

01. 0620_s21_ms_41 Q: 4

Question	Answer	Marks
(a)	the rate of forward reaction equals the rate of the reverse reaction (1) concentrations of reactants and products are constant (1)	2
(b)(i)	(increased pressure) nitrogen dioxide particles or molecules (forced) closer together OR same number of nitrogen dioxide particles or molecules in a smaller volume	1

Question	Answer	Marks
(b)(ii)	fewer number of gas moles or molecules on left hand side or reactant side (of the equation) ORA	1
(c)(i)	shifts to the right	1
(c)(ii)	increase / faster (1) increase / faster (1)	2

02. 0620_s21_ms_43 Q: 4

Question	Answer	Marks
(a)	the rate of forward reaction equals (the rate of the) reverse reaction (1) concentrations of reactants and products are constant (1)	2
(b)(i)	same number of gas moles on both sides of the equilibrium / same number of gas molecules on both sides of the equilibrium	1
(b)(ii)	iodine particles or molecules (forced) closer together / same number of iodine particles or molecules in a smaller volume	1
(c)(i)	shifted to the left	1
(c)(ii)	decrease / slower (1) decrease / slower (1)	2

03. 0620_w21_ms_42 Q: 4

Question	Answer	Marks
(a)	M1 E of making bonds > breaking bonds M2 bond making releases energy M3 bond breaking requires energy	3
(b)(i)	M1 exothermic mark horizontal line below energy level to R.H.S. of reactants line and labelled $\text{COCl}_2(\text{g})$ (1) M2 activation E mark activation energy 'hump' with upward arrow labelled A / activation energy (1) M3 energy change mark one downward arrow labelled ΔH and energy change starting from E level of reactants and finishing at E level of products (1)	3
(b)(ii)	increases rate of reaction	1
(c)(i)	equilibrium shifts to right hand side (1) fewer moles (of gas) on right hand side (1)	2
(c)(ii)	equilibrium shifts to left hand side (1) (forward) reaction is exothermic (1)	2

Question	Answer	Marks
(d)	M1 bond energy in making bonds $= [(2 \times 400) + 745] = 1545 \text{ (kJ mol}^{-1}\text{)}$ M2 use of total E change $-230 = [240 + E(\text{C}\equiv\text{O})] - 1545$ OR $[240 + E(\text{C}\equiv\text{O})] = -230 + 1545 = (+1315)$ M3 $E(\text{C}\equiv\text{O})$ $= [-230 + 1545] - 240 = 1075 \text{ (kJ mol}^{-1}\text{)}$	3
(e)	M1 all single bonding dot and cross pairs correct M2 double C=O bond dot and cross pairs are correct M3 complete diagram is correct	3

04. 0620_p20_ms_40 Q: 7

- (a) rates equal; [1]
 concentrations do not change / macroscopic properties remain constant; [1]
- (b) endothermic **and** because this direction is favoured by high temperatures; [1]
 note: reason is required
- (c) (i) move to left hand side / reactants favoured **and** because bigger volume / more moles on left hand side [1]
 note: reason is required
- (ii) less (yellow) solid / more (dark brown) liquid / green gas visible / turns darker brown / smell chlorine [1]
 allow: ecf from (c)(i)
- (d) (bond breaking =) $151 + 242 = 393$; [1]
 (bond making =) $208 \times 2 = -416$; not: 416 [1]
 (overall =) $393 - 416 = -23$; allow: ecf [1]
 note: sign must be given
- (e) Any two from:
 diagram shows exothermic reaction;
 activation energy shown;
 reactants and products labelled / both axes labelled;
 note: labelling is one mark only
 allow: ecf from (d) [2]

05. 0620_s18_ms_42 Q: 5

(a)	the rate of forward reaction equals (the rate of the) reverse reaction	1
	concentrations of reactants and products are constant	1
(b)(i)	same number of gas moles on both sides of the equilibrium / same number of gas molecules on both sides of the equilibrium	1
(b)(ii)	(increased pressure) particles or molecules (forced) closer together / same number of particles or molecules in a smaller volume	1
(c)(i)	to left / towards reactants / in reverse direction	1
(c)(ii)	increase / faster	1
	increase / faster	1

06. 0620_w18_ms_41 Q: 5

(a)	M1 forward and back reactions occur at equal rates	1
	M2 concentration (of substances) remains constant	1
(b)(i)	equal / same number of moles on each side or amount / molecules (of gas) on each side is the same	1
(b)(ii)	M1 (forward) reaction exothermic or reverse reaction endothermic M2 yield lower at higher temperature or (position of) equilibrium moves left at higher temperature ORA	2
(c)(i)	at the start / beginning	1
(c)(ii)	M1 new line is steeper than printed line and starts at origin	1
	M2 new line reaches same final volume as printed line	1
(d)(i)	M1 Faster and More particles per unit volume / $\text{dm}^3 / \text{cm}^3$ M2 More collisions per second / unit time or greater collision rate	2
(d)(ii)	Reaction faster and (particles) have more energy or (particles) move faster	1
	more collisions per second or greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy or more particles / collisions have sufficient energy to react or a greater percentage / proportion / fraction of collisions are successful	1

07. 0620_m17_ms_42 Q: 3

(a)	any 2 from: <input type="checkbox"/> forward and backward reactions occur at equal rates <input type="checkbox"/> amounts / moles / concentrations (of substances) remain constant <input type="checkbox"/> closed system	2
(b)	M1 (particles) have more energy OR (particles) move faster	1
	M2 more collisions per second OR greater collision rate	1
	M3 more (of the) particles / collisions have energy greater than the activation energy OR more particles / collisions have sufficient energy to react OR a greater percentage / proportion / fraction of collisions are successful	1
(c)	M1 equilibrium moves left / yield decreases	1
	M2 because the forward reaction is exothermic OR because the reverse reaction is endothermic	1
(d)	M1 no change	1
	M2 numbers of moles of gas on each side is the same	1
(e)(i)	M1 all bonding pairs correct (two pair of electrons shared between O and N AND one pair of electrons shared between N and C)	1
	M2 four non-bonding electrons on O AND two non-bonding electrons on N AND six non-bonding electrons on C to give a fully correct diagram	1
(e)(ii)	M1 weak forces (of attraction)	1
	M2 between molecules / intermolecular	1

08. 0620_w17_ms_42 Q: 5

(a)	both colours referred to correctly as observations in both parts of the answer	1
	(if sulfuric acid is added to solution Y,) equilibrium moves to the right-hand side	1
	because the concentration of acid has increased	1
	(if sodium hydroxide is added to solution Y,) equilibrium moves to the left-hand side	1
	because sodium hydroxide reacts with / neutralises sulfuric acid	1
(b)(i)	210 cm ³ M1 expected volume of hydrogen = 300 cm ³ M2 70% of M1	2
(b)(ii)	fewer moles / molecules / particles (of gas) on the left-hand side	1
(b)(iii)	endothermic	1
(b)(iv)	increases rate (of reaction)	1

09. 0620_p16_ms_40 Q: 7

- (a) rates equal; [1]
concentrations do not change / macroscopic properties remain constant; [1]
- (b) endothermic **and** because this direction is favoured by high temperatures; [1]
note: reason is required
- (c) (i) move to left hand side / reactants favoured **and** because bigger volume / more moles on left hand side [1]
note: reason is required
- (ii) less (yellow) solid / more (dark brown) liquid / green gas visible / turns darker brown / smell chlorine [1]
allow: ecf from (c)(i)
- (d) (bond breaking =) $151 + 242 = 393$; [1]
(bond making =) $208 \times 2 = -416$; not: 416 [1]
(overall =) $393 - 416 = -23$; allow: ecf [1]
note: sign must be given
- (e) Any two from: [2]
diagram shows exothermic reaction;
activation energy shown;
reactants and products labelled / both axes labelled;
note: labelling is one mark only
allow: ecf from (d)

10. 0620_w16_ms_41 Q: 2

(a)(i)	melt(ing)	1
(a)(ii)	sublimation / sublime	1
(a)(iii)	condensing / condensation	1
(b)	overcome / break the attractive forces	1
(c)	E AND particles hit the walls (of the container) more often	1

11. 0620_s14_ms_32 Q: 5

(a) (i) incomplete combustion **or** limited oxygen/less oxygen/not enough oxygen (1) [1]

(ii) any **two** from:

(forward) reaction is endothermic (1)

high temperature increases yield/favours forward reaction/shifts equilibrium to right (1)

faster reaction (rate) (1) [2]

(iii) any **two** from:

high pressure reduces yield **or** favours LHS (1)

because LHS has smaller volume **or** number of moles/number of molecules (of gas) ORA (1)

(high pressure plant is) expensive/dangerous/explosion/leaks [2]

(b) hydrogen **and** chlorine/H₂ **and** Cl₂ (1)

sodium hydroxide/NaOH/Na⁺OH⁻ (1)

2H⁺ + 2e⁻ → H₂/2H⁺ → H₂ - 2e⁻ (1)

2Cl⁻ → Cl₂ + 2e⁻/2Cl⁻ - 2e⁻ → Cl₂ (1)

Hydrogen/H₂/H/H⁺ at cathode **and** chlorine/chloride/Cl₂/Cl/Cl⁻ at anode (1) [5]

(c) each chlorine 1 bond pair and 3 non-bond pair (1)

oxygen atom 2 non-bond pairs and 2 bond pairs as double bond (1)

carbon atom 4 bond pairs including 2 bond pairs as double bond (1) [3]

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12. 0620_w14_ms_33 Q: 2

(a) (i) (X(s) ↔) X(l) [1]

(ii) melting point/freezing point (of X) [1]

(iii) gas/gaseous or vapour [1]

(iv) not horizontal **or** line slopes **or** line is lower [1]

- (b) (i) 14.3 [1]
- (ii) $85.7 \div 12$ and $14.3 \div 1$ or 7.14 and 14.3 [1]
 ratio 1:2 [1]
 CH_2 [1]
note: Award all 3 marks for correct answer
allow: alternative working e.g.
 $85.7 \times 84 \div 100$ and $14.3 \times 84 \div 100$ or 71.988/72 and 12/12.012 [1]
 6:12 or ratio 1:2 [1]
 CH_2 [1]
- (iii) C_6H_{12} [1]
- [Total: 9]

13.0620_s13_ms_32 Q: 4

- (a) (i) **first reaction**
 volume / moles / molecules of reactants and products are different [1]
- second reaction**
 volume / moles / molecules of reactants and products are the same [1]
- (ii) first reaction (forward) reaction is endothermic [1]
 second reaction (forward) reaction is exothermic [1]
- (b) (i) $\text{C}_8\text{H}_{18} \rightarrow 2\text{C}_4\text{H}_8 + \text{H}_2$ [1]
- (ii) $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ [2]
 or $2\text{H}_3\text{O}^+ + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{H}_2\text{O}$
accept: -2e^- on right hand side accept: e^-
note: not balanced = 1
- (iii) chlorine / Cl_2 / [1]
cond: water treatment / solvents / plastics / PVC / bleach / disinfectants / HCl / kill
 bacteria / sterilising water / chlorination of water / swimming pools / pesticides /
 herbicides / insecticides / germicides / pharmaceuticals [1]
 sodium hydroxide/ NaOH [1]
cond: making soap / degreasing / making paper / detergents / bio-diesel / paint stripper /
 clearing drains / alumina from bauxite / oven cleaner / bleach [1]

14. 0620_w13_ms_31 Q: 3

- (a) (i) fractional distillation [1]
(liquid) air [1]
- (ii) cracking / heat in presence of catalyst [1]
of alkane / petroleum [1]
to give an alkene and hydrogen [1]
- OR:** electrolysis (1)
named electrolyte (1)
hydrogen at cathode (1)
- OR:** from methane (1)
react water / steam (1)
heat catalyst (1)
only **ACCEPT:** water with methane **or** electrolysis
- (b) (i) the pair with both graphs correct is C [1]
NOTE: mark (b)(ii) independent of (b)(i)
- (ii) high pressure favours side with lower volume / fewer moles [1]
this is RHS / product / ammonia [1]
%NH₃ / yield increases as pressure increases [1]
- the forward reaction is exothermic [1]
exothermic reactions favoured by low temperatures [1]
%NH₃ / yield decreases as temperature increases [1]
ACCEPT: reverse arguments
- (iii) increases reaction rate [1]
ACCEPT: reduces activation energy [1]
OR: decreases the amount of energy particles need to react
OR: economic rate at lower temperature so higher yield

[Total: 14]

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