RLP-PSA · RLP Physical Science A — Matter, Bonding, Reactions and the Nucleus

Unit 4: Reaction Rates, Equilibrium and the Nucleus

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 4.1 — The Cold Chain: Why Cold Keeps Produce Fresh

FLUENCY

1. Name the three conditions a collision must meet for particles to react.

2. State the effect on reaction rate (faster or slower) of: raising temperature, lowering concentration, grinding a solid into powder, adding a catalyst.

3. A 1 cm cube has what surface area? What is the total surface area of eight such cubes?

4. Does a catalyst get used up in a reaction? What does it change?

5. Using the rule of thumb that rate roughly doubles for every 10 °C rise, by about what factor does the rate change from 25 °C to 5 °C?

APPLICATION

6. A 3 cm cube of potato is cut into 1 cm cubes. How many cubes result, and how does the total surface area change? Explain what this means for how fast the pieces cook or brown.

7. By the rule of thumb (an approximation), lettuce that keeps 2 days at 20 °C would keep about how long at 0 °C? Say why the real answer might differ.

8. Explain why a sealed storage room full of ripening pears can ripen faster than a ventilated one, using concentration.

CHALLENGE

9. Explain why raising the temperature from 20 °C to 30 °C can double a reaction's rate even though the average particle speed rises only a few percent.

REVIEW

10. For the balanced reaction $2Mg + O_2 \rightarrow 2MgO$, what mass of MgO forms from 50.0 g of Mg, assuming Mg is the limiting reactant?

11. Find the molar mass of H_2O.

Lesson 4.2 — Racing Antacid Tablets

FLUENCY

1. A tablet takes 50 s to react. What is its relative rate (100 ÷ time)?

2. A tablet reacts in 25 s in one trial and 50 s in another. How many times faster was the first?

3. In the temperature experiment, name the independent variable, the dependent variable and three controlled variables.

4. Which graph type suits temperature against rate, and which suits whole, quartered and crushed against rate?

5. Two trials at 20 °C took 46 s and 50 s. What is the average time?

APPLICATION

6. Illustrative averages from several at-home runs: 5 °C, 88 s; 20 °C, 45 s; 40 °C, 22 s. Calculate each relative rate and the ratio of the 40 °C rate to the 5 °C rate. Does it roughly fit 'doubles every 10 °C'?

7. At room temperature a whole tablet took 45 s and a crushed tablet 12 s. How many times faster was the crushed tablet, and why?

8. A student's times were consistently 10 s longer than the recorded runs in the reading at every temperature. Suggest a likely cause and explain why the student's trend is still useful evidence.

CHALLENGE

9. Design a better measurement of rate for this reaction than 'time until fizzing stops,' using only inexpensive equipment. Explain why it is better.

REVIEW

10. How many moles are in 180.0 g of O_2?

11. Estimate the energy change for $2H_2 + O_2 \rightarrow 2H_2O$ using H–H 436, O=O 498 and O–H 464 kJ/mol.

Lesson 4.3 — Shifting Equilibrium: Soda Fizz and Fertilizer

FLUENCY

1. At dynamic equilibrium, have the forward and reverse reactions stopped?

2. Count the gas molecules on each side of $N_2 + 3H_2 \rightleftharpoons 2NH_3$.

3. The forward reaction $N_2 + 3H_2 \rightarrow 2NH_3$ releases 92 kJ. Does raising the temperature favor ammonia or nitrogen and hydrogen at equilibrium?

4. Why does a warm bottle of soda fizz more when opened than a cold one?

5. Does a catalyst change the amount of product at equilibrium?

APPLICATION

6. For $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, an exothermic reaction used to make sulfuric acid, predict the effect on the amount of SO_3 of (a) raising pressure, (b) raising temperature, (c) removing SO_3.

7. A student writes: 'Ammonia plants use a catalyst so that more ammonia is present at equilibrium.' Evaluate the claim and rewrite it correctly.

8. Explain the temperature trade-off in ammonia synthesis using both equilibrium and rate reasoning.

CHALLENGE

9. Cold drinks go flat more slowly than warm ones, and a re-capped half-empty bottle still loses some fizz each time it is opened. Use equilibrium to explain both observations.

REVIEW

10. For the balanced reaction $CaCO_3 \rightarrow CaO + CO_2$, what mass of CO_2 forms from 50.0 g of $CaCO_3$, assuming $CaCO_3$ is the limiting reactant?

11. Balance: $N_2 + H_2 \rightarrow NH_3$

Lesson 4.4 — Inside the Nucleus: Decay, Fission and Fusion

FLUENCY

1. An isotope has a half-life of 50 days. How long until only 1/8 of the original sample remains?

2. A sample starts with 80 g of an isotope whose half-life is 30 years. How much remains after 90.0 years?

3. A wood sample has 25% of the carbon-14 of living wood. Using a half-life of 5,730 years, estimate its age.

4. A sample starts with 640 g of an isotope whose half-life is 8 years. How much remains after 24.0 years?

5. Complete: uranium-238 → thorium-234 + _____

6. Carbon-14 undergoes beta decay. What element and mass number does it become?

7. Does gamma emission change the element? Why or why not?

APPLICATION

8. Check that the fission uranium-235 + neutron → barium-141 + krypton-92 + 3 neutrons is balanced for mass number and for protons (U 92, Ba 56, Kr 36).

9. A hospital receives 200 mg of cobalt-60 (half-life 5.27 years). How much remains after 15.81 years?

10. One fission releases about 200 MeV; a typical chemical reaction releases about 4 eV per molecule. About how many times more energy is released per event in fission? Use this to explain why a nuclear plant needs so little fuel compared with a coal plant.

CHALLENGE

11. In the coin model, one run started with 100 coins and had 52, 27, 11, 6 and 2 left after five shakes. Compare with the ideal halving and explain why the average of 10 such runs gives results closer to the ideal.

REVIEW

12. What is the mass of 0.5 mol of H_2O?

13. Raising the pressure on $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (all gases) shifts the equilibrium which way?

Unit 4 checkpoint

1. Which change will NOT speed up the antacid reaction?
   A. Warmer water
   B. Crushing the tablet
   C. Colder water
   D. Stirring
2. The main reason a higher temperature speeds a reaction is that
   A. particles get heavier
   B. more collisions have at least the activation energy
   C. the activation energy disappears
   D. the products become less stable
3. A tablet that reacts in 20 s has a relative rate (100 ÷ time) of _____.
4. True or false: Cutting a solid into smaller pieces increases its surface area and speeds its reaction.
5. At dynamic equilibrium,
   A. all reactions have stopped
   B. forward and reverse rates are equal
   C. only products are present
   D. the temperature is zero
6. For N₂ + 3H₂ ⇌ 2NH₃ (exothermic), which change increases the amount of NH₃ at equilibrium?
   A. Raise the temperature
   B. Lower the pressure
   C. Raise the pressure
   D. Add a catalyst
7. True or false: A catalyst increases the amount of product at equilibrium.
8. Uranium-238 emits an alpha particle. The new nucleus is
   A. uranium-234
   B. thorium-234
   C. protactinium-238
   D. plutonium-242
9. Iodine-131 has a half-life of about 8 days. After 24 days, _____ of the original sample remains (as a fraction).

10. Which process powers the Sun?
    A. Fission of uranium
    B. Fusion of hydrogen into helium
    C. Burning of hydrogen with oxygen
    D. Radioactive decay of carbon-14
11. True or false: Fission of one uranium nucleus releases millions of times more energy than a typical chemical reaction of one molecule.
12. Ammonia plants run at a moderate temperature with a catalyst because
    A. this maximizes the equilibrium yield
    B. it balances a reasonable yield with a fast enough rate
    C. the catalyst only works when hot
    D. low temperatures are illegal

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