18. Which factors must be equal when a reversible chemical process reaches equilibrium?

(1) mass of the reactants and mass of the products
(2) rate of the forward reaction and rate of the reverse reaction
(3) concentration of the reactants and concentration of the products
(4) activation energy of the forward reaction and activation energy of the reverse reaction

19. A solute is added to water and a portion of the solute remains undissolved. When equilibrium between the dissolved and undissolved solute is reached, the solution must be

(1) dilute
(2) saturated
(3) unsaturated
(4) supersaturated

20. Which description applies to a system in a sealed flask that is half full of water?

(1) Only evaporation occurs, but it eventually stops.
(2) Only condensation occurs, but it eventually stops.
(3) Neither evaporation nor condensation occurs.
(4) Both evaporation and condensation occur.

21. Solution equilibrium always exists in a solution that is

(1) unsaturated
(2) saturated
(3) dilute
(4) concentrated

22. Given the reaction at equilibrium:

$$A(g) + B(g) \rightleftarrows C(g) + D(g)$$

The addition of a catalyst will

(1) shift the equilibrium to the right
(2) shift the equilibrium to the left
(3) increase the rate of forward and reverse reactions equally
(4) have no effect on the forward or reverse reactions

23. If a catalyst is added to a system at equilibrium and the temperature and pressure remain constant, there will be no effect on the

(1) rate of the forward reaction
(2) rate of the reverse reaction
(3) activation energy of the reaction
(4) heat of reaction

24. Consider the equation for the following reaction at equilibrium.

$$X + Y \rightleftarrows 2Z + \text{heat}$$

The concentration of the product could be increased by

(1) adding a catalyst
(2) adding more heat to the system
(3) increasing the concentration of Y
(4) decreasing the concentration of X

25. In a reversible reaction, chemical equilibrium is attained when the

(1) rate of the forward reaction is greater than the rate of the reverse reaction
(2) rate of the reverse reaction is greater than the rate of the forward reaction
(3) concentration of the reactants reaches zero
(4) concentration of the products remains constant

26. Consider the following equation.

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g) + \text{heat}$$

What stress would cause the equilibrium to shift to the left?

(1) increasing the temperature
(2) increasing the pressure
(3) adding $N_2(g)$ to the system
(4) adding $H_2(g)$ to the system

27. Consider the equation for the following reaction at equilibrium.

$$CaSO_4(s) \rightleftarrows Ca^{2+}(aq) + SO_4^{2-}(aq)$$

When Na_2SO_4 is added to the system, how will the equilibrium shift?

(1) The amount of $CaSO_4$ will decrease, and the concentration of $Ca^{2+}(aq)$ will decrease.
(2) The amount of $CaSO_4$ will decrease, and the concentration of $Ca^{2+}(aq)$ will increase.
(3) The amount of $CaSO_4$ will increase, and the concentration of $Ca^{2+}(aq)$ will decrease.
(4) The amount of $CaSO_4$ will increase, and the concentration of $Ca^{2+}(aq)$ will increase.

28. Consider the following equation.

$$Zn(s) + HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

As the concentration of the $HCl(aq)$ decreases at constant temperature, the rate of the forward reaction

(1) decreases
(2) increases
(3) remains the same

29. Consider the following equation.

$$H_2(g) + F_2(g) \rightleftarrows 2HF(g) + \text{heat}$$

Which change will not shift the point of equilibrium?

(1) changing the pressure
(2) changing the temperature
(3) changing the concentration of $H_2(g)$
(4) changing the concentration of $HF(g)$

30. Consider the following equation.

$$H_2(g) + Cl_2(g) \rightleftarrows 2HCl(g)$$

As the pressure increases at constant temperature, the mass of $H_2(g)$

(1) decreases
(2) increases
(3) remains the same

31. Consider a reaction at STP and at equilibrium.

$$H_2(g) + Cl_2(g) \rightleftarrows 2HCl(g)$$

Which change will result in an increase in the concentration of $Cl_2(g)$?

(1) decreasing the pressure on the system
(2) decreasing the concentration of HCl
(3) increasing the concentration of $H_2(g)$
(4) increasing the concentration of HCl

32. Consider the following equation.

$$N_2(g) + O_2(g) \rightleftarrows 2NO(g)$$

As the concentration of $N_2(g)$ increases, the concentration of $O_2(g)$ will

(1) decrease
(2) increase
(3) remain the same

33. Consider the following equation.

$$2SO_2(g) + O_2(g) \rightleftarrows 2SO_3(g) + \text{heat}$$

Which change will shift the equilibrium to the right?

(1) decreasing the concentration of SO_2
(2) decreasing the pressure
(3) increasing the concentration of O_2
(4) increasing the temperature

34. The addition of a catalyst to a system at equilibrium will increase the rate of

(1) the forward reaction only
(2) the reverse reaction only
(3) both the forward and reverse reactions
(4) neither the forward nor the reverse reaction

35. A system is said to be in a state of dynamic equilibrium when the

(1) concentration of products is greater than the concentration of reactants
(2) concentration of products is less than the concentration of reactants
(3) rate at which products are formed is greater than the rate at which reactants are formed
(4) rate at which products are formed is the same as the rate at which reactants are formed