FACTORS AFFECTING RATE OF REACTION

1. Chemical Nature of the Reactants

- How fast a reaction will proceed will depend on the reactants': state, bond strengths, the amount and types of bonds that must be broken and rearranged and the mechanism of the reaction (what has to react with what and in what sequence)
- Reactions involving electron transfer are very fast since no bonds are being broken/made
- Homogeneous reactions (all reactants in the same phase) are faster than their heterogenous counterparts since these reactants can only react at their surface where they come in contact with other reactants

  - Cr^{+2}(**aq**) + Fe^{+3}(**aq**) → Cr^{+3}(aq) + Fe^{+2}(aq)
    - Homogeneous; no bonds broken
  - $3Fe^{+2}$(**aq**) + NO_3^{-1}(**aq**) + $4H^{+1}$(**aq**) → $3Fe^{+3}$(aq) + NO_2(g) + $2H_2O$(g)
    - homogeneous; some bonds broken/made
  - $2C_8H_{18}$(**aq**) + $25O_2$(**g**) → $16CO_2$(g) + $18H_2O$(l)
    - heterogeneous; lots of bonds broken/made

2. Concentration

- Reaction rate increases as the initial concentration of any/all reactants increases
- To increase the concentration:
  i. Add more material (not for solids)
  ii. Decrease the volume of a solution or gas
  iii. Increase the pressure of the gas

3. Temperature

- Increasing the temperature increases the average speed of the molecules and will increase the rate of reaction
- A rise of 10°C, often doubles the rate of a chemical reaction

4. Presence of a Catalyst

- The chemical composition and amount of a catalyst are identical at the start and at the end of a chemical reaction
- Most catalysts will increase the rate of reaction by a fair amount
- Enzymes are biological catalysts

5. Surface Area

- When a reaction is heterogeneous, the reaction occurs only at the surface where the reactants come in contact
- The amount of exposed surface area where the reactants are in contact affects the rate of reaction
- By increasing the surface area, there are more spots "to react" and the rate will increase

Answer:

1. Which of the 5 factors that affect the rate of reaction applies only to heterogeneous systems? Give an example of such a system.

2. What would happen to the rate of reaction if the temperature were raised from 20°C to 40°C? Explain qualitatively and make a quantitative prediction.

3. A match can be applied to a lump of coal with little effect. However, the ignition of coal dust has caused many fatal mining explosions. Explain.

4. In each of the following examples, identify the factor that affects the rate of the reaction described:
    a. Gold and copper are both used in jewellery, but copper bracelets will turn green over time.
    b. Milk kept in the refrigerator will keep for a week or more, but milk left out on the counter will quickly sour.
    c. Papain is a food additive that is sometimes added to meat to make it more tender.
    d. The dust in grain silos has been known to explode whereas kernels of grain are almost non-flammable.
    e. Vinegar is safe to add to food and consume, but pure acetic acid will burn skin on contact.