1 The Chemical Revolution
2 What is matter and how is it changed?
3 Changing Matter
   • Quicklime + Water + Breath       Chalk + Water
   • CaO + H₂O + CO₂    CaCO₃ + H₂O
   • The key to change is language -- devising names to give to things
4 The Roots of Modern Chemistry
   • Chemistry not a part of natural philosophy, but rooted more in practical matters
5 Practical Arts
   • Mining, metallurgy, assaying
   • Manufactures: glass, soap, salt, gunpowder
6 Alchemy
   • Very different from chemistry
     – The questions are different
     – The goals are different
     – The organizing principles are different
   • Legacy of dealing with the transformations of matter
   • Some instruments and techniques: distillation, purification, etc.
7 Iatrochemistry
   • medical chemistry
   • Paracelsus
     – Challenged authorities
     – Encouraged seeking out new materials & chemicals
8 Chemistry formalized
9 The Scientific Revolution
   • Mechanical philosophy
   • Robert Boyle
     – Boyle’s Law (for gases)
10 Boyle on Air
11 The Eighteenth Century
   • Key Problems of Matter:
     – What is “air?”
     – What is “fire” or “heat?”
12 Air
• Subject of experiments through the 18th century
• "Gas Sylvestre" [CO2]--Van Helmont

13 “Vegetable Staticks”-- Stephen Hales
• Invents the pneumatic trough for collecting the products of reactions

14 Joseph Black
• Fixed Air [CO2]
  – From heating "Magnesia Alba" [MgCO3]
  – Also from Chalk (limestone)
  – Fixed air added to lime [CaO] produces chalk [CaCO3]

15 Henry Cavendish
• Inflammable Air [H2]

16 Joseph Priestley
• Nitrous air (H2NO3)
• Further discoveries:
  – CO, SO2, HCl, NH3--Priestley
• “Dephlogisticated” Air
  – From heating the “Red Calx of Mercury” [mercuric oxide] with a lens (and not a flame) “Even purer than common air”

17 Heat
• Originally the element “Fire”
• Johann Becher--17th century speculations
• Georg Ernst Stahl
  – “Phlogiston” -- liberated in burning

18 Phlogiston
• Charcoal phlogiston + ashes
• Metal phlogiston + calx

19 Antoine Laurent Lavoisier
• Sought to synthesize discoveries of gases and observations about heat
• Believed heat came from substances combining, not separating
• But what?

20

21 Oxygen Theory of Combustion
• Metal + oxygen Calx (or “oxide”)
• Respiration--a form of combustion

22 Lavoisier and the Chemical Revolution
• Language & Method
• Nomenclature chimique [Chemical Nomenclature] (1787)
• Traité elementaire de chimie [Elements of Chemistry] (1789)

23 Chemical combination
• Do specific chemicals combine only in specific proportions, or can they combine in any proportions?
  – Indefinite proportions (Berthollet)
  – Definite proportions (Proust)

24 Constant proportions:
• If 10g of A combine with 10g of B
• AND 20g of C combine with 10g of B
• THEN 20g of C will combine with 10g of A

25 Atomic Theory
• John Dalton
• Idea of “Atomic weights”

27 Question:
• Why does language make such a difference in chemistry?