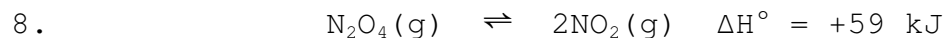


Equilibrium Problems Answers



a) S: \uparrow heat energy

R: \downarrow heat energy

H: endothermic reactions

D: shift right

E: \downarrow $[\text{N}_2\text{O}_4(\text{g})]$

b) S: \downarrow pressure

R: \uparrow pressure

H: make more moles of gas

D: shift right

E: \downarrow $[\text{N}_2\text{O}_4(\text{g})]$

c) S: \uparrow $[\text{NO}_2(\text{g})]$

R: \downarrow $[\text{NO}_2(\text{g})]$

H: use up $\text{NO}_2(\text{g})$

D: shift left

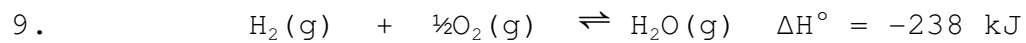
E: \uparrow $[\text{N}_2\text{O}_4(\text{g})]$

d) addition of He will have no effect

- He is not a part of the equilibrium

- even though, total pressure will increase, the partial pressures of the gases at equilibrium will not change (partial pressure is not altered by addition of a different gas and in fact pressure changes really are concentration changes!!!)

e) addition of a catalyst will have no effect on equilibrium position but will decrease the time required for equilibrium to be reached in the first place



a) S: \uparrow heat energy

R: \downarrow heat energy

H: endothermic reactions

D: shift left

E: \downarrow $[\text{H}_2\text{O}(\text{g})]$

b) S: \downarrow pressure

R: \uparrow pressure

H: make more moles of gas

D: shift left

E: \downarrow $[\text{H}_2\text{O}(\text{g})]$

d) same as above

e) same as above

10.



consider temperature

D: shift to the right

H: exothermic reaction

R: $\uparrow Q$

S: $\downarrow Q$

therefore reduce the temperature

consider pressure

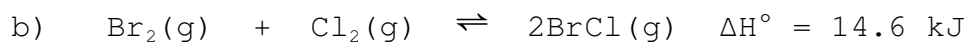
D: shift to the right

H: make more moles of gas

R: $\uparrow P$

S: $\downarrow P$

therefore reduce the pressure



consider temperature

D: shift to the right

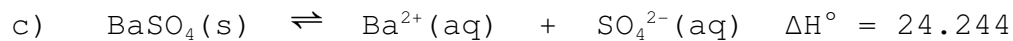
H: endothermic reaction

R: $\downarrow Q$

S: $\uparrow Q$

therefore increase the temperature

consider pressure: Since this reaction is equimolar with respect to moles of gas, pressure will not be able to have any effect on equilibrium position



consider temperature

D: shift to the right

H: endothermic reaction

R: ↓ Q

S: ↑ Q

therefore increase the temperature

consider pressure: Since no gases are present in this reaction, virtually no volume change will occur during a reaction and hence pressure has no effect on the equilibrium position.

11.

a)
$$K_{\text{eq}} = \frac{[\text{HF}(\text{g})]^2}{[\text{H}_2(\text{g})][\text{F}_2(\text{g})]}$$

b)
$$K_{\text{eq}} = \frac{[\text{N}_2\text{O}_5(\text{g})]^2}{[\text{NO}(\text{g})]^4[\text{O}_2(\text{g})]^3}$$

c)
$$K_{\text{eq}} = [\text{CO}_2(\text{g})]$$

d)
$$K_{\text{eq}} = [\text{H}_2\text{O}(\text{g})]^9$$

12. Answer is based on the fact that K_{eq} values are based on product concentration over reactant concentrations.
Therefore:

- if $K_{eq} = 1.5 \times 10^{12}$ reactants \ll products
- if $K_{eq} = 0.15$ reactants $>$ products
- if $K_{eq} = 4.3 \times 10^{-15}$ reactants \gg products

Therefore:

- a) products over reactants ratio is large for the first example
- b) products over reactants ratio is small for the last example

13. $Br_2(l) \rightleftharpoons Br_2(g)$ $\Delta H^\circ = +$ as written (i.e. particles further apart, must overcome attractive forces)

$$K_{eq} = [Br_2(g)]$$

S: $\uparrow Q$

R: $\downarrow Q$

H: endothermic reaction (use up heat)

D: Shifts to the right

E: $\therefore \uparrow [Br_2(g)], \therefore \uparrow K_{eq}$ i.e $K_{eq} = [Br_2(g)]$

therefore if $[Br_2(g)]$ goes up
the K_{eq} will increase as well

15. $\text{CO(g)} + \text{Cl}_2(\text{g}) \rightleftharpoons \text{COCl}_2(\text{g})$ $\Delta H^\circ = -$ as written (i.e. particles are getting closer together)

a) 15 s

b)

$$K_{\text{eq}} = \frac{[\text{COCl}_2(\text{g})]}{[\text{CO}(\text{g})][\text{Cl}_2(\text{g})]}$$

$$K_{\text{eq}} = \frac{[0.8]}{[1.7][0.7]}$$

$$K_{\text{eq}} = 0.672$$

Please note that units are not required for any part of the this type of calculation.

- c) Injection of CO (only an injection would cause an abrupt increase in concentration).
- d) Is most likely a change in temperature (could verify this by seeing if the K_{eq} value is different after equilibrium is re-established).
- e) Yes - the continuous activity at the molecular level is at work.
- f) Injection of COCl_2 (see c) above).
- g) Addition of catalyst will not alter equilibrium concentrations but will increase the rate at which equilibrium recovers from a stress. Any shifts in concentration would become more abrupt.
- h) Decrease temperature and increase pressure
- i) Temperature will alter K_{eq} values. Hence if there is a change in K_{eq} values, temperature must have been changed