1. chem10b 19.5-1

A common name for methanol (CH_3OH) is wood alcohol. The normal boiling point of methanol is and the molar enthalpy of vaporization if 71.8 kJ/mol. The value of S when 2.15 mol of vaporizes at 64.7 °C is

Student Response	Correct Answer
A. 457	
B. 2.39×10^3	
C. 5.21×10^7	
D. 0.457	
E. 2.39	

2. chem10b 19.2-15

Which reaction produces a decrease in the entropy of the system?

Student Response	Correct Answer
A. $2C\ (s) + O_2\ (g) \rightarrow 2CO\ (g)$	
B. $2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l)$	
C. $CO_2\ (s) \rightarrow CO_2\ (g)$	
D. $H_2O\ (l) \rightarrow H_2O\ (g)$	
E. $CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$	

3. chem10b 19.1-9

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

__
Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K-mol)

Carbon
C (s, diamond) 1.88 2.84 2.43
C (s, graphite) 0 0 5.69
C_2H_2 (g) 226.7 209.2 200.8
C_2H_4 (g) 52.30 68.11 219.4
C_2H_4 (g) -84.68 -32.89 229.5
CO (g) -110.5 -137.2 197.9
CO_2 (g) -393.5 -394.4 213.6

Hydrogen
H_2(g) 0 0 130.58

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

The combustion of ethane in the presence of excess oxygen yields carbon dioxide and water:

$2C_2H6\ (g) + 7O_2\ (g) \rightarrow 4CO_2\ (g) + 6H_2O\ (l)$

The value of ΔS° for this reaction is _____ J/K.

Student Response	Correct Answer
A. -718.0	
B. +151.0	
C. +718.0	
D. -151.0	
E. -620.9	

4. chem10b 19.2-36

If ΔG° for a reaction is greater than zero, then _____.

Student Response	Correct Answer
A. K > 1	
B. K = 1	
C. K < 1	
D. K = 0	
E. More information is needed.	

5. chem10b 19.2-11

The second law of thermodynamics states that _____☐__.

Student Response	Correct Answer
A. $\Delta S = q_{rev}/T$ at constant temperature	
B. $\Delta E = q + w$	
C. for any spontaneous process, the entropy of the universe increases	
D. the entropy of a pure crystalline substance is zero at absolute ze☐o	
E. $\Delta H°_{rxn} = \Sigma n\Delta H°_f$ (products) - $\Sigma m\Delta H°_f$ (reactants)	

6. chem10b 19.2-30

Given the following table of thermodynamic data,

complete the following sentence. The vaporization of PCl_3 (l) is _____.

Student Response	Correct Answer
A. spontaneous at low temperature and nonspontaneous at high temperature	
B. nonspontaneous at low temperature and spontaneous at high temperature	
C. nonspontaneous at all temperatures	
D. spontaneous at all temperatures	
E. not enough information given to draw a conclusion	

Score: 1/1

7. chem10b 19.2-12

ΔS is positive for the reaction _____.

Student Response	Correct Answer

A. CO_2 (g) → CO_2 (s)
B. BaF_2 (s) → Ba^{2+} (aq) + $2F^-$ (aq)
C. $2H_2$ (g) + O_2 (g) → $2H_2O$ (g)
D. 2Hg (l) + O_2 (g) → 2HgO (s)
E. $2NO_2$ (g) → N_2O_4 (g)

8. chem10b 19.1-15

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔS° for the formation of $POCl_3$ from its constituent elements,

P_2 (g) + O_2 (g) + $3Cl_2$ (g) → $2POCl_3$ (g)

is _____ J/K.

Student Response	Correct Answer
A. -321	
B. -442	

C. -771	
D. +771	☐
E. +321	

9. chem10b 19.1-21

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔH° for the oxidation of solid elemental sulfur to gaseous sulfur trioxide,

$2S\ (s, rhombic) + 3O_2(\ g) \rightarrow 2SO_3\ (g)$

is _____ kJ/mol.

Student Response	Correct Answer
A. +105.1	
B. +790.4	
C. -395.2	
D. -790.4	

E. +395.2

10. chem10b 19.2-32

Consider the reaction:

Ag^+ (aq) + Cl^- (aq) → AgCl (s)

Given the following table of thermodynamic data,

determine the temperature (in °C) above which the reaction is nonspontaneous under standard conditions.

Student Response	Correct Answer
A. 1641	
B. 133.0	
C. 1235	
D. 150.5	
E. 432.8	

11. chem10b 19.1-12

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus

P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔS° for the oxidation of solid elemental sulfur to gaseous sulfur dioxide,

S (s, rhombic) + O_2(g) → SO_2(g)

is _____ J/K.

Student Response	Correct Answer
A. +485.4	
B. +11.6	
C. -248.5	
D. +248.5	
E. -11.6	

12. chem10b 19.2-20

Which one of the following correctly indicates the relationship between the entropy of a system and the number of different arrangements, W, in the system?

Student Response	Correct Answer
A. S = Wk	
B. S = k ln$W$	
C. S =	
D. S = kW	
E. S =	

13. chem10b 19.2-22

Of the following, the entropy of gaseous _____ is the largest at 25 °C and 1 atm.

Student Response	Correct Answer
A. C_2H_4	
B. H_2	
C. C_2H_6	
D. CH_4	
E. C_2H_2	

14. chem10b 19.2-8

Which one of the following is always positive when a spontaneous process occurs?

Student Response	Correct Answer
A. $\Delta S_{universe}$	
B. $\Delta H_{surroundings}$	
C. $\Delta H_{universe}$	
D. ΔS_{system}	
E. $\Delta S_{surroundings}$	

15. chem10b 19.2-18

ΔS is negative for the reaction _____.

Student Response	Correct Answer
A. $2SO_2\ (g) + O_2\ (g) \rightarrow 2SO_3\ (g)$	
B. $NH_4Cl\ (s) \rightarrow NH_3\ (g) + HCl\ (g)$	
C. $H_2O\ (l) \rightarrow H_2O\ (g)$	
D. $PbCl_2\ (s) \rightarrow Pb^{2+}\ (aq) + 2Cl^-\ (aq)$	
E. $2C\ (s) + O_2\ (g) \rightarrow 2CO_2\ (g)$	

16. chem10b 19.2-5

A reversible process is one that _____.

Student Response	Correct Answer
A. must be carried out at high temperature	
B. is spontaneous in both directions	
C. happens spontaneously	
D. must be carried out at low temperature	
E. can be reversed with no net change in either system or surroundings	

17. chem10b 19.1-6

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K-mol)

Carbon
C (s, diamond) 1.88 2.84 2.43
C (s, graphite) 0 0 5.69
C_2H_2 (g) 226.7 209.2 200.8
C_2H_4 (g) 52.30 68.11 219.4
C_2H_4 (g) -84.68 -32.89 229.5
CO (g) -110.5 -137.2 197.9
CO_2 (g) -393.5 -394.4 213.6

Hydrogen
H_2(g) 0 0 130.58

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

The value of ΔS° for the oxidation of carbon to carbon monoxide,

$2C\ (s, graphite) + O_2\ (g) \rightarrow 2CO\ (g)$

is _____ J/K. Carbon monoxide is produced in the combustion of carbon with limited oxygen.

Student Response	Correct Answer
A. +408.6	
B. -408.6	
C. +395.8	
D. +179.4	

E. -12.8

18. chem10b 19.5-4

The value of G° at 100.0 °C for the formation of calcium chloride from its constituent elements:

$Ca\ (s) + Cl_2\ (g) \rightarrow CaCl_2\ (s)$

is _____ kJ/mol. At 25.0 °C for this reaction, H° is -795.8 kJ/mol, G° is -748.1 kJ/mol, and is

Student Response	Correct Answer
A. -779.8	
B. 1.52×10^4	
C. -736.2	
D. -855.4	
E. 5.88×10^4	

Score: 1/1

19. chem10b 19.2-3

Of the following, only _____ is not a state function.

Student Response	Correct Answer
A. q	
B. T	
C. H	
D. E	
E. S	

20. chem10b 19.2-27

For the reaction

$C_2H_6\ (g) \rightarrow C_2H_4\ (g) + H_2\ (g)$

ΔH° is +137 kJ/mol and ΔS° is +120 J/K · mol. This reaction is _____.

Student Response	Correct Answer
A. spontaneous at all temperatures	
B. nonspontaneous at all temperatures	
C. spontaneous only at high temperature	
D. spontaneous only at low temperature	

1. chem10b 19.2-14

ΔS is positive for the reaction _____.

Student Response	Correct Answer
A. H_2O (l) → H_2O (s)	
B. $2SO_3$ (g) → $2SO_2$ (g) + O_2 (g)	
C. CaO (s) + CO_2 (g) → $CaCO_3$ (s)	
D. Ag^+ (aq) + Cl^- (aq) → AgCl (s)	
E. N_2 (g) + $3H_2$ (g) → $2NH_3$ (g)	

2. chem10b 19.5-2

The value of G° at 100.0 °C for the oxidation of solid elemental sulfur to gaseous sulfur dioxide,

S (s,rhombic) + O_2 (g) → SO_2 (g)

is _____ kJ/mol. At 25.0 °C for this reaction, H° is -269.9 kJ/mol, G° is and

is

Student Response	Correct Answer
A. -4,598	
B. -274.2	

C. -271.1
D. -1,430
E. -265.6

3. chem10b 19.2-1

The first law of thermodynamics can be given as _____.

Student Response	Correct Answer
A. the entropy of a pure crystalline substance at absolute zero is zero	
B. $\Delta E = q + w$	
C. $\Delta S = q_{rev}/T$ at constant temperature	
D. $\Delta H°_{rxn} =$ -	
E. for any spontaneous process, the entropy of the universe increases	

4. chem10b 19.4-2

The vaporization of a substance at its boiling point is an isothermal process

Student Response	Value	Correct Answer

5. chem10b 19.1-8

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K-mol)

Carbon
C (s, diamond) 1.88 2.84 2.43
C (s, graphite) 0 0 5.69
C_2H_2 (g) 226.7 209.2 200.8
C_2H_4 (g) 52.30 68.11 219.4
C_2H_4 (g) -84.68 -32.89 229.5

CO (g) -110.5 -137.2 197.9
CO_2 (g) -393.5 -394.4 213.6

Hydrogen
H_2(g) 0 0 130.58

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

The combustion of ethene in the presence of excess oxygen yields carbon dioxide and water:

C_2H_4 (g) + $3O_2$ (g) → $2CO_2$ (g) + $2H_2O$ (l)

The value of ΔS° for this reaction is _____ J/K.

Student Response	Correct Answer
A. +347.6	
B. -347.6	
C. -140.9	
D. +140.9	
E. -267.4	

6. chem10b 19.2-23

The standard Gibbs free energy of formation of _____ is zero.

(a) H_2O (l)
(b) O (g)
(c) H_2 (g)

Student Response	Correct Answer
A. (a) only	
B. (b) only	
C. (c) only	
D. (b) and (c)	
E. (a), (b), and (c)	

7. chem10b 19.1-33

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

__
Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔG° at 25 °C for the decomposition of gaseous sulfur trioxide to solid elemental sulfur and gaseous oxygen,

$2SO_3$ (g) → 2S (s, rhombic) + $3O_2$ (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. -370.4	
B. -740.8	
C. +740.8	
D. +185.2	
E. +370.4	

8. chem10b 19.1-13

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

__

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔS° for the decomposition of gaseous sulfur trioxide to solid elemental sulfur and gaseous oxygen,

$2SO_3$ (g) → 2S (s, rhombic) + $3O_2$ (g)

is _____ J/K.

Student Response	Correct Answer
A. -493.1	
B. -19.3	
C. +166.4	
D. +493.1	
E. +19.3	

9. chem10b 19.2-29

For a reaction to be spontaneous under standard conditions at all temperatures, the signs of ΔH° andΔS° must be _____ and _____, respectively.

Student Response	Correct Answer
A. +, +	

B. +, -
C. -, +
D. -, -
E. +, 0

10. chem10b 19.2-10

A system that doesn't exchange matter or energy with its surroundings is called an _____ system.

Student Response	Correct Answer
A. adiabatic	
B. isolated	
C. isothermal	
D. isotonic	
E. isobaric	

Score: 1/1

11. chem10b 19.2-3

Of the following, only _____ is not a state function.

Student Response	Correct Answer
A. T	
B. S	
C. q	
D. H	
E. E	

12. chem10b 19.1-7

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

__

Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K-mol)

Carbon

C (s, diamond) 1.88 2.84 2.43
C (s, graphite) 0 0 5.69
C_2H_2 (g) 226.7 209.2 200.8
C_2H_4 (g) 52.30 68.11 219.4
C_2H_4 (g) -84.68 -32.89 229.5
CO (g) -110.5 -137.2 197.9
CO_2 (g) -393.5 -394.4 213.6

Hydrogen
H_2(g) 0 0 130.58

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

The value of ΔS° for the oxidation of carbon to carbon dioxide,

C (s, graphite) + O_2 (g) → CO_2(g)

is _____ J/K. The combustion of carbon, as in charcoal briquettes, in the presence of abundant oxygen produces carbon dioxide.

Student Response	Correct Answer
A. -2.9	
B. -205.0	
C. +424.3	
D. +2.9	
E. +205.0	

---

1. chem10b 19.1-30

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance ΔH°_f (kJ/mol) ΔG°_f (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔH° for the decomposition of calcium chloride into its constituent elements,

$CaCl_2$ (s) → Ca (s) + Cl_2 (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. +397.9	
B. -0.00	
C. -397.9	
D. -795.8	
E. +795.8	

---

2. chem10b 19.1-40

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance ΔH°_f (kJ/mol) ΔG°_f (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔG° at 25 °C for the decomposition of calcium chloride into its constituent elements,

$CaCl_2$ (s) → Ca (s) + Cl_2 (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. -748.1	
B. +795.8	
C. +763.7	
D. +748.1	
E. -795.8	

---

3. chem10b 19.1-34

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1

PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔG° at 25 °C for the decomposition of gaseous sulfur dioxide to solid elemental sulfur and gaseous oxygen,

SO_2 (g) → S (s, rhombic) + O_2 (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. +395.2	
B. +269.9	
C. -269.9	
D. -300.4	
E. +300.4	

4. chem10b 19.2-34

Consider the reaction:

FeO (s) + Fe (s) + O_2 (g) → Fe_2O_3 (s)

Given the following table of thermodynamic data,

determine the temperature (in °C) above which the reaction is nonspontaneous.

Student Response	Correct Answer
A. 756.3	
B. This reaction is spontaneous at all temperatures.	
C. 1235	
D. 2439	
E. 618.1	

Score: 1/1

5. chem10b 19.2-30

Given the following table of thermodynamic data,

complete the following sentence. The vaporization of PCl_3 (l) is _____.

Student Response	Correct Answer
A. spontaneous at low temperature and nonspontaneous at high temperature	
B. nonspontaneous at low temperature and spontaneous at high temperature	
C. nonspontaneous at all temperatures	
D. spontaneous at all temperatures	
E. not enough information given to draw a conclusion	

6. chem10b 19.2-9

The entropy of the universe is _____.

Student Response	Correct Answer
A. continually decreasing	
B. continually increasing	
C. zero	
D. the same as the energy, E	
E. constant	

7. chem10b 19.2-20

Which one of the following correctly indicates the relationship between the entropy of a system and the number of different arrangements, W, in the system?

Student Response	Correct Answer
A. $S =$	

B. S = kW
C. S = Wk
D. S =
E. S = $k \ln W$

8. chem10b 19.1-23

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance	ΔH°_f (kJ/mol)	ΔG°_f (kJ/mol)	S (J/K-mol)
Calcium			
Ca (s)	0	0	41.4
$CaCl_2$ (s)	-795.8	-748.1	104.6
Ca_2^+ (aq)	226.7	209.2	200.8
Chlorine			
Cl_2 (g)	0	0	222.96
Cl- (aq)	-167.2	-131.2	56.5
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	-285.83	-237.13	69.91
Phosphorus			
P_2 (g)	144.3	103.7	218.1
PCl_3 (g)	-288.1	-269.6	311.7
$POCl_3$ (g)	-542.2	-502.5	325
Sulfur			
S (s, rhombic)	0	0	31.88
SO_2(g)	-269.9	-300.4	248.5
SO_3(g)	-395.2	-370.4	256.2

The value of ΔH° for the oxidation of solid elemental sulfur to gaseous sulfur dioxide,

S (s, rhombic) + O_2 (g) → SO_2 (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. +0.00	
B. -11.6	

C. +269.9
D. +11.6
E. -269.9

9. chem10b 19.2-19

Consider a pure crystalline solid that is heated from absolute zero to a temperature above the boiling point of the liquid. Which of the following processes produces the greatest increase in the entropy of the substance?

Student Response	Correct Answer
A. vaporizing the liquid	
B. heating the liquid	
C. melting the solid	
D. heating the solid	
E. heating the gas	

Score: 1/1

10. chem10b 19.1-44

The equilibrium constant for a reaction is 0.48 at 25 °C. What is the value of ΔG° (kJ/mol) at this temperature?

Student Response	Correct Answer
A. 1.5×10^2	
B. -4.2	
C. 4.2	
D. 1.8	
E. More information is needed.	

11. chem10b 19.1-47

Consider the reaction:

$FeO\ (s) + Fe\ (s) + O_2\ (g) \rightarrow Fe_2O_3\ (s)$

Given the following table of thermodynamic data at 298 ^oK:

The value K for the reaction at 25 °C is _____.

Student Response	Correct Answer
A. 8.1×10^{19}	
B. 370	
C. 5.9×10^{4}	
D. 3.8×10^{-14}	
E. 7.1×10^{85}	

12. chem10b 19.2-25

The equilibrium position corresponds to which letter on the graph of G vs f (course of reaction) below?

Student Response	Correct Answer
A. A	
B. B	
C. C	
D. D	
E. E	

1. chem10b 19.1-33

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6

Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔG° at 25 °C for the decomposition of gaseous sulfur trioxide to solid elemental sulfur and gaseous oxygen,

$2SO_3$ (g) → 2S (s, rhombic) + $3O_2$ (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. +370.4	
B. -370.4	
C. +740.8	
D. +185.2	
E. -740.8	

Score: 1/1

---

2. chem10b 19.5-7

In the Haber process, ammonia is synthesized from nitrogen and hydrogen:

N_2 (g) + $3H_2$ (g) → $2NH_3$ (g)

G° at 298 °K for this reaction is -33.3 kJ/mol. The value of G at 298 K for a reaction mixture that consists of 1.9 atm N_2, 1.6 atm H_2, and 0.65 atm NH_3 is _____.

Student Response	Correct Answer

A. -7.25×10^3
B. -3.86×10^3
C. -1.8
D. -40.5
E. -104.5

3. chem10b 19.1-17

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔS° for the formation of phosphorous trichloride from its constituent elements,

P_2 (g) + $3Cl_2$ (g) → $2PCl_3$ (g)

is _____ J/K.

Student Response	Correct Answer
A. +129.4	
B. -263.7	

C. -129.4
D. -311.7
E. +311.7

4. chem10b 19.1-39

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔG° at 25 °C for the formation of calcium chloride from its constituent elements,

$Ca\ (s) + Cl_2\ (g) \rightarrow CaCl_2\ (s)$

is _____ kJ/mol.

Student Response	Correct Answer
A. +795.8	
B. +748.1	
C. -748.1	

D. -795.8
E. +763.7

5. chem10b 19.1-2

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K-mol)

Carbon
C (s, diamond) 1.88 2.84 2.43
C (s, graphite) 0 0 5.69
C_2H_2 (g) 226.7 209.2 200.8
C_2H_4 (g) 52.30 68.11 219.4
C_2H_4 (g) -84.68 -32.89 229.5
CO (g) -110.5 -137.2 197.9
CO_2 (g) -393.5 -394.4 213.6

Hydrogen
H_2(g) 0 0 130.58

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

The combustion of acetylene in the presence of excess oxygen yields carbon dioxide and water:

$2C_2H_2\ (g) + 5O_2\ (g) \rightarrow 4CO_2\ (g) + 2H_2O\ (l)$

The value of ΔS^{o} for this reaction is _____ J/K.

Student Response	Correct Answer
A. +432.4	
B. -122.3	
C. +122.3	
D. -432.4	
E. +689.3	

6. chem10b 19.2-31

Given the following table of thermodynamic data,

complete the following sentence. The vaporization of $TiCl_4$ is _____.

Student Response	Correct Answer
A. spontaneous at low temperature and nonspontaneous at high temperature	
B. spontaneous at all temperatures	
C. nonspontaneous at low temperature and spontaneous at high temperature	
D. nonspontaneous at all temperatures	
E. not enough information given to draw a conclusion	

7. chem10b 19.1-15

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of $\Delta S°$ for the formation of $POCl_3$ from its constituent elements,

P_2 (g) + O_2 (g) + 3Cl_2 (g) → 2$POCl_3$ (g)

is _____ J/K.

Student Response	Correct Answer
A. -771	
B. -442	
C. +771	
D. +321	
E. -321	

8. chem10b 19.2-16

Which reaction produces an increase in the entropy of the system?

Student Response	Correct Answer
A. N_2 (g) + 3 H_2 (g) → 2 NH_3 (g)	
B. H_2 (g) + Cl_2 (g) → 2 HCl (g)	
C. Ag^+ (aq) + Cl^- (aq) → AgCl (s)	
D. H_2O (l) → H_2O (s)	
E. CO_2 (s) → CO_2 (g)	

9. chem10b 19.4-5

The more negative ΔG is for a given reaction, the larger the value of the corresponding equilibrium constant, K.

Student Response	Value	Correct Answer

10. chem10b 19.1-47

Consider the reaction:

FeO (s) + Fe (s) + O_2 (g) → Fe_2O_3 (s)

Given the following table of thermodynamic data at 298 ^{o}K:

The value K for the reaction at 25 °C is _____.

Student Response	Correct Answer
A. 3.8×10^{-14}	
B. 5.9×10^{4}	
C. 370	
D. 8.1×10^{19}	
E. 7.1×10^{85}	

11. chem10b 19.2-19

Consider a pure crystalline solid that is heated from absolute zero to a temperature above the boiling point of the liquid. Which of the following processes produces the greatest increase in the entropy of the substance?

Student Response	Correct Answer
A. heating the liquid	
B. melting the solid	
C. vaporizing the liquid	
D. heating the solid	
E. heating the gas	

12. chem10b 19.5-4

The value of G° at 100.0 °C for the formation of calcium chloride from its constituent elements:

Ca (s) + Cl_2 (g) → $CaCl_2$ (s)

is _____ kJ/mol. At 25.0 ^{o}C for this reaction, H° is -795.8 kJ/mol, G° is -748.1

kJ/mol, and is

Student Response	Correct Answer
A. -855.4	
B. -779.8	
C. 5.88×10^4	
D. -736.2	
E. 1.52×10^4	

1. chem10b 19.1-17

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔS° for the formation of phosphorous trichloride from its constituent elements,

P_2 (g) + $3Cl_2$ (g) → $2PCl_3$ (g)

is _____ J/K.

Student Response	Correct Answer
A. +311.7	
B. +129.4	
C. -311.7	
D. -129.4	
E. -263.7	

2. chem10b 19.2-35

With thermodynamics, one cannot determine _____.

Student Response	Correct Answer
A. the direction of a spontaneous reaction	
B. the speed of a reaction	
C. the value of the equilibrium constant	
D. the temperature at which a reaction will be spontaneous	
E. the extent of a reaction	

3. chem10b 19.1-29

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7

$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔH° for the formation of calcium chloride from its constituent elements,

$Ca\ (s) + Cl_2\ (g) \rightarrow CaCl_2\ (s)$

is _____ kJ/mol.

Student Response	Correct Answer
A. +397.9	
B. +0.00	
C. +795.8	
D. -397.9	
E. -795.8	

---

4. chem10b 19.1-25

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88

SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔH° for the formation of $POCl_3$ from its constituent elements,

P_2 (g) + O_2 (g) + 3Cl_2 (g) → 2$POCl_3$ (g)

is _____ kJ/mol.

Student Response	Correct Answer
A. +1228.7	
B. -1228.7	
C. +686.5	
D. -397.7	
E. -686.5	

5. chem10b 19.1-21

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance ΔH°_f (kJ/mol) ΔG°_f (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔH° for the oxidation of solid elemental sulfur to gaseous sulfur trioxide,

$2S\ (s, rhombic) + 3O_2(\ g) \rightarrow 2SO_3\ (g)$

is _____ kJ/mol.

Student Response	Correct Answer
A. -395.2	
B. +395.2	
C. +105.1	
D. -790.4	
E. +790.4	

6. chem10b 19.1-22

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔH° for the decomposition of gaseous sulfur trioxide to its component elements,

$2SO_3\ (g) \rightarrow 2S\ (s, rhombic) + 3O_2\ (g)$

is _____ kJ/mol.

Student Response	Correct Answer
A. -395.2	
B. +790.4	
C. +105.1	
D. +395.2	
E. -790.4	

---

7. chem10b 19.1-42

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25°C)

Substance $\Delta H°_f$ (kJ/mol) $\Delta G°_f$ (kJ/mol) S (J/K-mol)

Calcium
Ca (s) 0 0 41.4
$CaCl_2$ (s) -795.8 -748.1 104.6
Ca_2^+ (aq) 226.7 209.2 200.8

Chlorine
Cl_2 (g) 0 0 222.96
Cl- (aq) -167.2 -131.2 56.5

Oxygen
O_2 (g) 0 0 205.0
H_2O (l) -285.83 -237.13 69.91

Phosphorus
P_2 (g) 144.3 103.7 218.1
PCl_3 (g) -288.1 -269.6 311.7
$POCl_3$ (g) -542.2 -502.5 325

Sulfur
S (s, rhombic) 0 0 31.88
SO_2(g) -269.9 -300.4 248.5
SO_3(g) -395.2 -370.4 256.2

The value of ΔG° at 373 K for the oxidation of solid elemental sulfur to gaseous sulfur trioxide,

$2S\ (s, rhombic) + 3O_2\ (g) \rightarrow 2SO_3\ (g)$

is _____ kJ/mol.

Student Response	Correct Answer
A. -740.8	
B. -61.3	
C. +740.8	
D. +61.3	
E. -728.3	

8. chem10b 19.5-8

Phosphorous and chlorine gases combine to produce phosphorous trichloride:

P_2 (g) + $3Cl_2$ (g) → $2PCl_3$ (g)

$\Delta G°$ at 298 ^oK for this reaction is -642.9 kJ/mol. The value of ΔG at 298 K for a reaction mixture that consists of 1.52 atm P2, 1.62 atm Cl2 and 0.65 atm is _____.

Student Response	Correct Answer
A. -44.2	
B. -708.4	
C. -3.88×10^3	
D. -649.5	
E. -7.28×10^3	

9. chem10b 19.5-2

The value of $\Delta G°$ at 100.0 °C for the oxidation of solid elemental sulfur to gaseous sulfur dioxide,

S (s,rhombic) + O_2 (g) → SO_2 (g)

is _____ kJ/mol. At 25.0 ^oC for this reaction, $\Delta H°$ is -269.9 kJ/mol, $\Delta G°$ is -300.4 kJ/mol and $\Delta S°$ is +11.6 J/mol-K

Student Response	Correct Answer
A. -265.6	
B. -271.1	
C. -274.2	

D. -4,598	
E. -1,430	

10. chem10b 19.2-30

Given the following table of thermodynamic data,

delta H is positive delta S is positive

complete the following sentence. The vaporization of PCl_3 (l) is _____.

Student Response	Correct Answer
A. spontaneous at low temperature and nonspontaneous at high temperature	
B. nonspontaneous at low temperature and spontaneous at high temperature	
C. nonspontaneous at all temperatures	
D. spontaneous at all temperatures	
E. not enough information given to draw a conclusion	

11. chem10b 19.2-5

A reversible process is one that _____.

Student Response	Correct Answer
A. can be reversed with no net change in either system or surroundings	
B. must be carried out at high temperature	
C. is spontaneous in both directions	
D. happens spontaneously	
E. must be carried out at low temperature	

Score: 0/1

12. chem10b 19.2-23

The standard Gibbs free energy of formation of _____ is zero.

(a) H_2O (l)

(b) O (g)
(c) H_2 (g)

Student Response	Correct Answer
A. (a) only	
B. (b) only	
C. (c) only	
D. (b) and (c)	
E. (a), (b), and (c)	