqueous ammonia* *1m not awarded if reagent is not added in excess*
(ii)	A **black solid is formed** and the **solution turns into a lighter shade of brown**. **Iodine is more reactive than astatine**, and **will displace astatine** from sodium astatide solution.	1 1	*No mark awarded if explanation is incorrect.*

Question	Solutions	Marks	Remarks
6 (a) (i)	**Z**, **W**, **X**, **Y**	1	
(ii)	$3\mathbf{X}\ (s) + 2\mathbf{W}(NO_3)_3\ (aq) \rightarrow 3\mathbf{X}(NO_3)_2\ (aq) + 2\mathbf{W}\ (s)$	1	
(b)	Zinc	1	
(c) (i)	**No gas is produced for metal Z**. Metal **Z**, which is less reactive than copper, must an **unreactive metal and does not react with steam**. **X** is **more reactive than W** and will **produce more gas** than **W** during the fixed time interval.	1 1	
(ii)	Fused/anhydrous calcium chloride	1	
(d)	Metal **V** is below **Y** in the Periodic Table. Since metal **V** is more reactive than **Y**, the **electrostatic forces of attraction between the nucleus and valence electrons for V must be weaker.** This implies that the **valence electron is further from the positively charged nucleus, and V has more electron shells than Y.**	1 1	*1m on linking reactivity to forces of attraction* *1m on concluding the no. of electron shells*

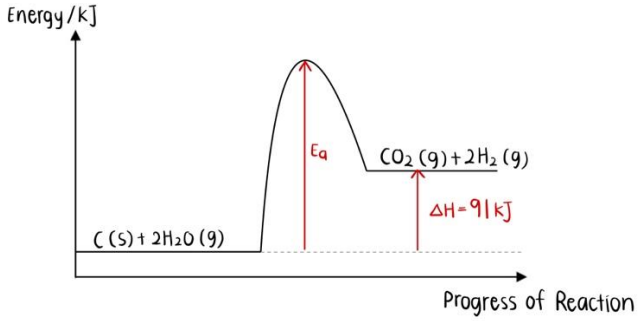
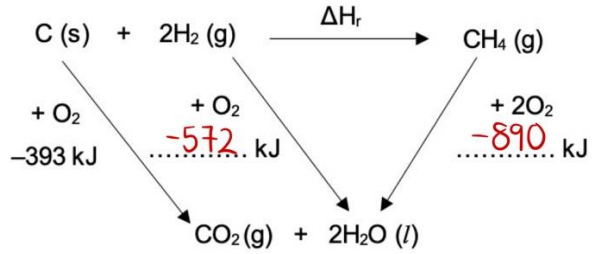
Question	Solutions	Marks	Remarks
7 (a) (i)	**Carbon monoxide and oxides of nitrogen react** with each other to **form nitrogen gas and carbon dioxide** through **redox reactions**. Unburnt hydrocarbons **combust / burn / react with oxygen in air** to form **carbon dioxide and water vapour**	1 1	*type of reaction and products must be stated clearly for mark to be awarded*
(ii)	When the temperature of the car engine is higher, **nitrogen gas will react with the oxygen** present in the air to **form more oxides of nitrogen**.	1	
(b)	**Ammonia is oxidised** as the oxidation state of nitrogen increases from –3 in NH_3 to 0 in N_2 **Nitrogen dioxide is reduced** as the oxidation state of nitrogen decreases from +4 in NO_2 to 0 in N_2. Since **oxidation and reduction occurs simultaneously**, this is a redox reaction.	1 1	*Deduct 1m if last sentence on both oxidation and reduction occurring is not stated*

Question	Solutions	Marks	Remarks
8 (a)	C_2H_2	1	
(b) (i)	$2C_4H_6 + 11O_2 \rightarrow 8CO_2 + 6H_2O$ *accept* $C_4H_6 + \frac{11}{2} O_2 \rightarrow 4CO_2 + 3H_2O$ *but must be in mixed fractions*	1	
(ii)	Add a few drops of aqueous bromine to separate test-tubes of butyne and butane. Butyne: Aqueous bromine decolourises Butane: Aqueous bromine remains brown.	1	*Test and results for both butyne and butane must be included for 1m*
(iii)	Addition reaction  OR 	1 1	*or any structure that makes sense (such as double addition where only single bonds and 2 hydroxyl groups and present)*
(c)		1	
(d)	No, the bromine atoms are **not on adjacent carbon atoms** and cannot be broken to from an alkyne.	1	

(e)	 	1 1	

Question	Solutions	Marks	Remarks
9 (a)	**<u>Experiment 1:</u>** ***anode:*** **$4OH^-$ (aq) → $2H_2O$ (*l*) + O_2 (g) + $4e^-$** ***cathode:*** **Ag^+ (aq) + e^- → Ag (s)** Observations & Explanations: **Effervescence observed at the platinum electrode. Colourless, odourless gas evolved** relights a glowing splint. **Hydroxide ions are preferentially discharged to form water and oxygen gas**, due to the greater ease of discharge than nitrate ions. **Silver solid deposited on steel electrode**. **Silver ions are preferentially discharged to form silver solid,** due to the greater ease of discharge than hydrogen ions. **<u>Experiment 2:</u>** ***anode:*** **Ag (s) → Ag^+ (aq) + e^-** ***cathode:*** **Ag^+ (aq) + e^- → Ag (s)** Observations & Explanations: **Silver anode decreases in size and mass**. **Silver electrode is reactive and is preferentially oxidised** to form silver ions, over hydroxide and nitrate ions. *(Similar to Expt 1)* Silver solid deposited on steel electrode. Silver ions are preferentially discharged to form silver solid, due to the greater ease of discharge than hydrogen ions. **<u>The runtime for experiment 2 is longer</u>** as the **silver ions in the electrolyte are constantly replenished by the oxidation of the silver electrode**, unlike experiment 1 which will end once all the silver ions in the electrode is reduced.	1 1 1 1 1 1	*1m correct half equations at Expt 1* *1m correct observations and explanation at Expt 1 anode* *1m correct observations and explanation at Expt 1 and 2 cathode* *1m correct half equations at Expt 2* *1m correct observations and explanation at Expt 2 anode* *1m difference in run times*

(b)	The **steel electrode will decrease in mass** and become smaller. **Iron is more reactive than silver** and will be **preferentially oxidised to form iron ions** in the simple cell.	1 1	

Question	Solutions	Marks	Remarks
10 (a)	 *1m for correct diagram (endothermic) with correct reactants and products, and enthalpy change* *1m for presentation including labelling of axes, and activation energy*	2	
(b) (i)	 –286 × 2 = **–572 kJ**	1 1	*1m for each value*
(ii)	By Hess Law, $\Delta H_r + (-890) = -393 + (-572)$ $\Delta H_r = -393 + (-572) - (-890)$ = **– 75 kJ**	1 1	*1m for arranging enthalpy changes correctly (CW=ACW)*

(c) (i)	<table><tr><td>substance</td><td>sample</td></tr><tr><td>methane</td><td>**2**</td></tr><tr><td>ethanol</td><td>**1**</td></tr><tr><td>butanol</td><td>**3**</td></tr></table>	1	
(ii)	The **higher the temperature rise, the greater the enthalpy change of combustion** of substance. Butanol, with the highest enthalpy change of combustion, will result in the highest temperature rise, followed by ethanol and methane. In the combustion of all three fuels, the **energy released from forming bonds in carbon dioxide and water (C=O and O–H) is more than the energy absorbed to break the C–H and O=O bonds present** in the molecules. Since butanol contains the **largest number of C and H atoms, most number of C=O and O–H bonds are formed and most amount of energy is released** from the reaction.	1 1 1	*1m for linking temperature rise to enthalpy change* *1m for comparing energy absorbed and energy released* *1m for stating that butanol is the largest molecule and will result in the most energy released from most number of products formed.*
(iii)	**–2670 kJ/mol**	1	*proportional to temperature rise, compared to methane and ethanol*
(d)	The black powder is soot which is **formed from the incomplete combustion of butanol**, **due to limited amount of oxygen gas**.	1	*both points 1m*

<table>
<tr><th>Question</th><th>Solutions</th><th>Marks</th><th>Remarks</th></tr>
<tr><td>11 (a)</td><td>
<table>
<tr><td>experiment</td><td>concentration of acid / mol/dm^3</td><td>volume of acid /cm^3</td><td>particle size of metal</td></tr>
<tr><td>D</td><td>0.25</td><td>20</td><td>large</td></tr>
<tr><td>A</td><td>0.40</td><td>30</td><td>large</td></tr>
<tr><td>C</td><td>0.40</td><td>25</td><td>large</td></tr>
<tr><td>B</td><td>0.50</td><td>20</td><td>small</td></tr>
</table>
</td><td>3</td><td>1m for 2 correct answers</td></tr>
<tr><td>(b)</td><td>Using results from Experiment A,

No. of moles of H_2 gas = $\frac{144}{1000} \div 24$
= 0.006 mol

Since metal has a valency of 1,

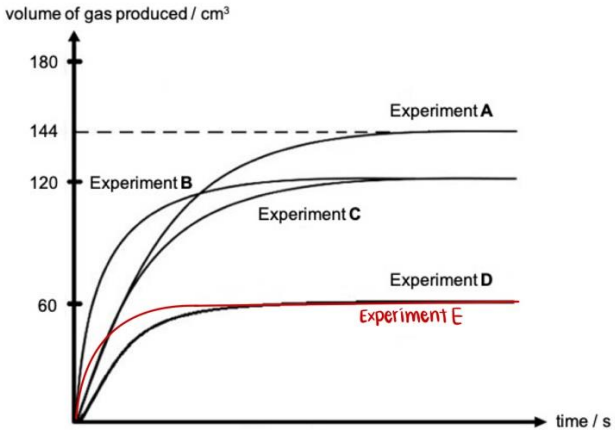
$2X + 2HNO_3 \rightarrow 2XNO_3 + H_2$

mole ratio of X : H_2
2 : 1

no. of moles of X = 0.006 × 2
= 0.0120 mol

molar mass of X = 0.468 ÷ 0.0120
= 39

X is potassium</td><td>1

1</td><td></td></tr>
<tr><td>(c)</td><td> 

initial rate of reaction is slower than B but higher than A and C
final volume of gas is similar to D.</td><td>1</td><td></td></tr>
</table>

(d)	At lower temperature, the **initial rate of reaction will decrease**. At a lower temperature, the particles have **less kinetic energy**. They **move slower and collide more less frequently**. In addition, there are **fewer reacting particles with energy greater than or equal to the activation energy**. Hence, there is a **decrease in the frequency of effective collisions**, resulting in a slower reaction. *deduct 1m if frequency of effective collision is not seen*	1 1 1	
(e)	**No gas will be produced** as silver is unreactive and does not react with acid.	1	

Question	Solutions	Marks	Remarks
12 (a)	No, the **concentration ClO_2 of has a greater effect** on the rate of reaction than the **concentration of OH^- ions**. In experiment 1 and 2, when the concentration of **ClO_2 doubles** from 0.020 to 0.040 mol/dm^3**, the initial rate of reaction increased by four times** from 0.00358 to 0.01432 mol/dm^{3}s. In experiment 1 and 3, when the concentration of **OH^- doubles** 0.015 to 0.030 mol/dm^3**, the initial rate of reaction only increased by two times** from 0.00358 to 0.0716 mol/dm^{3}s**.** Hence, the effect of concentration of each reactant is not equal.	1 1 1	
(b)	$0.00358 \times 9 \times 5 =$ **0.1611 mol/dm^{3}s**	1	
(c)	When catalyst is present, it provides **an alternative pathway with a lower activation energy** for the reaction to occur. Hence, **more reactant particles have energy greater than or equal to activation energy**. Hence, there is an in**crease in the frequency of effective collisions**, resulting in a faster reaction.	1 1 1	
(d)	mole ratio of $ClO_2 : OH^-$ 1 : 1 Since the same volume of both solutions is used, ClO_2, with a lower concentration, is the limiting reactant. no. of moles of $ClO_2 = 0.020 \times \frac{50}{1000}$ $= 0.00100$ mol mole ratio of $ClO_2 : H_2O$ 2 : 1 no. of moles of $H_2O = 0.00100 \div 2$ $= 0.0005$ mol mass of $H_2O = 0.0005 \times 18$ = **0.009 g**	1 1 1	