

- 1 (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 =) $151 + 242 = \underline{393}$; [1]
 (bond making =) $208 \times 2 = \underline{-416}$; not: 416 [1]
 (overall =) $393 - 416 = \underline{-23}$; 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]
- 2 (a) rate of forward reaction equals rate of back reaction [1]
 concentrations do not change / macroscopic properties remain constant (with time) [1]
accept: amounts
- (b) (i) increase [1]
 reaction 2 [1]
 $V_r > V_p$ [1]
- (ii) same [1]
 reaction 1 [1]
 $V_r = V_p$ [1]
- (iii) decrease [1]
 reaction 3 [1]
 $V_p > V_r$ [1]
accept: moles of gas / molecules of gas as an alternative to volume

- 3 (a) rates equal [1]
 concentrations do not change / macroscopic properties remain constant [1]
accept amounts do not change
- (b) endothermic [1]
cond favoured by high temperatures [1]
- (c) move to left [1]
cond bigger volume / more moles etc [1]
 do not insist on "gas"
- (ii) less yellow solid / more brown liquid [1]
accept yellow to brown / less solid more liquid / goes brown
- 4 (a) (i) accept all metals excluding Group I (lithium is acceptable) [1]
not lead **accept** silver
- (ii) M nitrite / nitrate(III) [1]
not nitride
- (b) (i) exothermic [1]
not reverse reaction is endothermic as the question asks about the forward reaction
cond forward reaction favoured by low temperature / reverse reaction favoured by high temperature [1]
 second mark only scores if exothermic is correct.
- (ii) position of equilibrium to right / forwards / more products / more N₂O₄ / lighter colour [1]
 because this side has smaller volume / fewer moles [1]
- (c) if the final answer is between 86–89% award all 4
 if the final answer is between 66–67% award 3 marks (M_r of 32 must have been used)
 for all other answers marks can be awarded using the mark scheme as below and applying ecf if necessary
- number of moles of O₂ formed = 0.16/24 = 0.0067/0.00667 or 1/150
 number of moles of Pb(NO₃)₂ in the sample = 0.0133/0.013 or 1/75
 mass of one mole of Pb(NO₃)₂ = 331 g
 mass of lead(II) nitrate in the sample = 4.4(1) g
 percentage of lead(II) nitrate in sample = 88.3% (**allow** 88–89) [4]
- mark **ecf** in this question but **not** to simple integers
 if mass of lead(II) nitrate > 5.00 only marks 1 and 2 available
 If divides by 32 (not 24) only last 3 marks can score consequentially

- 5 (a) (i) (concentration) of reactants/CO and Cl_2 increases [1]
 (concentration) of product decreases/ $COCl_2$ [1]
- (ii) (decrease in pressure favours side) [2]
 with more molecules **or** moles **or** side with bigger volume (of gas)
NB [2] or [0]
- (b) forward reaction is exothermic [1]
COND because it is favoured by low temperatures **or** cool [1]
ACCEPT argument re back reaction
- (c) hydrogen chloride **or** hydrochloric acid [1]
 carbon dioxide **or** carbonic acid **or** hydrogen carbonate [1]
- (d) 8e around both chlorine atoms [1]
 4e between carbon and oxygen atoms [1]
 8e around carbon atom [1]
 8e around oxygen [1]
 if a bond contains a line with no electrons, no marks for atoms joined by that line
 ignore keying

[Total: 12]

- 6 (a)(i) because concentration of $BiCl_3$ decreases [2]
 bismuth chloride used up **ONLY** [1]
- (ii) products are being formed **or** concentration of products [1]
 increases. Concentration mark given either (i) **or** (ii)
- (iii) reaction has come to equilibrium [1]
 rates equal **or** no change in concentration [1]
- (iv) equilibrium to left **or** favours backward reaction **or** [1]
 equilibrium moves to use up hydrochloric acid [1]
 $BiOCl$ used up **or** $BiCl_3$ formed
- (b)(i) No change in volume **or** same number of moles on [1]
 both sides
- (ii) move to right [1]
 Increase in pressure favour side with smaller volume **or** [1]
 smaller number of moles (of gas) **or** moves to side that
 tends to reduce pressure [1]

TOTAL = 10

- 7 (a) (i) no change in concentration of reagents **or** rates equal [1]
 Accept no change in amounts or it is as if the reaction has Stopped
- (ii) back reaction is endothermic **or** the forward reaction is exothermic [1]
 Increase in temperature favours the endothermic reaction which is the back
 reaction or vice versa. [1]
 NB look for correct conclusion re thermicity and comment re position of
 equilibrium.
- (iii) increased rate [1]
 because molecules collide more frequently **or** concentration of molecules is
 increased **or** molecules are closer [1]
NOT they have more KE
 increased yield [1]
 high pressure favours side with few molecules **or** smaller volume **or** moves
 to reduce the pressure [1]
 this is product side this can be implied [1]
- (b) CO₂ and H₂O [1]
 balanced [1]
 $2\text{CH}_3\text{OH} + 3\text{O}_2 = 2\text{CO}_2 + 4\text{H}_2\text{O}$
- (ii) methyl ethanoate [1]
 water [1]
- (iii) Methanoic (acid) accept formic acid [1]

TOTAL = 13