Prelim 4Ex Chem 2024 – mark scheme

P1

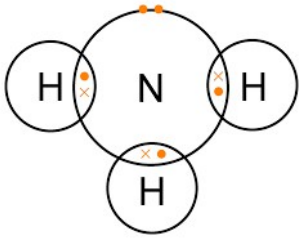
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
B	B	D	D	A	A	C	B	B	C
Q11	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**
D	D	D	C	D	B	B	D	B	D
Q21	**Q22**	**Q23**	**Q24**	**Q25**	**Q26**	**Q27**	**Q28**	**Q29**	**Q30**
C	B	A	D	C	C	C	D	C	A
Q31	**Q32**	**Q33**	**Q34**	**Q35**	**Q36**	**Q37**	**Q38**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

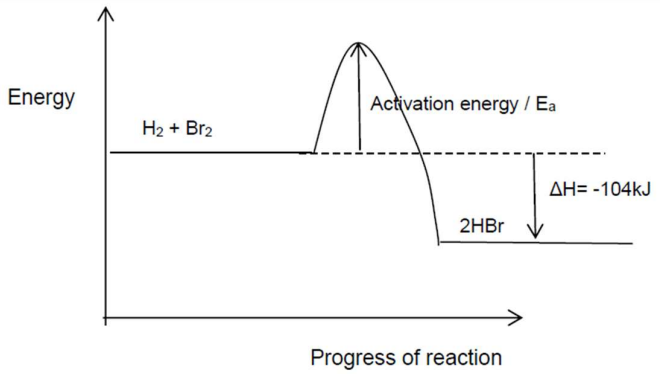
P2 Section A

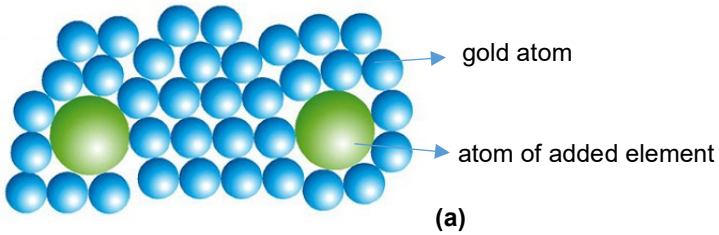
	Suggested answers		marks	Remarks
1	(a)	N	[1]	
	(b)	He/ Ne/ Ar/ Kr	[1]	
	(c)	O	[1]	
	(d)	F/Cl/Br	[1]	
	(e)	Br/Kr	[1]	
	(f)	N	[1]	
2	(a)	The lower the relative mass, the shorter the time for diffusion of 100cm^3 of the gas. Example: Chlorine, having a higher relative mass of 71, than carbon monoxide, which has a lower relative mass of 28, has a longer diffusion time.	[1] [1]	
	(b)	132s	[1]	
	(c)	Ammonia is very soluble in water and will dissolve in water.	[1]	

3	(a)	pink	[1]	
	(b)	0.5 1.25	[1] [1]	
	(c)	It has a high pH of 14, therefore It is a strong alkali as this indicates a high concentration of hydroxide ions.	[1] [1]	
	(d)	Blue Pink		
4	(a)(i)	CuO H_2SO_4	[1] [1]	
	(ii)	Filtration	[1]	
	(iii)	sodium metal will be too explosive in oxygen to be heated up in hot air to form sodium oxide. In addition, sodium oxide is soluble in water and will not be filtered off in step 3.	[1] [1]	
	(b)	It can reduce acidity in soils.	[1]	
	(e)		[2]	
5	(a)	A simple molecular structure consists of small discrete molecules held together by weak intermolecular forces of attraction. A giant molecular structure consist of atoms joined together by strong covalent bonds throughout the structure.	[1] [1]	
	(b)	Diamond consists of carbon atoms covalently bonded throughout its giant molecular structure. a large amount of energy/force to is needed to break the strong bonds. Hence diamond is very hard.	[1] [1]	
	(c)	graphite is made up of flat hexagonal layers of carbon held together by weak intermolecular forces of attraction. the layers of carbon can easily slide over one another when a force is applied. hence graphite is used as a lubricant.	[1] [1]	
	(d)	Very high melting and boiling points Does not conduct electricity	[1] [1]	

6	(a)	experiment 1 anode: $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ cathode: $Ag^+(aq) + e^- \rightarrow Ag(s)$ experiment 2 anode: $Ag(s) \rightarrow Ag^+(aq) + e^-$ cathode: $Ag^+(aq) + e^- \rightarrow Ag(s)$	 [1] [1] [1]	 For both cathode
	(b)(i)	A **white precipitate** is observed as silver chloride is insoluble in water $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$	[1] [1]	
	(ii)	Silver ions in experiment 1 has all be **reduced/discharged** to form silver metal while in experiment 2, the silver anode **oxidises to form silver ions** which increases the **supply** of silver ions in the solution compared to experiment 1 A white precipitate of silver chloride would be observed in experiment 2 only when sodium chloride is added to test for silver ions.	[1] [1] [1]	
	(c)	Iron is **more reactive** than silver in the reactivity series of metals, thus it is able to **displace** silver from aqueous silver nitrate/ Gold is less reactive than silver in the reactivity series of metals, thus is it unable to displace silver from aqueous silver nitrate	[1] [1]	
7	(a)(i)	$6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$	[1]	
	(ii)	Advantage: NO is removed which can react with moisture and air (or water and oxygen) to form nitric acid which dissolves in water; to form acid rain which corrodes limestone buildings/kills aquatic life; Disadvantage: CO_2 is released which is a greenhouse gas which leads to climate change that leads to melting ice caps that could result in rising sea levels / (any effects of climate change)	[1] [1] [1]	[1 for listing both nitrogen monoxide and carbon dioxide]
	(b)	Increasing the temperature increases kinetic energy of particles and move faster. In addition, particles collide with energy equal or more than the activation energy required for the reaction. This increases the frequency of effective collision which increases rate of reaction;	[1] [1] [1]	

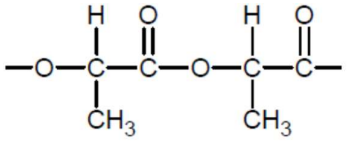
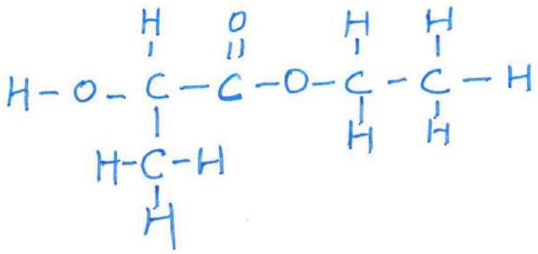
	(c)		[2]	[1 for correct number of shared valence electrons] [1 correct number of atoms]

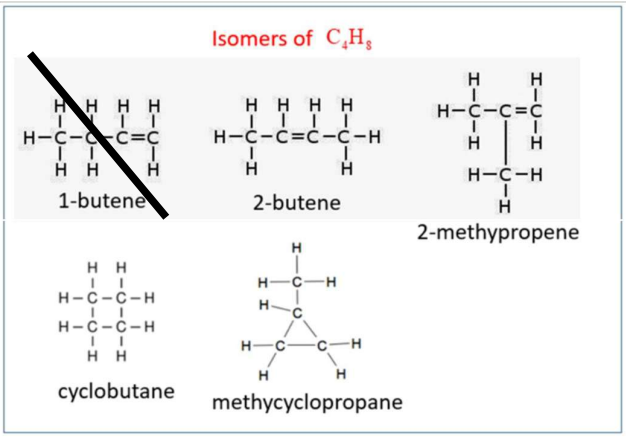
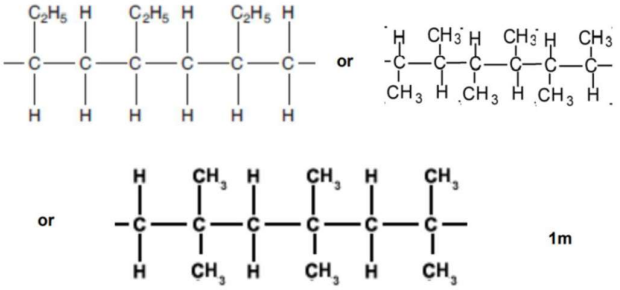
8	(a)	**(a)** The greater the number of bonds between two atoms, the smaller the bond length. (Can be substituted with Group 17 trend/Can use data on Grp 17 for answering/relative mass as alternative) The bond length decreases from 154pm to 120pm when the number of bonds increase from C-C to C≡C. **(b)** As the bond energy decreases, the bond length increases. As bond energy decreases from 431kJ/mol to 299kJ/mol from H–Cl to H–I, bond length increases from 127pm to 161pm. **(c)** As the number of bonds increase, more energy is absorbed to break the bonds. **(d)** This increases the bond energy of the atoms. OR **(c)** increase in atomic radius down Group 17 results in the decrease of the strength of the electrostatic attraction of attraction. **(d)** This lowers the bond energy.	[1] [1] [1] [1] [1] / [1] [1]	
	(b)(i)	*ΔH* = Energy absorbed during bond breaking – Energy released during bond forming = (435 + 193) – 2 x 366 = -104 kJ		
	(b)(ii)		[2]	[1 for correct shape of graph. 1 for labelling]
	(c)	**(a1)** Reaction of iodine with hydrogen is slower/requires catalyst]than the reaction of hydrogen with chlorine **(a2)** because chlorine is more reactive than iodine.	[1]	

		(b1) Reaction of iodine with hydrogen is **exothermic** and the reaction of hydrogen with chlorine is **endothermic** **(b2)** because the **energy absorbed for bond breaking of the chlorine and hydrogen is less than the energy released from bond forming of the hydrogen chloride while the opposite is true for iodine.** **(c1)** Reaction of iodine with hydrogen is **reversible** and the reaction of hydrogen with chlorine is not/ Reaction of iodine with hydrogen produced a halide which decomposes at high temperature while reaction of chlorine produced a halide that does not decompose at high temperature. **(c2)** because **hydrogen iodide is thermally less stable** as compared to hydrogen chloride hence it breaks down easily to form hydrogen and iodine.	[1] [1] [1]	
	(d)	91 pm (accept 87 to 107pm)	[1]	
9	(a)	To increase the **total surface area (to volume ratio)** of the gold particles so as to increase the **rate** at which the gold dissolves in the cyanide solution.	[1]	
	(b)(i)	+1	[1]	
	(ii)	**(a)** Gold is oxidised as the oxidation state of gold increased from 0 in Au to +1 in gold ion / Na[Au(CN)2]. (e.c.f. allowed **(b)** Oxygen is reduced as the oxidation state of oxygen decreased from 0 in O_2 to –2 in NaOH. Since oxidation and reduction occurred simultaneously, the reaction is redox.	[1] [1]	
	(c)	Any one of the following: • The anode in electroplating is made of gold while the anode in electrowinning is made of an inert material. • The concentration of gold(I) ions in the electrolyte decreases in electrowinning but the concentration of gold(I) ions in the electrolyte remains the same in electroplating.	[1]	
	(d)	 **(a)**	[1]	

		Atoms of the added element have a different atomic size compared to the gold atoms. **(b)** This disrupts the orderly arrangement of atoms in the gold metal. **(c)** The atoms of different sizes cannot slide over one another easily, making the gold alloy harder/stronger.	[1] [1]	

Section B

10	Either			
	(a)(i)	can be decomposed naturally / can be broken down by bacterial action.	[1]	
	(ii)		[2]	ester linkage drawn correctly (1) structure with 'n' (1)
	(iii)	Poly(lactic acid) is make by condensation polymerisation, besides the polymer, small molecules (water) is also formed.	[1]	
	(iv)	No of mol of lactic acid = 500 x 10^6/ 90 = 5.555 x 10^6 mol During condensation polymerisation, there is a remove of a mole of water molecules from 1 mole of acid. Therefore mass of water formed from 500 tonnes = 5.555 x10^6 mol x18g/mol = 99.99 x 110^6 g Mass of poly(lactic acid) = 500 tonnes – 99.99 tonnes = 400 tonnes	[1] [1]	
	(b)(i)	concentrated sulfuric acid as a catalyst.	[1]	
	(ii)		[1]	
	(c)	The rate of reaction in hydrochloric acid is faster. Hydrochloric acid is a **strong acid** and lactic acid is a **weak** acid, so for equal concentration and volume of hydrochloric acid give a **higher number /concentration of hydrogen ions** in hydrochloric acid than lactic acid This leads to a faster rate of reaction.	[1] [1]	

10	Or			
	(a)	Cracking	[1]	
	(b)	Propane $C_{11}H_{24} \rightarrow 2C_4H_8 + C_3H_8$	[1] [1]	
	(c)	Moles of $C_{11}H_{24}$ = Mole of butene = 1 x 2 = 2 mol Mass of butene = 2 x (12 x 4 + 8) = 112 g % yield of butene = (50.4 ÷ 112) x 100% = 45% [Allow ecf]	[1] [1]	
	(d)			
	(e)		[2]	[1 for correct polymer drawn, 1 for 3 repeat units]
	(f)	Method : fractional distillation [Reject : distillation] Reason : Isomers have different boiling points.	[1] [1]	