**CH3.5 91391 “Cheat sheet” for learning reactions**

Print pages back to back, cut out the cards and shuffle them. You can use the cards in a number of ways.

**Flash card / recall**

Pick up a card, with black print facing towards you. Name as many reactions that involve that card as a reactant, reagent or product. Then turn over the card to see if you are correct.

**Game challenge**

Share out the cards amongst players. See how many reactions you can make or how many cards you can use up. The one who can make the most reactions / uses the most cards wins. (If playing by yourself, then draw 15 cards)

**Reaction scheme :**

 



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| **RC=CR’** | **RC=CH2** | **1o** **R–X** |
| **2o** **R–X**  | **1o** **R–OH** | **2o** **R–OH** |
| **R–NH2** |  **R’**ӏ**R – NH** | **R–C–H** |

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| **OH-*(alc)*****1o R–X → RC=CH2****Conc NH3****1o R–X → RNH2****R’–NH2****1o R–X → RNH–R’****OH­-*(aq)*****1o R–X → 1o R–OH** **SOCl2****1o R–OH → 1o R–X****HX****RC=CH2 → 1o R–X** |  **H2/Pt****RC=CH2 → RCH2–CH3****HX****RC=CH2 → 1o R–X** (minor)**Conc H2SO4/H2O****RC=CH2 → 1o R–OH** (minor)**Conc H2SO4/H2O****RC=CH2 → 2o R–OH** (major)**Conc H2SO4****1o R–OH → RC=CH2****OH-*(alc)*****1o R–X → RC=CH2**  | **H2/Pt****RC=CR’ → RCH–CHR’****HX****RC=CR’ → 2o R–X****Conc H2SO4/H2O****RC=CR’ → 2o R–OH****Conc H2SO4****2o R–OH → RC=CR’****OH-*(alc)*****2o R–X → RC=CR’** |
| **Conc H2SO4****2o R–OH → RC=CR’****SOCl2****2o R–OH → 2o R–X****R’COOH / conc H2SO4****2o R–OH → R’COOR****H+/Cr2O72- *reflux* OR H+/MnO4-****2o R–OH → RCOR’** **Conc H2SO4/H2O****RC=CH2 → 2o R–OH** (major) **Conc H2SO4/H2O****RC=CR → 2o R–OH** (major)**OH­-*(aq)*****2o R–X → 2o R–OH** **NaBH4****RCOR’ → 2o R–OH**  | **Conc H2SO4****1o R–OH → RC=CH2****SOCl2****1o R–OH → 1o R–X****H+/Cr2O72- *distil*****1o R–OH → RCHO** **R’COOH / conc H2SO4****1o R–OH → R’COOR****H+/Cr2O72- *reflux* OR H+/MnO4-****1o R–OH → RCOOH****Conc H2SO4/H2O****RC=CH2 → 1o R–OH (minor)****OH­-*(aq)*****1o R–X → 1o R–OH** **NaBH4****RCHO → 1o R–OH**  | **OH-*(alc)*****2o R–X → RC=CR’****Conc NH3****2o R–X → R-NH2****OH­-*(aq)*****2o R–X → 2o R–OH** **SOCl2****2o R–OH → 2o R–X****HX****RC=CR’ → 2o R–X** **HX****RC=CH2 → 2o R–X** (major) |
| **H+/Cr2O72- *reflux* OR H+/MnO4-****RCHO → RCOOH****NaBH4****RCHO → 1o R–OH** **H+/Cr2O72- *distil*****1o R–OH → RCHO** **Turns damp red litmus blue** |  **R’–NH2** **R-X → R-NH-R’** **R’X** **R–NH2 → R-NH-R’****H­+*(aq)*****R-NH-R’→ R-NH2+R’****Turns damp red litmus blue** | **Conc NH3****2o R–X → R-NH2****Conc NH3****1o R–X → R-NH2****H­+*(aq)*****R-NH2 → R-NH3+** **Tollen’s; Fehling’s; Benedict’s solution** |

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| **O****ǁ****R–C–R’** |  **R–C–OH** | **R–C–O–** |
|  **R–C–OR’** |  **R–C–Cl** | **R–C–NH2** |
| **R–C–NHR’** | Major product | Minor product |

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| **OH—*(aq)*****RCOOR → RCOO—****(base hydrolysis of esters)****OH—*(aq)*****RCONHR’ → RCOO—****(base hydrolysis of peptide links)****OH—*(aq)*****RCOOH → RCOO—**  | **SOCl2****RCOOH → RCOCl** **H+/Cr2O72- *reflux* OR H+/MnO4-****RCHO → RCOOH****R’OH / conc H2SO4****RCOOH → RCOOR’****H+/Cr2O72- *reflux* OR H+/MnO4-****1o R–OH → RCOOH****H2O****RCOCl → RCOOH** **OH—*(aq)*****RCOOH → RCOO—** **H+*(aq)*****R’COOR → RCOOH**  | **NaBH4****RCOR’ → 2o R–OH** **H+/Cr2O72- *reflux* OR H+/MnO4-****2o R–OH → RCOR’**  |
| **OH—*(aq)*****RCONH2 → RCOO—****(base hydrolysis of amides)****Conc NH3*(alc)*****ROCl → R’CONH2** | **SOCl2****RCOOH → RCOCl****R’OH** **RCOCl → RCOOR’****Conc NH3*(alc)*****ROCl → R’CONH2** **R’NH2*(alc)*****ROCl → R’CONHR’****H2O****RCOCl → RCOOH** | **OH—*(aq)*****RCOOR → RCOO—****(base hydrolysis of esters)****R’OH / conc H2SO4****RCOOH → RCOOR’****R’COOH / conc H2SO4****ROH → R’COOR****R’OH****RCOCl → RCOOR’** |
| **Elimination****Sayseff’s rule**: The hydrogen is removed from the C atom with the least number of H atoms (so minor product is the other way).**Addition**Markovnikov’s rule: The hydrogen is removed from the C atom with the least number of H atoms. (so minor product is the other way) | **Elimination****Sayseff’s rule**: The hydrogen is removed from the C atom with the least number of H atoms.**Addition**Markovnikov’s rule: The hydrogen is removed from the C atom with the least number of H atoms. | **OH—*(aq)*****RCONHR’ → RCOO—****(base hydrolysis of peptide links)****R’NH2*(alc)*****RCOCl → R’CONHR’** |

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| **HX****HCl or HBr** | **SOCl2** | **conc H2SO4** |
| **OH–*(alc)*****NaOH or KOH** | **OH–*(aq)*****NaOH or KOH** | **conc NH3 *(alc)*** |
| **H2O** | **H3O+** | **H+ / MnO4–** |

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| **R’COOH / conc H2SO4****R–OH → R’COOR****R’OH / conc H2SO4****RCOOH → RCOOR’****Conc H2SO4/H2O****RC=CH2 → 1o R–OH (minor)****Conc H2SO4/H2O****RC=CH2 → 2o R–OH (major)****Conc H2SO4/H2O****RC=CR’ → 2o R–OH**  | **SOCl2****RCOOH → RCOCl****SOCl2****1o ROH → 1o R–X****(chloride added)****SOCl2****2o ROH → 2o R–X****(chloride added)** | **H­+*(aq)*****R-NH2 → R-NH3+****HX****RC=CH2 → 1o R–X****H+*(aq)*****R’COOR → RCOOH** **H+*(aq)*****RCOOR → RCOO—****(acid hydrolysis of esters)** |
| **Conc NH3*(alc)*****R–X → R–NH2****Conc NH3*(alc)*****ROCl → R’CONH2** | **OH­-*(aq)*****1o R–X → 1o R–OH****OH­-*(aq)*****2o R–X → 2o R–OH** **OH—*(aq)*****RCONHR’ → RCOO—****(base hydrolysis of peptide links)****OH—*(aq)*****RCOOR → RCOO—****(base hydrolysis of esters)****OH—*(aq)*****RCOOH → RCOO—**  | **OH-*(alc)*****1o R–X → RC=CH2****OH-*(alc)*****2o R–X → RC=CR’** |
| **H+ / MnO4– *(reflux.)*****1o R–OH → RCOOH** **H+ / MnO4– *(reflux.)*****2o R–OH → RCOR’****H+ / MnO4– *(reflux.)*****RC=CR’ → RC(OH) –C(OH)R’****Colour change from purple MnO4- to colourless Mn2+** (turns to brown MnO2 if no H+ is present) | **H3O+****RCOOR’ → RCOOH****H­+*(aq)*****R-NH2 → R-NH3+****Acid hydrolysis of condensation polymers** | **H2O****RCOCl → RCOOH** **Conc H2SO4 / H2O****RC=CH2 → 2o R–OH** (major)**Good starting point when trying to identify unknown liquids** (does it dissolve in water?) |

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| **H+ / Cr2O72–*****distil.*** | **H+ / Cr2O72–*****reflux*** | **NaBH4** |
| ***Tollen’s******Reagent*** | ***Benedict’s******Reagent*** | ***Fehling’s******Reagent*** |
| **Br2*(aq)*** | **1o ROH** ***(as reagent)*** | **1o RNH2** ***(as reagent)*** |

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|  **NaBH4****RCHO → 1o R–OH**  **NaBH4****RCOR’ → 2o R–OH**  | **H+ / Cr2O72– *(reflux.)*****1o R–OH → RCOOH** **H+ / Cr2O72– *(reflux.)*****2o R–OH → RCOR’** **Colour change from orange Cr2O72- to green Cr3+ test for 1o and 2o ROH and RCHO** | **H+ / Cr2O72– *(distil.)*****1o R–OH → RCHO****Colour change from green Cr2O72- to green Cr3+ test for 1o and 2o ROH** |
| **Colour change test for RCHO****Fehling’s reagent**Blue CuSO4 solution (with citrate and carbonate) is reduced to brick red Cu+ solidAldehyde oxidised to carboxylic acid | **Colour change test for RCHO****Benedict’s reagent**Blue Cu2+ solution (with tartrate and NaOH) is reduced to brick red Cu+ solidAldehyde oxidised to carboxylic acid | **Colour change test for RCHO****Silver mirror test**Ag+ in warmed ammonia solution is reduced to Ag (silver mirror or grey deposit).Aldehyde oxidised to carboxylic acid |
| **R’–NH2****1o R–X → RNH–R’** **R’NH2*(alc)*****ROCl → R’CONHR’** | **R’OH / conc H2SO4****RCOOH → RCOOR’****R’OH** **RCOCl → RCOOR’** | **Colour change test for C=C****Bromine water**Yellow / orange-brown bromine water rapidly goes colourless in presence of alkene as colourless dibromoalkane is formed(Note: other organic compounds react much more slowly) |