

1. In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is the

- (1) heat of reaction (3) free energy
(2) heat of fusion (4) activation energy

2. The free energy change (ΔG) that occurs during a chemical reaction is equal to

- (1) $\Delta H - T\Delta S$ (3) $\Delta S - T\Delta H$
(2) $\Delta H + T\Delta S$ (4) $\Delta S + T\Delta H$

3. As the reactants are converted to product in the reaction
 $A(g) + B(g) \rightarrow C(s)$,
the entropy of the system

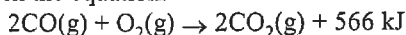
- (1) decreases (3) remains the same
(2) increases

4. Given the reaction:

$A(g) + B(g) \rightarrow AB(g)$ with $\Delta H_f^\circ = -10$ kilocalories per mole and $\Delta G_f^\circ = +2$ kilocalories per mole. This reaction is

- (1) endothermic and will occur spontaneously
(2) endothermic and will not occur spontaneously
(3) exothermic and will occur spontaneously
(4) exothermic and will not occur spontaneously

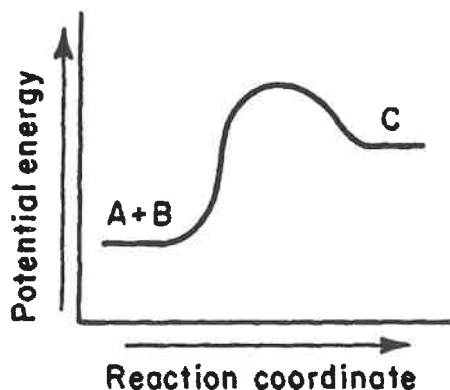
5. Given the equation:



What is the heat of reaction, in kilojoules per mole, of the $\text{CO}_2(g)$ formed?

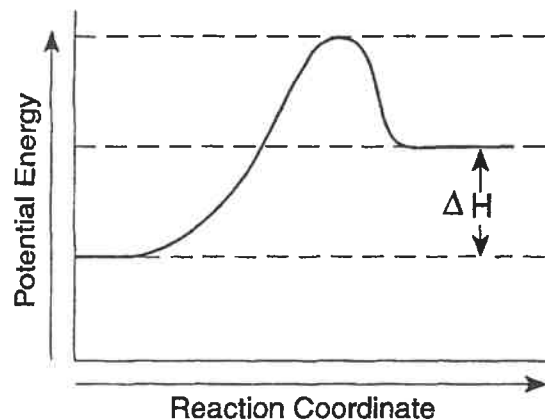
- (1) +566 (3) -566
(2) +283 (4) -283

6. According to the potential energy diagram below, what is the reaction $A + B \rightarrow C$?



- (1) endothermic and ΔH is positive
(2) endothermic and ΔH is negative
(3) exothermic and ΔH is positive
(4) exothermic and ΔH is negative

7. The diagram below represents the energy changes that occur during the formation of a certain compound under standard conditions.



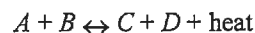
According to Reference Table I, the compound could be

- (1) $\text{HI}(g)$ (3) $\text{C}_2\text{H}_6(g)$
(2) $\text{NH}_3(g)$ (4) $\text{CO}_2(g)$

8. Activation energy is required to initiate

- (1) exothermic reactions, only
(2) endothermic reactions, only
(3) both exothermic and endothermic reactions
(4) neither exothermic nor endothermic reactions

9. Given the reaction:



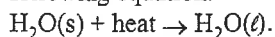
Which statement best describes this reaction?

- (1) The forward reaction is exothermic, and the reverse reaction is always exothermic.
(2) The forward reaction is exothermic, and the reverse reaction is always endothermic.
(3) The forward reaction is exothermic, and the reverse reaction can be either exothermic or endothermic.
(4) The forward reaction is endothermic, and the reverse reaction can be either endothermic or exothermic.

10. Which reaction results in an increase in entropy?

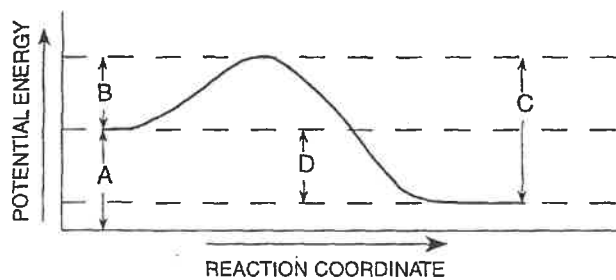
- (1) $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(s)$
(2) $\text{CO}_2(g) \rightarrow \text{CO}_2(s)$
(3) $\text{NaCl}(aq) + \text{AgNO}_3(aq) \rightarrow \text{AgCl}(s) + \text{NaNO}_3(aq)$
(4) $\text{Ca}(s) + 2\text{H}_2\text{O}(l) \rightarrow \text{Ca}(\text{OH})_2(aq) + \text{H}_2(g)$

11. Above 0°C , ice changes spontaneously to water according to the following equation:



The changes in $\text{H}_2\text{O}(\text{s})$ involve

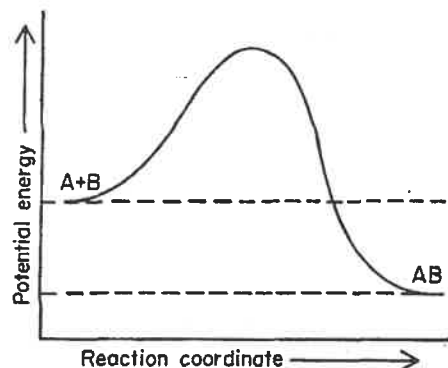
- (1) a release of heat and an increase in entropy
 - (2) an absorption of heat and an increase in entropy
 - (3) a release of heat and a decrease in entropy
 - (4) an absorption of heat and a decrease in entropy
12. The graph below is a potential energy diagram of a compound which is formed from its elements.



Which interval represents the heat of reaction?

- (1) A
 - (2) B
 - (3) C
 - (4) D
13. According to Reference Table I, what is the heat of reaction for the formation of two moles of $\text{H}_2\text{O}(\ell)$ from hydrogen and oxygen gas at 1 atmosphere and 298 K?
- (1) -571.6 kJ
 - (2) -483.6 kJ
 - (3) -55.8 kJ
 - (4) $+571.6 \text{ kJ}$
14. Which statement describes characteristics of an endothermic reaction?
- (1) The sign of ΔH is positive, and the products have more potential energy than the reactants.
 - (2) The sign of ΔH is positive, and the products have less potential energy than the reactants.
 - (3) The sign of ΔH is negative, and the products have more potential energy than the reactants.
 - (4) The sign of ΔH is negative, and the products have less potential energy than the reactants.

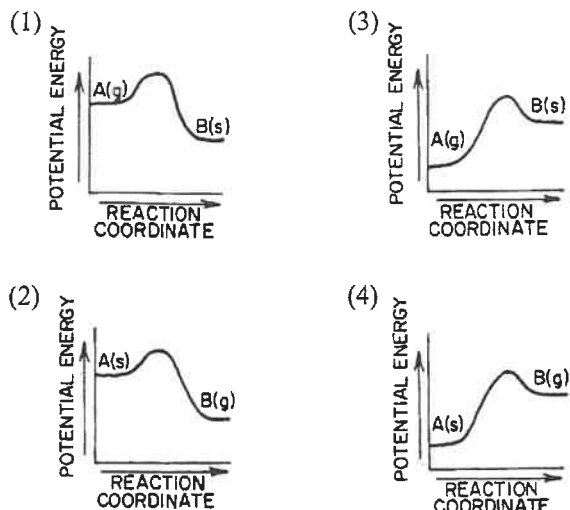
15. Given the potential energy diagram:



With reference to energy, the reaction $A + B \rightarrow AB$ can best be described as

- (1) exothermic, having a $+\Delta H$
 - (2) exothermic, having a $-\Delta H$
 - (3) endothermic, having a $+\Delta H$
 - (4) endothermic, having a $-\Delta H$
16. When NH_4NO_3 is dissolved in water, the temperature of the water decreases. When NaOH is dissolved in a separate water sample, the temperature of the water increases. Based on these observations, it can be concluded that the dissolving of
- (1) NH_4NO_3 is exothermic and the dissolving of NaOH is endothermic
 - (2) NH_4NO_3 is endothermic and the dissolving of NaOH is exothermic
 - (3) both salts is exothermic
 - (4) both salts is endothermic
17. Given the reaction:
- $$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) + 182.6 \text{ kJ} \rightarrow 2\text{NO}(\text{g})$$
- What is the heat of formation of nitrogen (II) oxide in kJ/mole ?
- (1) $\Delta H = 91.3$
 - (2) $\Delta H = 182.6$
 - (3) $\Delta H = -182.6$
 - (4) $\Delta H = -91.3$

18. Which potential energy diagram indicates a reaction that must occur spontaneously?



19. Given the reaction:



Which statement about this reaction is true?

- (1) The potential energy of the reactants is the same as the potential energy of the product.
- (2) The potential energy of the reactants is lower than the potential energy of the product.
- (3) It is exothermic.
- (4) It is endothermic.

20. Which chemical reaction will always be spontaneous?

- (1) an exothermic reaction in which entropy increases
- (2) an exothermic reaction in which entropy decreases
- (3) an endothermic reaction in which entropy increases
- (4) an endothermic reaction in which entropy decreases

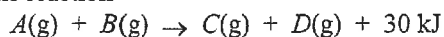
21. Which type of reaction is the Haber process,
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g}) + \text{heat}$?

- (1) endothermic, with an increase in entropy
- (2) endothermic, with a decrease in entropy
- (3) exothermic, with an increase in entropy
- (4) exothermic, with a decrease in entropy

22. Which condition is necessary for a chemical reaction to occur spontaneously?

- (1) ΔG must be positive.
- (2) ΔG must be negative.
- (3) ΔS must be positive.
- (4) ΔS must be negative.

23. The reaction



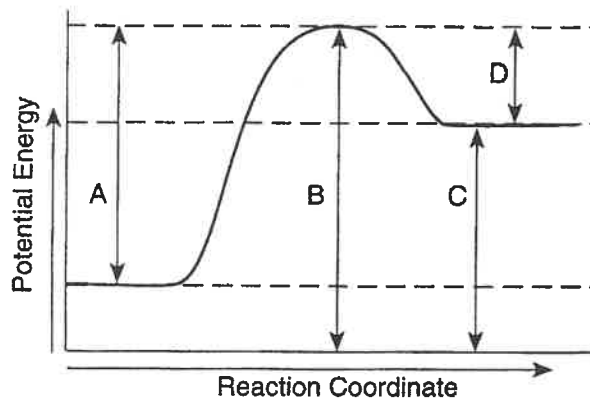
has a forward activation energy of 20 kJ. What is the activation energy for the reverse reaction?

- (1) 10 kJ
- (2) 20 kJ
- (3) 30 kJ
- (4) 50 kJ

24. A 1 gram sample of a substance has the greatest entropy when it is in the

- (1) crystalline state
- (2) gaseous state
- (3) solid state
- (4) liquid state

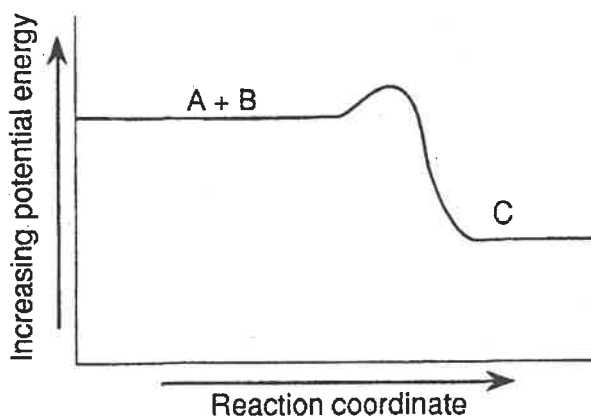
25. Base your answer on the potential energy diagram of a chemical reaction shown below.



Which arrow represents the activation energy for the forward reaction?

- (1) A
- (2) B
- (3) C
- (4) D

26. The graph below represents a chemical reaction.



This reaction is best described as

- (1) endothermic, because energy is released
- (2) endothermic, because energy is absorbed
- (3) exothermic, because energy is released
- (4) exothermic, because energy is absorbed

27. As $\text{NaCl}(\text{s})$ dissolves according to the equation
 $\text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$,
 the entropy of the system

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

