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2.5-111

^{19}F is the only naturally occurring isotope of fluorine. On the other hand, naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . Mass spectrometry will give how many peaks for CF_4 ?

- (a) 2 (b) 3 (c) 4 (d) 5

2.5-112

^{19}F is the only naturally occurring isotope of fluorine. On the other hand, naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In the mass spectrum of CF_4 , the ratio of the intensity of the peak for the heavier mass to the intensity of the peak for lighter mass will be

(a) $98.89 / 1.11$

(b) $1.11 / 98.89$

2.5-121

^{19}F is the only naturally occurring isotope of fluorine. On the other hand, naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . Mass spectrometry will give how many peaks for C_2F_6 ?

- (a) 2 (b) 3 (c) 4 (d) 5

2.5-122

^{19}F is the only naturally occurring isotope of fluorine. On the other hand, naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In the mass spectrum of C_2F_6 , the peak with intensity equal to the fraction

$$(0.011)^2$$

of the combined intensity of all the MS peaks will correspond to a mass (in u) of

- (a) 138 (b) 139 (c) 140

2.5-123

^{19}F is the only naturally occurring isotope of fluorine. On the other hand, naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In the mass spectrum of C_2F_6 , the ratio of the intensity of the smallest peak to the intensity of the largest peak

(a) $(1.11 / 98.89)$

(b) $2 * (1.11 / 98.89)$

(c) $(1.11 / 98.89)^2$

(d) $2 * (1.11 / 98.89)^2$

2.5-131

Naturally occurring chlorine comprises 75.53% ^{35}Cl and 24.47% ^{37}Cl , while naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . Mass spectrometry will give how many peaks for CCl_4 ?

- (a) 5 (b) 8 (c) 10 (d) 25

2.5-132

Naturally occurring chlorine comprises 75.53% ^{35}Cl and 24.47% ^{37}Cl , while naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In mass spectrum of CCl_4 , the intensity of the peak for the heaviest mass (161 u) will be what fraction of the combined intensity of all the peaks ?

- (a) $0.9889 (0.7553)^4$ (b) $0.9889 (0.2447)^4$
(c) $0.0111 (0.7553)^4$ (d) $0.0111 (0.2447)^4$

2.5-133

Naturally occurring chlorine comprises 75.53% ^{35}Cl and 24.47% ^{37}Cl , while naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In mass spectrum of CCl_4 , the peak with intensity equal to the fraction

$$0.9889 [4 (0.7553)^3 (0.2447)]$$

of the combined intensity of all the peaks will correspond to a mass (in u) of

- (a) 153 (b) 154 (c) 159 (d) 160

2.5-134

Naturally occurring chlorine comprises 75.53% ^{35}Cl and 24.47% ^{37}Cl , while naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In mass spectrum of CCl_4 , the peak with intensity equal to the fraction

$$0.0111 [6 (0.7553)^2 (0.2447)^2]$$

of the combined intensity of all the peaks will correspond to a mass (in u) of

- (a) 156 (b) 157 (c) 158 (d) 159

2.5-135

Naturally occurring chlorine comprises 75.53% ^{35}Cl and 24.47% ^{37}Cl , while naturally occurring carbon comprises 98.89% ^{12}C and 1.11% ^{13}C . In the mass spectrum of CCl_4 , the intensity of the peak for the third to heaviest mass will be what fraction of the combined intensity of all the peaks ?

- (a) 0.0111 [4 (0.7553) (0.2447)³]
- (b) 0.0111 [4 (0.7553)³ (0.2447)]
- (c) 0.9889 [4 (0.7553)³ (0.2447)]
- (d) 0.9889 [4 (0.7553) (0.2447)³]

2.5-140

Naturally occurring magnesium comprises 78.70% ${}_{12}^{24}\text{Mg}$, 10.13% ${}_{12}^{25}\text{Mg}$, and 11.17% ${}_{12}^{26}\text{Mg}$. The average atomic mass (in u) for magnesium is

(a) $(78.70 * 24) + (10.13 * 25) + (11.17 * 26)$

(b) $(78.70 * 36) + (10.13 * 37) + (11.17 * 38)$

(c) $(0.7870 * 24) + (0.1013 * 25) + (0.1117 * 26)$

(d) $(0.7870 * 36) + (0.1013 * 37) + (0.1117 * 38)$

2.5-150

Boron has two naturally occurring isotopes, ^{10}B and ^{11}B . The average atomic mass of boron is 10.811. Solving which equation will give the fractional abundance, f , of the heavier isotope?

(a) $f * 10 + (1-f) * 11 = 10.811$

(b) $(1-f) * 10 + f * 11 = 10.811$

(c) $f * 10 + (100-f) * 11 = 10.811$

(d) $(100-f) * 10 + f * 11 = 10.811$

2.5-210

Which of the following contains the largest number of molecules ?

- (a) 1 g of NH_3 (b) 1 g of HF
(c) 1 g of H_2O (d) 1 g of CH_4

2.5-220

Under standard conditions, water has a density of 1.0 gm/ml. How many moles of water are in a liter of water under standard conditions?

(a) $1000 / 18$

(b) $100 / 18$

(c) $1000 * 18$

(d) $100 * 18$

2.5-230

Benzene (C_6H_6) is a liquid with density 0.8765 g/ml. If 2 moles of benzene are wanted, the volume of benzene required is

- (a) $(2 * 78) (0.8765) \text{ ml}$
- (b) $(2 * 78) (1 / 0.8765) \text{ ml}$
- (c) $2 (1 / 0.8765) \text{ ml}$
- (d) $78 (1 / 0.8765) \text{ ml}$

2.5-241

Ferrocene has the molecular formula $\text{Fe}(\text{C}_5\text{H}_5)_2$. The molecular mass (in u) is

- (a) $55.847 + 5 * (1.0079 + 12.011)$
- (b) $55.847 + 2 * (1.0079 + 12.011)$
- (c) $55.847 + 10 * (1.0079 + 12.011)$

2.5-242

Ferrocene $\text{Fe}(\text{C}_5\text{H}_5)_2$ has a molecular mass of 186.04 u. The mass % iron in ferrocene is

(a) $(1 / 21)$

(b) $(1 / 21) * 100$

(c) $(55.847 / 186.04)$

(d) $(55.847 / 186.04) * 100$

2.5-250

A sample of CaCO_3 contains 20 g of calcium.
How much oxygen does it contain?

(a) 8 g

(b) 60 g

(c) 48 g

(d) 24 g

2.5-260

What is the empirical formula of a substance with a composition by mass of 6/15 carbon, 1/15 hydrogen and 8/15 oxygen ?

- (a) C_6HO_8 (b) CH_2O (c) $C_2H_4O_2$

2.5-270

What is the empirical formula of a substance with a composition by mass of 26.1% carbon, 4.3% hydrogen and 69.6% oxygen ?

- (a) $\text{C}_3\text{H}_8\text{O}_2$ (b) CH_2O_2 (c) $\text{C}_2\text{H}_4\text{O}$

2.5-280

To ascertain the molecular formula of a compound, given the empirical formula, it is necessary to determine

- (a) the molar mass of the compound
- (b) the exact number of any one kind of atom in the molecule
- (c) either of the above
- (d) both of the above

2.5-290

A substance with empirical formula CH_2O is found to have a molecular mass of 180 u. The molecular formula for this compound is

- (a) $\text{C}_5\text{H}_{10}\text{O}_5$ (b) $\text{C}_6\text{H}_{10}\text{O}_7$
(c) $\text{C}_6\text{H}_{12}\text{O}_6$ (d) $\text{C}_7\text{H}_{14}\text{O}_7$

2.5-310

An alkali metal is burned in hydrogen to form a powder with the following results:

initial hydrogen	1.0 g
initial metal	30.0 g
final powder	24.0 g
left over	metal only

The mass of left over metal is

- | | |
|------------|------------|
| (a) 29.0 g | (b) 7.0 g |
| (c) 6.0 g | (d) 23.0 g |

The mass ratio of metal to hydrogen in the powder is

- (a) 23 (b) 24 (c) 29 (d) 30

What is the alkali metal?

- (a) Li (b) Na (c) K (d) Rb

2.5-320

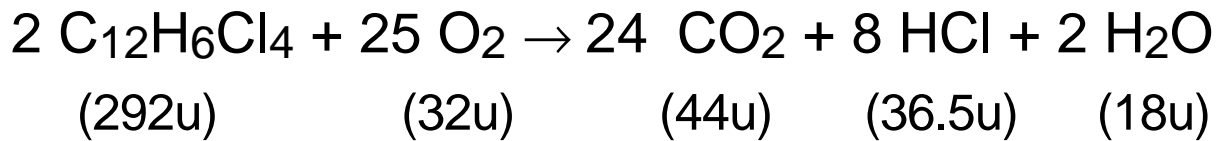
Element X reacts with oxygen to produce a pure sample of X_2O_3 . In an experiment it is found that 1.0000g of X produces 1.1596 g of X_2O_3 . The atomic weight of X is

- | | |
|-----------|-----------|
| (a) 20.70 | (b) 66.85 |
| (c) 100.2 | (d) 150.4 |

2.5-420

Incineration of chlorinated organic compounds produces toxins such as dioxins and furans. An alternative is uranium oxide catalyzed breakdown into CO₂ and HCl.

For example, for a polychlorinated biphenyl,

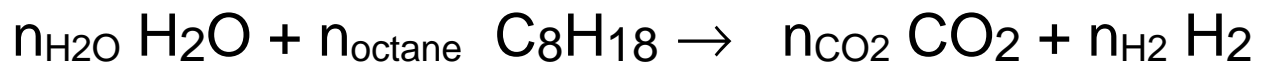


The amount of HCl that is recovered from the breakdown of $3 \times 292 = 876$ kg of C₁₂H₆Cl₄ is

- (a) 4×876 kg (b) 8×36.5 kg
(c) 8×876 kg (d) 12×36.5 kg

2.5-441

In the anaerobic first stage of a catalytic converter, unburned fuel reacts with water to generate H_2 , which then reduces nitrogen oxides. With octane as a representative fuel, the equation for the first reaction is



If $n_{\text{octane}} = 1$,

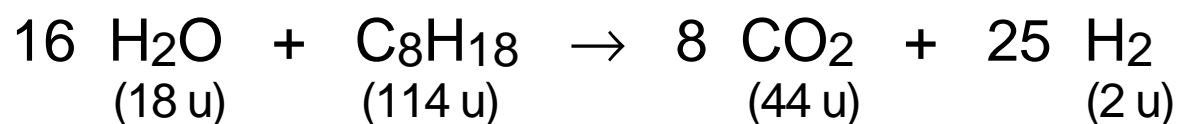
$$n_{CO_2} = \quad (a) \ 1 \quad (b) \ 4 \quad (c) \ 8 \quad (d) \ 9$$

$$n_{H_2O} = \quad (a) \ 1 \quad (b) \ 2 \quad (c) \ 9 \quad (d) \ 16$$

$$n_{H_2} = \quad (a) \ 9 \quad (b) \ 10 \quad (c) \ 17 \quad (d) \ 25$$

2.5-442

In the anaerobic first stage of a catalytic converter, unburned fuel reacts with water to generate H₂, which then reduces nitrogen oxides. With octane as a representative fuel, the equation for the first reaction is

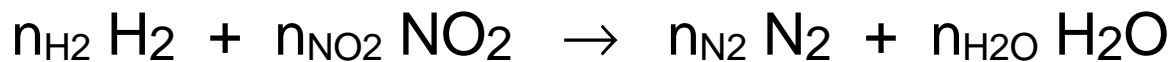


How many grams of unburned octane is required to produce 100 g of hydrogen ?

- (a) 4 (b) 114 (c) 228 (d) 5200

2.5-443

In the anaerobic first stage of a catalytic converter, unburned fuel reacts with water to generate H_2 , which then reduces nitrogen oxides. With NO_2 as a representative nitrogen oxide, the equation for reduction by H_2 is



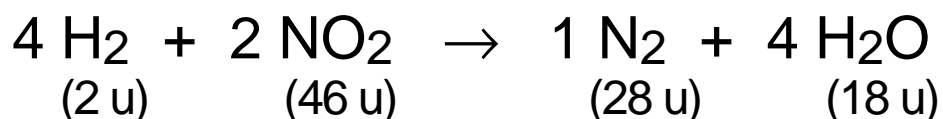
$$n_{N_2} / n_{NO_2} = \quad (a) \ 1 \quad (b) \ 1/2 \quad (c) \ 2$$

$$n_{H_2O} / n_{NO_2} = \quad (a) \ 1 \quad (b) \ 1/2 \quad (c) \ 2$$

$$n_{H_2} / n_{H_2O} = \quad (a) \ 1 \quad (b) \ 1/2 \quad (c) \ 2$$

2.5-444

In the anaerobic first stage of a catalytic converter, unburned fuel reacts with water to generate H₂, which then reduces nitrogen oxides. With NO₂ as a representative nitrogen oxide, the equation for reduction by H₂ is

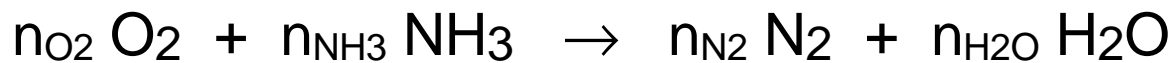


How many grams of hydrogen are required to reduce 100 grams of NO₂ ?

- (a) 100 (8/92) (b) 100 (4/2) (d) 100 (2/46)

2.5-445

Excess hydrogen (due to excess unburned fuel) will reduce nitrogen oxides to ammonia, instead of dinitrogen, in the first stage of a catalytic converter. In the second stage, air is allowed in and the ammonia is oxidized to nitrogen according to the equation



$$n_{\text{NH}_3} / n_{\text{N}_2} = \quad (\text{a}) \quad 1 \quad (\text{b}) \quad 1/2 \quad (\text{c}) \quad 2$$

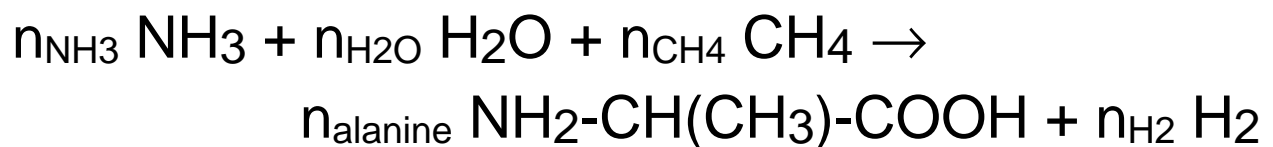
$$n_{\text{H}_2\text{O}} / n_{\text{O}_2} = \quad (\text{a}) \quad 1 \quad (\text{b}) \quad 1/2 \quad (\text{c}) \quad 2$$

$$n_{\text{NH}_3} / n_{\text{H}_2\text{O}} = \quad (\text{a}) \quad 1 \quad (\text{b}) \quad 3/2 \quad (\text{c}) \quad 2/3$$

2.5-460

Electrical discharges through a "primordial" gas mixture of ammonia (NH₃), methane (CH₄) and water (H₂O) produce a wide variety of complex molecules. Among the products is the α -amino acid alanine [NH₂-CH(CH₃)-COOH] and the α -hydroxy acid glycolic acid [OH-CH(CH₃)-COOH].

In the formation of alanine



$$n_{\text{NH}_3}/n_{\text{alanine}} = \text{(a) } 1/2 \quad \text{(b) } 1 \quad \text{(c) } 2 \quad \text{(d) } 3$$

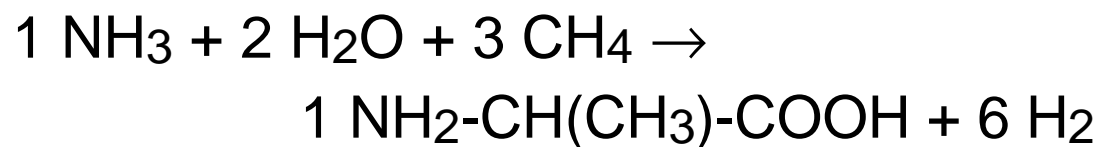
$$n_{\text{H}_2\text{O}}/n_{\text{alanine}} = \text{(a) } 1/2 \quad \text{(b) } 1 \quad \text{(c) } 2 \quad \text{(d) } 3$$

$$n_{\text{CH}_4}/n_{\text{alanine}} = \text{(a) } 1/2 \quad \text{(b) } 1 \quad \text{(c) } 2 \quad \text{(d) } 3$$

$$n_{\text{H}_2}/n_{\text{alanine}} = \text{(a) } 4 \quad \text{(b) } 6 \quad \text{(c) } 8 \quad \text{(d) } 10$$

2.5-531

The following reaction takes place in an electrical discharge reaction vessel

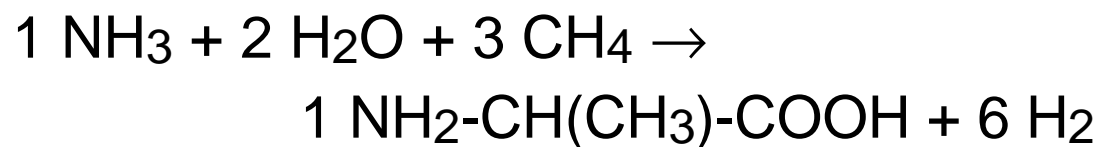


When the extent of reaction is 0.2 moles, the number of moles of H₂O that has been consumed is

- (a) 0.1 (b) 0.2 (c) 0.4 (d) 0.6

2.5-532

The following reaction takes place in an electrical discharge reaction vessel

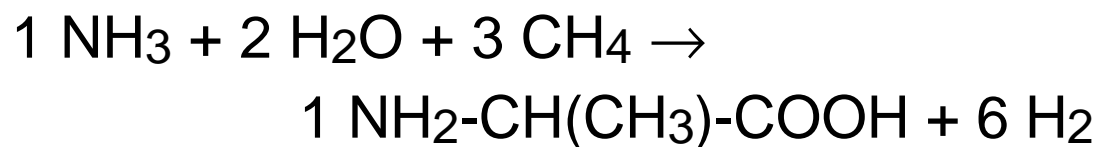


When the 3.6 moles, of H_2 has been produced, the extent of reaction in moles is

- (a) 0.1 (b) 0.6 (c) 1.2 (d) 4.2

2.5-533

The following reaction takes place in an electrical discharge reaction vessel



If 0.3 moles of each of the three gaseous reactants are introduced, the maximum extent of reaction in moles is

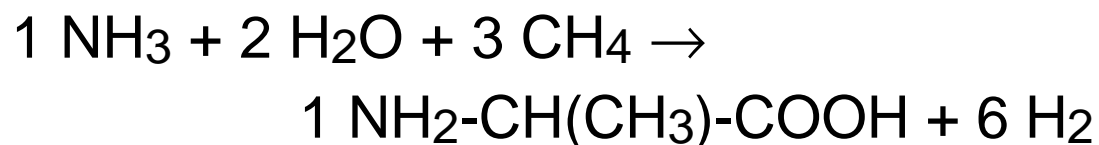
- (a) 0.1 (b) 0.15 (c) 0.2 (d) 0.3

The limiting reagent in this case is

- (a) NH_3 (b) H_2O (c) CH_4

2.5-534

The following reaction takes place in an electrical discharge reaction vessel



If 0.1 moles of NH_3 , 0.3 moles of H_2O , and 0.45 moles of CH_4 are introduced, the maximum extent of reaction in moles is

- (a) 0.1 (b) 0.15 (c) 0.3 (d) 0.45

The limiting reagent in this case is

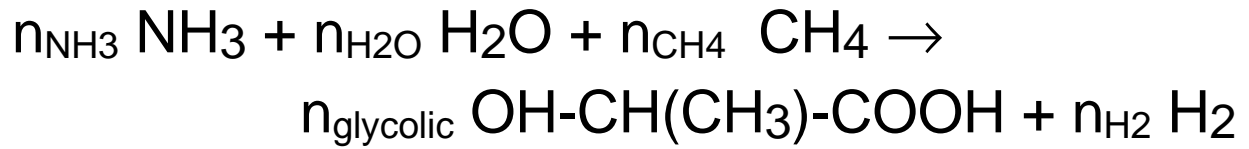
- (a) NH_3 (b) H_2O (c) CH_4

The excess moles CH_4 remaining is

- (a) 0.15 (b) 0.25 (c) 0.3 (d) 0.35

2.5-541

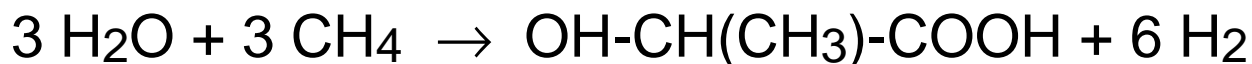
In the formation of glycolic acid



$$n_{\text{H}_2}/n_{\text{glycolic}} = \quad (\text{a}) \ 5 \quad (\text{b}) \ 6 \quad (\text{c}) \ 11 \quad (\text{d}) \ 13$$

2.5-542

In the formation of glycolic acid



if there are initially 10 moles of H_2O and 11 moles of CH_4 , the maximum extent of reaction is

(a) $10/3$

(b) $11/3$

If this produces 1 mole of glycolic acid, the yield is

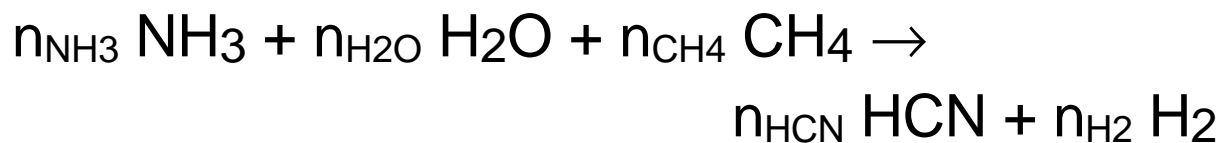
(a) 60 %

(b) 30%

(c) 100 %

2.5-551

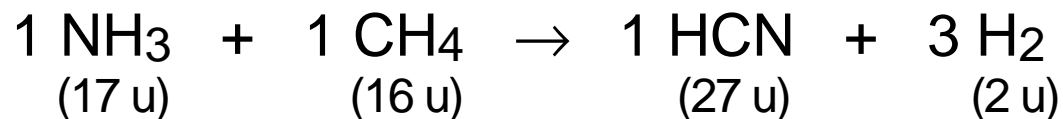
Sparking a mixture of ammonia (NH₃), methane (CH₄) and water (H₂O) also produces hydrogen cyanide (HCN) which can polymerize to form a variety of important molecules (including the nucleotide adenine which occurs in RNA and DNA). In the reaction for forming HCN



$$n_{\text{H}_2}/n_{\text{HCN}} = \quad (\text{a}) \quad 1 \quad (\text{b}) \quad 2 \quad (\text{c}) \quad 3 \quad (\text{d}) \quad 4$$

2.5-552

In the reaction for forming HCN



if there are 34 g of NH₃ and 40 g of CH₄, the maximum extent of reaction in moles is

- (a) 2 (b) 2.5 (c) 34 (d) 40

The limiting reagent in the formation of HCN is

- (a) NH₃ (b) CH₄

If 27 g of HCN are produced, the actual extent of reaction in moles is

- (a) 1/27 (b) 1 (c) 27

The yield is

- (a) 100% (b) 50% (c) 27%

The number of grams of unreacted NH₃ is

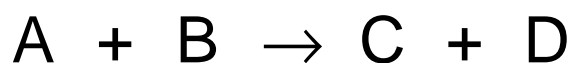
- (a) 1 (b) 7 (c) 10 (d) 17

The number of grams of unreacted CH₄ is

- (a) 8 (b) 11 (c) 13 (d) 24

2.5-610

Consider the elementary (single step) reaction

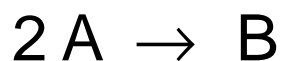


If the concentration of A is suddenly increased, the rate of the reaction will initially

- (a) increase
- (b) decrease
- (c) stay the same

2.5-620

Consider the elementary (single step) reaction

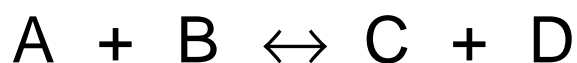


If the concentration of A is suddenly doubled, the rate of the reaction will initially

- (a) not change
- (b) double
- (c) quadruple

2.5-630

Consider a mixture of A, B, C & D in which the reaction



is at equilibrium. Adding some extra C will initially

- (a) increase the forward rate
- (b) increase the backward rate
- (c) decrease the forward rate
- (d) decrease the backward rate

The amount of D will

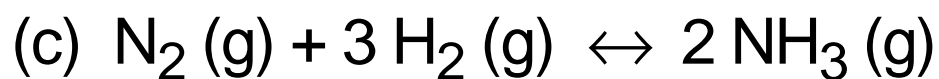
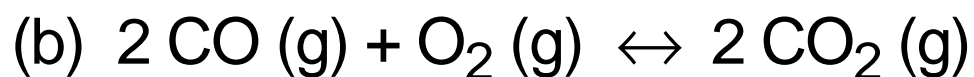
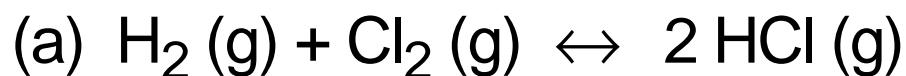
- (a) increase
- (b) decrease
- (c) remain the same

The amount of A and B will

- (a) increase
- (b) decrease
- (c) remain the same

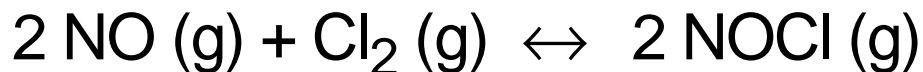
2.5-640

For which of the following systems at equilibrium will doubling the volume cause a shift to the right?



2.5-650

Consider the system



at equilibrium. If the volume of the container is suddenly doubled at constant temperature, when the system returns to equilibrium

- (a) the number of moles of NOCl will have increased
- (b) the value of the equilibrium constant will have increased
- (c) the number of moles of Cl₂ will have increased
- (d) the number of moles of NO will have decreased

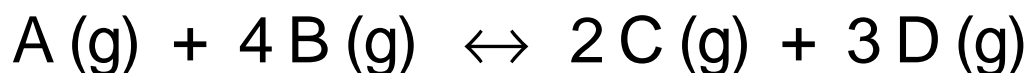
2.5-660

Which of the following statements about the reaction quotient, Q , is FALSE?

- (a) The reaction quotient and the equilibrium constant always have the same numerical value
- (b) The reaction quotient may sometimes be zero
- (c) The reaction quotient may be larger than the equilibrium constant
- (d) The numerical value of the reaction quotient changes as the reaction proceeds

2.5-670

3 mol of A and 4 mol of B are mixed in a container. When the reaction



has equilibrated, there is 1 mol of C.

The equilibrium extent of the reaction (in mol) is

- (a) 1/4 (b) 1/3 (c) 1/2 (d) 1

The equilibrium constant is

(a) $\left[(3-1/2) (4-4/2)^4 \right] / \left[(2/2)^2 (3/2)^3 \right]$

(b) $\left[(1/2)^2 (1/2)^3 \right] / \left[(3-1/2) (4-1/2)^4 \right]$

(c) $\left[(2/2) (3/2) \right] / \left[(3-1/2) (4-4/2) \right]$

(d) $\left[(2/2)^2 (3/2)^3 \right] / \left[(3-1/2) (4-4/2)^4 \right]$

2.5-680

At a given temperature, the equilibrium constant for the reaction



is 2.25. If 0.500 mol of each reactant is placed in a 1.00 L container, the equilibrium extent of reaction, ϕ , will be given by

- (a) $2.25 = (0.500 - \phi) / (\phi)$
- (b) $2.25 = (2 \phi) / (0.500 - 2 \phi)$
- (c) $1.50 = (0.500 - \phi) / (\phi)$
- (d) $1.50 = (\phi) / (0.500 - \phi)$