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5.3-110

In the rusting of iron

$$4\ Fe\ (s)\ +\ 3\ O_2\ (g)\ \rightarrow\ 2\ Fe_2O_3\ (g)$$

the entropy (disorder) of the chemicals

(a) increases
(b) decreases
(c) remains the same
(d) not enough information

The reaction is exothermic. As a result, the entropy (disorder) of the surroundings

(a) increases
(b) decreases
(c) remains the same
(d) not enough information

5.3-120

In the dissolution of ammonium nitrate in water

$$NH_4NO_3\,(s) \rightarrow NH_4^+\,(aq) + NO_3^-\,(aq)$$

the entropy (disorder) of the chemicals

(a) increases
(b) decreases
(c) remains the same
(d) not enough information

The reaction is endothermic. As a result, the entropy (disorder) of the surroundings

(a) increases
(b) decreases
(c) remains the same
(d) not enough information

5.3-130

Which of the following changes of a system does not increase the entropy of the universe?

(a) increase in volume
(b) decrease in energy
(c) increase in entropy

5.3-210

Which toss of 3 dice is more disordered (has more realizations, is more probable) than the others?

(a) three ● 's

(b) two ● 's and a ●● (in any order)

(c) a ●, a ●● and a ●●● (in any order)

(d) none of the above

5.3-220

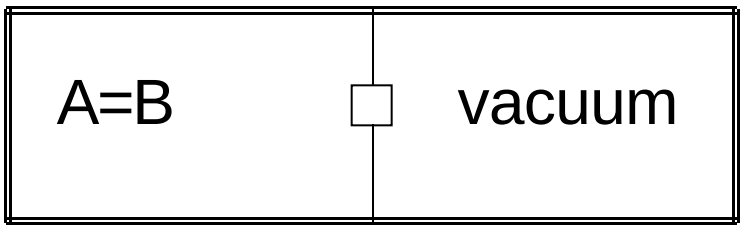
A gas of 1000 molecules is contained in a box. What is the probability that a corner of the box with a volume 1/4 of the whole box will be found empty at a given instant?

(a) $(1/4)^{1000} = 10^{-602}$
(b) $(3/4)^{1000} = 10^{-125}$
(c) $(1/1000)^{3/4} = 5.6 \times 10^{-3}$
(d) $(1/1000)^{1/4} = 1.8 \times 10^{-1}$

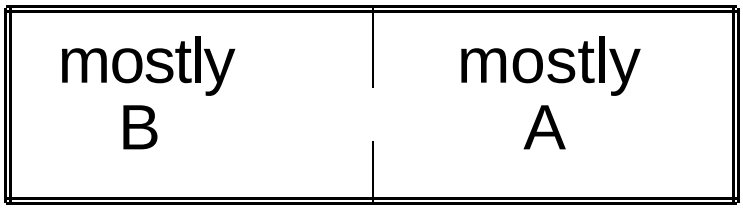
5.3-240

Consider an ideal gas mixture of A and B ($M_A << M_B$)

with initial state



and later state



ΔS for the system during this process is

(a) > 0 (b) < 0 (c) $= 0$

5.3-290

Which of the following is not true?
Putting Humpty Dumpty back together again

(a) is not possible
(b) requires $\Delta S_{HD} < 0$
(c) requires $\Delta S_{surr} > 0$
(d) requires $\Delta S_{surr} > -\Delta S_{HD}$

5.3-310

Suppose that a macromolecule has 2 conformations with different energies. In a collection of such molecules, the population in the lower energy conformation is

(a) lowest at low temperature
(b) lowest at high temperature
(c) highest at high temperature
(d) does not depend on temperature

5.3-320

Suppose that a macromolecule has 2 conformations with different volumes. In a collection of such molecules, the population in the smaller volume conformation is lowest at

(a) low temperature and high pressure
(b) low temperature and low pressure
(c) high temperature and high pressure
(d) high temperature and low pressure

5.3-410

If a process is both endothermic and spontaneous at constant T and P, then its

(a) $\Delta S > 0$ (b) $\Delta H < 0$ (c) $\Delta G > 0$

5.3-420

A process cannot occur spontaneously at constant T and P, if

(a) $\Delta S > 0$ and $\Delta H > 0$

(b) $\Delta S > 0$ and $\Delta H < 0$

(c) $\Delta S < 0$ and $\Delta H > 0$

(d) $\Delta S < 0$ and $\Delta H < 0$

5.3-430

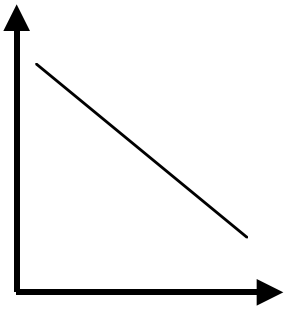
For a spontaneous process at constant T and P, which of the following is not true.

(a) A spontaneous process with $\Delta H > 0$ is entropy driven.
(b) A spontaneous process with $\Delta V < 0$ is volume driven.
(c) A spontaneous process with $\Delta E > 0$ is energy driven.
(d) A spontaneous process with $\Delta S > 0$ is entropy driven.

5.3-451

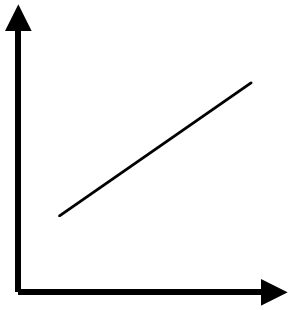
Consider a system comprising a weight suspended by a rubber band. The energy (and enthalpy) of the rubber band depends only very weakly on length, so the energy (and enthalpy) of the system is primarily determined by the position of the weight. The plot of the energy (or the enthalpy) of the system vs. the length of the rubber band looks like

(a)



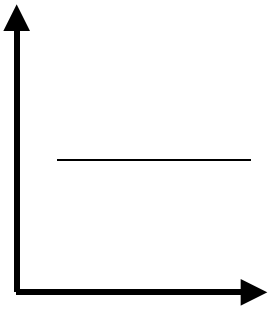
length

(b)



length

(c)

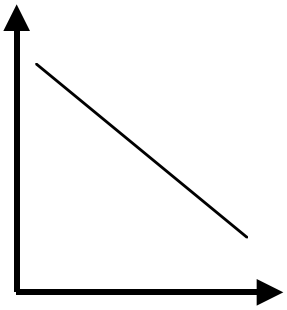


length

5.3-452

Consider a system comprising a weight suspended by a rubber band. The entropy of the system is primarily determined by the entropy of the rubber band. The plot of the entropy of the system vs. the length of the rubber band looks like

(a)



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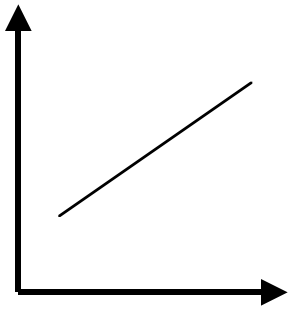
(b)



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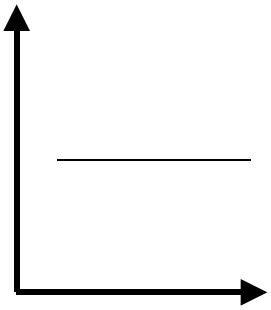
(c)

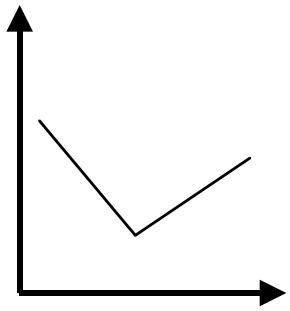


length

5.3-453

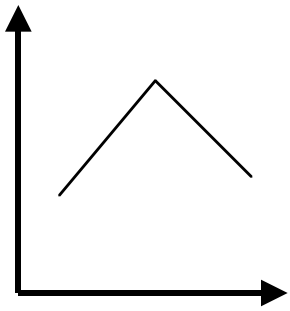
Consider a system comprising a weight suspended by a rubber band. The plot of the free energy of the system vs. the length of the rubber band looks like

(a)



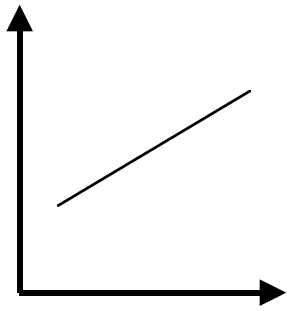
length

(b)



length

(c)



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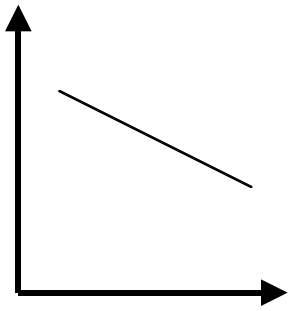
(d)

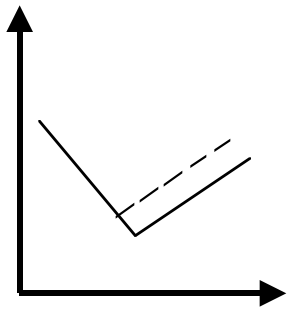


length

5.3-454

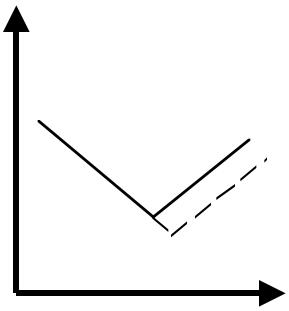
Consider a system comprising a weight suspended by a rubber band. The plot of the free energy of the system vs. the length of the rubber band is shown by the solid line. Which dashed line shows the new free energy curve after the temperature is increased?

(a)



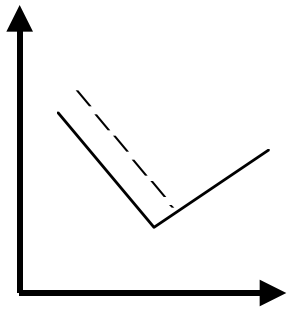
length

(b)



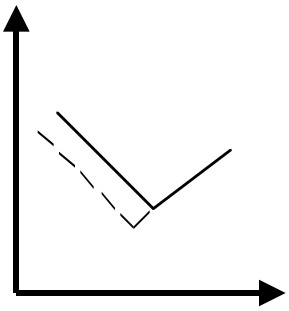
length

(c)



length

(d)



length

5.3-455

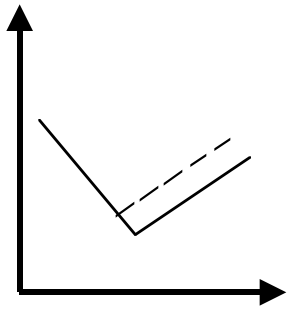
Consider a system comprising a weight suspended by a rubber band. Upon heating, the rubber band will

(a) shorten
(b) lengthen
(c) stay the same length

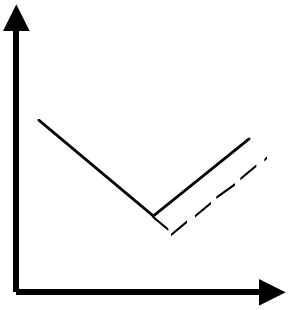
5.3-456

Consider a system comprising a weight suspended by a rubber band. The plot of the free energy of the system vs. the length of the rubber band is shown by the solid line. Which dashed line shows the new free energy curve after a second weight is added to the first?

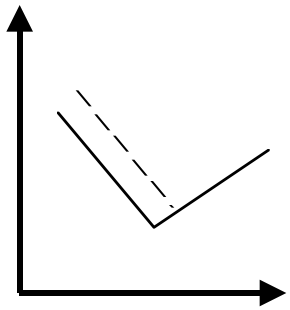
(a)



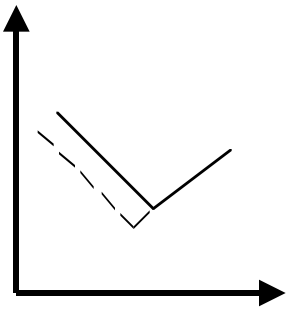
(b)



(c)



(d)



5.3-457

Consider a system comprising a weight suspended by a rubber band. If a second weight is added to the first, the rubber band will

(a) shorten
(b) lengthen
(c) stay the same length

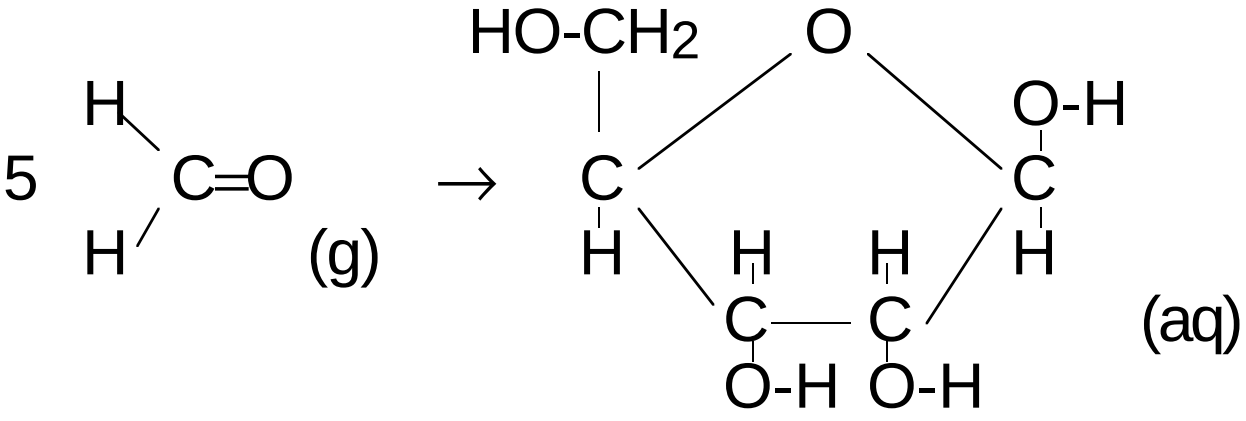
5.3-510

Which of the following is not a possible value for S for a substance?

(a) -31.9 J / mol K
(b) 85.0 J / mol K
(c) 1.9 J / mol K
(d) 0.0 J / mol K

5.3-520

Ribose, a sugar, is believed to have formed in the “prebiotic soup” by condensation of 5 formaldehyde molecules



Since S° (H_2CO,g) = 219 J/mol K and S°(ribose,aq) = 177 J/mol K, $\Delta S°$ for the condensation equals

(a) (- 219 + 177) J/mol K
(b) (+ 219 - 5 x 177) J/mol K
(c) (-5 x 219 - 177) J/mol K
(d) (-5 x 219 + 177) J/mol K

(d) state function, a path going through T = 0 K
negative: g → aq and 5 → 1
Ribose and deoxyribose the sugars in RNA & DNA

5.3-530

Using CO_2 as their carbon source, photosynthetic organisms must obtain hydrogen from one of the following

	$\Delta G_f°$ (kJ/mol)
H_2O (g)	-285.59
H_2S (g)	-33.56
H_2 (g)	0.0

Abstracting hydrogen atoms will be easiest from

(a) H_2O (g) (b) H_2S (c) H_2

and most difficult from

(a) H_2O (g) (b) H_2S (c) H_2

5.3-551

$\Delta G^{\circ\prime}$= -43.1 and +30.5 kJ/mol for the reactions

$$RCHO + H_2O + NAD^+ \rightarrow RCOOH + NADH + H^+$$

$$ADP^{2-} + H_2PO_4^- \rightarrow ATP^{3-} + H_2O$$

In living organisms, a more frequent rxn is

$$RCHO + ADP^{2-} + H_2PO_4^- + NAD^+ \rightarrow RCOOH + ATP^{3-} + NADH + H^+$$

For this reaction $\Delta G^{\circ\prime}$=

(a) +73.6 kJ/mol (b) – 73.6 kJ/mol
(c) +12.6 kJ/mol (d) – 12.6 kJ/mol

5.3-552

Organisms carry out the phosphorylation of ADP to give ATP in 2 steps. The first step is phosphorylation of an aldehyde

$$RCHO + H_2PO_4^- + NAD^+ \rightarrow RCOOPO_3^{2-} + NADH + 2\,H^+$$

Given that $\Delta G^{\circ\prime}$= -43.1 and -49.4 kJ/mol for rxns

$$RCHO + H_2O + NAD^+ \rightarrow RCOO^- + NADH + 2\,H^+$$

$$RCOOPO_3^{2-} + H_2O \rightarrow RCOO^- + H_2PO_4^-$$

$\Delta G^{\circ\prime}$for the aldehyde phosphorylation is

(a) + 92.5 kJ/mol (b) – 92.5 kJ/mol
(c) + 6.3 kJ/mol (d) – 6.3 kJ/mol

5.3-553

Organisms carry out the phosphorylation of ADP to give ATP in 2 steps. The second step is phosphate transfer

$$ADP^{2-} + RCOOPO_3^{2-} \rightarrow RCOO^{-} + ATP^{3-}$$

Given that $\Delta G^{\circ\prime}$= -30.5 and -49.4 kJ/mol for the reactions

$$ATP^{3-} + H_2O \rightarrow ADP^{2-} + H_2PO_4^{-}$$

$$RCOOPO_3^{2-} + H_2O \rightarrow RCOO^{-} + H_2PO_4^{-}$$

$\Delta G^{\circ\prime}$ for phosphate transfer is

(a) +18.9 kJ/mol (b) – 18.9 kJ/mol
(c) +79.9 kJ/mol (d) – 79.9 kJ/mol

5.3-610

For a given substance, the highest entropy physical state is

(a) gas (b) liquid (c) solid

(d) impossible to generalize

5.3-620

For the change

$$H_2O\ (l) \rightarrow H_2O\ (g)$$

at 99°C and 1 atm

(a) $\Delta H > T\,\Delta S$
(b) $\Delta H = T\,\Delta S$
(c) $\Delta H < T\,\Delta S$

5.3-630

When a small amount of pure liquid benzene is mixed with a large amount of pure liquid water, the entropy change is expected to be

(a) positive (b) negative (c) zero

When the entropy due solely to mixing is subtracted, the residual "cratic" entropy change is negative. This is inconsistent with which of the following conclusions?

(a) the ordering of a benzene molecule that is surrounded by water molecules is greater than in pure benzene
(b) the ordering of water molecules in the vicinity of a benzene molecule is less than in pure water
(c) molecules of benzene and water form a complex

5.3-640

Once synthesized, proteins need to be folded into their active conformation. The entropy of the folded state is expected to be

(a) greater than
(b) less than
(c) the same as

However, the entropy change during folding is often found to be positive. This is indicates

(a) disordering of the solvent during folding
(b) ordering of the solvent during folding
(c) a violation of the second law

5.3-710

$\Delta G^{\circ\prime} = -30.5$ kJ/mol for the reaction

$$ATP^{3-} + H_2O \rightarrow ADP^{2-} + H_2PO_4^-$$

Recalling that at 310 K, RT=2.58 kJ/mol, the reaction quotient, Q, at equilibrium will be

(a) exp (- 30.5 / 2.58) = 7.35×10^{-6}
(b) exp (+30.5 / 2.58) = 1.36×10^{5}
(c) exp (- 2.58 / 30.5) = 0.92
(d) exp (+2.58 / 30.5) = 1.09

5.3-720

$\Delta G^{\circ\prime} = -30.5$ kJ/mol for the reaction

$$ATP^{3-} + H_2O \rightarrow ADP^{2-} + H_2PO_4^-$$

Which of the following reactions will produce glycogen from the most dilute glucose solution?

(a) $\text{glucose} + (\text{glycogen})_n \rightarrow (\text{glycogen})_{n+1} + H_2O$

(b) $ATP^{3-} + \text{glucose} + (\text{glycogen})_n \rightarrow ADP^{2-} + H_2PO_4^- + (\text{glycogen})_{n+1}$

(c) $2\ ATP^{3-} + H_2O + \text{glucose} + (\text{glycogen})_n \rightarrow 2\ ADP^{2-} + 2\ H_2PO_4^- + (\text{glycogen})_{n+1}$

5.3-740

A warm solution of cobalt chloride is blue, but turns pink when it cools. This indicates that the reaction

$$\underset{\text{blue}}{CoCl_4^{2-}} + 6\,H_2O \rightarrow \underset{\text{pink}}{Co(H_2O)_6^{2+}} + 4\,Cl^-$$

is

(a) exothermic
(b) endothermic
(c) not enough information

5.3-750

The reaction

$$Cu^{2+}(aq) + 4\,Br^{-}(aq) \rightarrow [CuBr_4]^{2-}(aq)$$

blue green

is endothermic. To shift the reaction to the left the solution should be

(a) warmed
(b) cooled
(c) not enough information

5.3-810

The earliest organisms are presumed to have lived by fermenting organic molecules, as for example the fermentation of ribose to acetic acid (the distinctive component of vinegar)

$3\ C_5H_{10}O_5\ (aq)\ +\ 5\ H_2O\ (l)\ \rightarrow$

$5\ CH_3COOH\ (aq)\ +\ 5\ CO_2\ (g)\ +\ 10\ H_2(g)$

$\Delta S°$ for this reaction is expected to be

(a) positive (b) negative (c) zero

Since fermentation releases heat, $\Delta H°$ is

(a) positive (b) negative (c) zero

With $\Delta S°>0$ and $\Delta H°<0$, $\Delta G°$ is

(a) positive at high T, negative at low T
(b) negative at high T, positive at low T
(c) negative at all T
(d) positive at all T

5.3-820

Life is oppportunistic and the waste H_2 of fermentors is used by other organisms

$$4\,H_2\,(g) + CO_2\,(g) \rightarrow CH_4\,(g) + 2\,H_2O\,(g)$$

$$4\,H_2\,(g) + H^+\,(aq) + SO_4^{-2}\,(aq) \rightarrow HS^-\,(aq) + 4\,H_2O\,(l)$$

For these reactions $\Delta H° < 0$ and $\Delta S° < 0$.
Therefore, at constant P, these reactions

(a) are insensitive to T
(b) are more favorable at high T
(c) are more favorable at low T

5.3-830

Life is opportunistic and the waste CH_3COOH of fermentors is used by other organisms

$$CH_3COOH\,(aq) \rightarrow CH_4\,(g) + CO_2\,(g)$$

$$CH_3COOH\,(aq) + H^+\,(aq) + SO_4^{-2}\,(aq) \rightarrow HS^-\,(aq) + 2\,CO_2\,(g) + 2\,H_2O\,(l)$$

For these reactions $\Delta H° > 0$ and $\Delta S° > 0$.
Therefore, at constant P, these reactions

(a) are insensitive to T
(b) are more favorable at high T
(c) are more favorable at low T

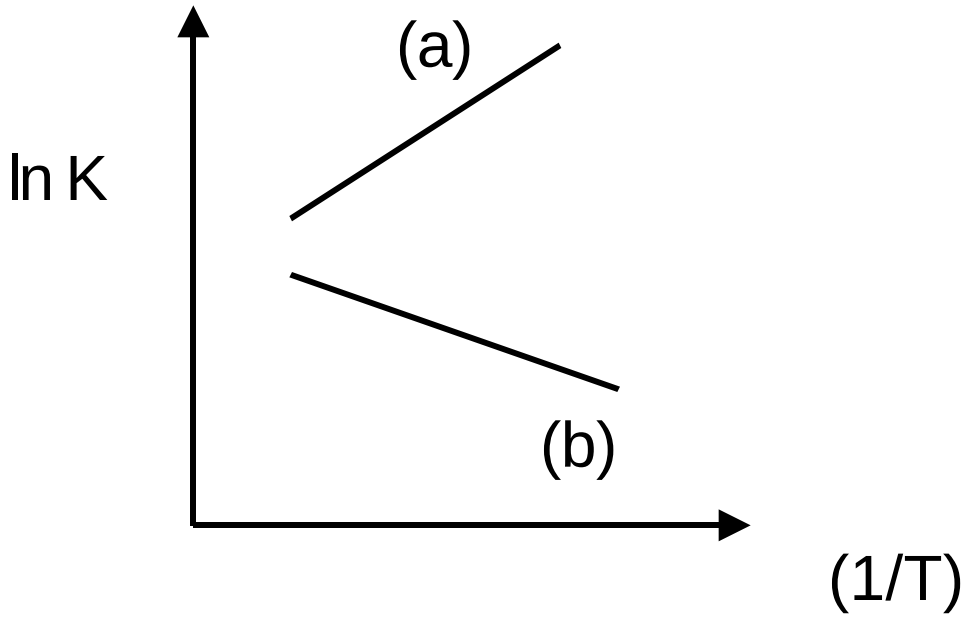
5.3-910

Which of the following graphs is expected to be linear?

(a) K vs. T
(b) K vs. 1/T
(c) ln K vs. T
(d) ln K vs. 1/T

5.3-930

Proteins unfold on heating. Which of the following graphs represents the temperature dependence of the equilibrium constant for folding of a protein.

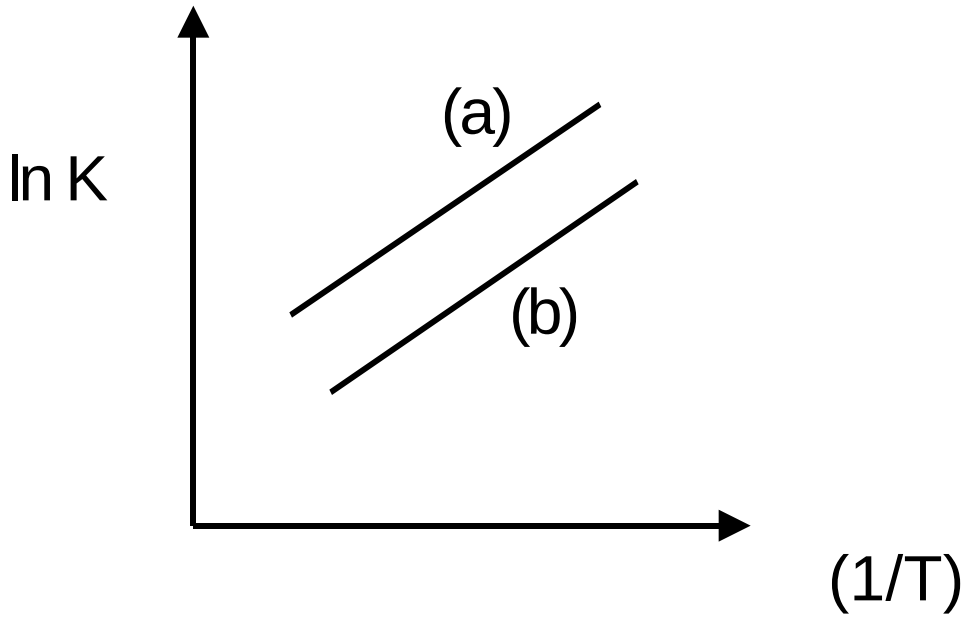


ΔH for folding is

(a) positive (b) zero (c) negative

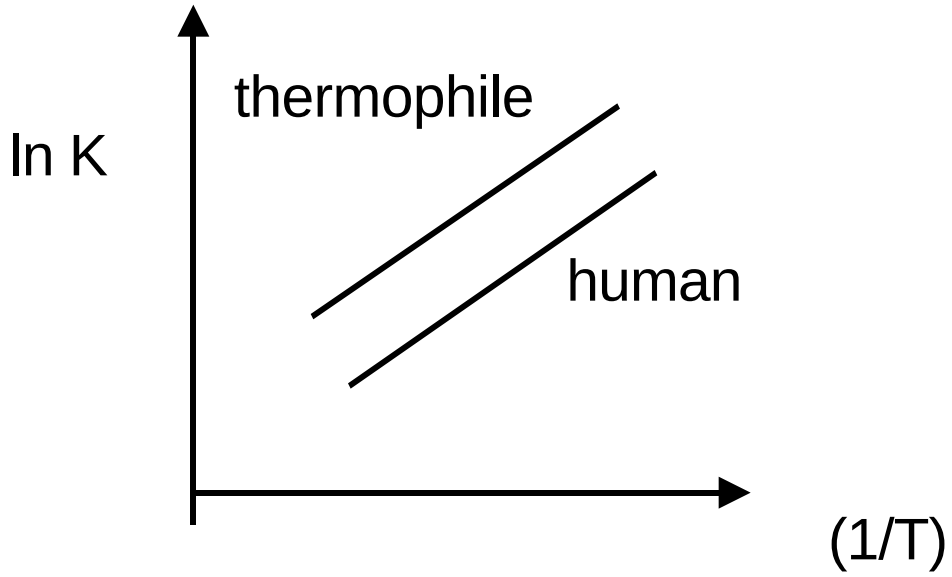
5.3-940

Thermophiles thrive at high temperatures. To understand how their proteins can be folded at higher temperatures than ours, scientists have compared the temperature dependence of the equilibrium constants for folding for a thermophile protein and the corresponding human protein. Which of the following graphs is for folding of the thermophile protein?



5.3-950

To understand how the proteins of thermophilic organisms can be folded at higher temperatures than ours, scientists obtained the following data for the equilibrium constants for folding a thermophile protein and the corresponding human protein.



It can be concluded that the enthalpy for folding of the thermophile protein is
(a) greater than (b) equal to (c) less than the enthalpy for folding of human protein.

It can be concluded that the entropy for folding of the thermophile protein is
(a) greater than (b) equal to (c) less than the entropy for folding of human protein.