
When computed on a calculator, the algebraic expression \( \frac{40.00 \text{ kg} \times 486 \text{ J}}{(6.1 \times 10^2 \text{ m} + 27.6 \text{ m})} \) has a value of 30.48933501. Expressed to the appropriate number of significant figures, this is:

a) 30 kg J m\(^{-1}\)
b) 30. kg J m\(^{-1}\)
c) 30.4 kg J m\(^{-1}\)
d) 30.5 kg J m\(^{-1}\)
e) 30.49 kg J m\(^{-1}\)

2. A particular chemical reaction has \( \Delta H^\circ = +5 \text{ kJ mol}^{-1} \) and \( \Delta S^\circ = +25 \text{ J K}^{-1} \text{ mol}^{-1} \). Assuming that these values do not change with temperature, in what temperature range is this reaction spontaneous?

a) It is spontaneous at all temperatures
b) It is not spontaneous at any temperature
c) \( T > 200 \text{ K} \)
d) \( T < 200 \text{ K} \)
e) \( T < -200 \text{ K} \)

An ideal gas receives 245 J of heat and expands by 1.30 L against an external pressure of 60.0 kPa. What is the change in internal energy of the system?

a) +167 J  b) +323 J  c) –323 J  d) –167 J  e) 0 J

4. Use the data below to calculate \( \Delta_{\text{universe}}S^\circ \) for the deposition of iodine at 298 K.

\[
\begin{array}{ccc}
\text{I}_2(\text{s}) & \Delta H^\circ (\text{kJ mol}^{-1}) & S^\circ (\text{J K}^{-1} \text{ mol}^{-1}) \\
\hline
0.00 & 116 \\
62.0 & 261 \\
\end{array}
\]

5. In which one of the following processes does the entropy of the system decrease? Assume constant temperature and pressure unless specifically indicated otherwise.

a) \( \text{CO}_2(\text{s}) \rightarrow \text{CO}_2(\text{g}) \)
b) 1 mol H\(_2\)(g) at 10 atm \( \rightarrow \) 1 mol H\(_2\)(g) at 1 atm
c) \( \text{O}_2(\text{g}) + 2\text{CO}(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) \)
d) \( \text{C}_2\text{H}_5\text{OH}(\text{l}) \text{ at 20}^\circ\text{C} \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l}) \text{ at 200}^\circ\text{C} \)
e) \( \text{C}_8\text{H}_{14}(\text{l}) \rightarrow \text{C}_4\text{H}_6(\text{g}) + \text{C}_4\text{H}_8(\text{g}) \)
Questions 5 and 6 refer to the following reaction:

\[ 2\text{NO}_2(g) \rightleftharpoons \text{N}_2\text{O}_4(g) \]

\( K_p = 7.1 \) at 25 °C and \( K_p = 0.31 \) at 70 °C with reference to a standard state of \( 1 \times 10^5 \) Pa pressure.

6. Which one of the following statements is true?
   a) \( \Delta_r H^\circ > 0 \) and \( \Delta_r S^\circ > 0 \)
   b) \( \Delta_r H^\circ < 0 \) and \( \Delta_r S^\circ > 0 \)
   c) \( \Delta_r H^\circ < 0 \) and \( \Delta_r S^\circ < 0 \)
   d) \( \Delta_r H^\circ > 0 \) and \( \Delta_r S^\circ < 0 \)
   e) There is insufficient information to work out both signs.

7. Which is closest to the value of \( K_p \) for the following reaction at 25 °C?
   a) –7.1
   b) –3.6
   c) 0.14
   d) 0.38
   e) 0.020

8. Methanol, \( \text{CH}_3\text{OH} \), (8.011 g) was burnt in excess oxygen to yield liquid water and \( \text{CO}_2(g) \). 181.8 kJ of heat energy was liberated at 298 K and 101.3 kPa. The equation for the reaction is:

\[ 2\text{CH}_3\text{OH}(l) + 3\text{O}_2(g) \rightarrow 4\text{H}_2\text{O}(l) + 2\text{CO}_2(g) \]

What is the heat of combustion, \( \Delta H^\circ_{298} \) (in kJ mol\(^{-1}\)) for methanol?
   a) –363.5
   b) +363.5
   c) +181.8
   d) –727.2
   e) +727.2

9. Given the following thermochemical data, what is the enthalpy of formation \( \Delta f H^\circ_{298} \) for \( \text{C}_6\text{H}_6(l) \) at 298 K and 101.3 kPa?
   a) +329 kJ mol\(^{-1}\)
   b) +206 kJ mol\(^{-1}\)
   c) +83 kJ mol\(^{-1}\)
   d) –83 kJ mol\(^{-1}\)
   e) –329 kJ mol\(^{-1}\)

10. Samples of A (2.0 mol) and B (3.0 mol) are placed in a 10.0 L container and the following reaction takes place:

\[ 2\text{A}(g) \rightleftharpoons 3\text{B}(g) \]

At equilibrium, the concentration of A is 0.14 M. What is the value of \( K_c \)?
   a) 3.0
   b) 0.33
   c) 2.4
   d) 0.42
   e) 6.8

Correct answers: 1B, 2C, 3A, 4C, 5C, 6C, 7D, 8D, 9C, 10A

When computed on a calculator, the algebraic expression \( \frac{3.69 \text{ kg} \times 30. \text{ J}}{(87.1 \text{ m} + 98.5 \text{ m})} \) has a value of 0.596443966. Expressed to the appropriate number of significant figures, this is:

a) 0.5 kg J m\(^{-1}\)
b) 0.6 kg J m\(^{-1}\)
c) 0.59 kg J m\(^{-1}\)
d) 0.60 kg J m\(^{-1}\)
e) 0.596 kg J m\(^{-1}\)

2. A particular chemical reaction has \( \Delta H^\circ = -5 \text{ kJ mol}^{-1} \) and \( \Delta S^\circ = +25 \text{ J K}^{-1} \text{ mol}^{-1} \). Assuming that these values do not change with temperature, in what temperature range is \( \Delta G^\circ \) negative?

a) at all temperatures
b) at no temperature
c) \( T > 200 \text{ K} \)
d) \( T < 200 \text{ K} \)
e) \( T < -200 \text{ K} \)

3. An ideal gas receives 245 J of heat and contracts by 1.30 L against an external pressure of 60.0 kPa. What is the change in internal energy of the system?

a) +167 b) +323 J c) −323 J d) −167 J e) 0 J

4. Use the data below to calculate \( \Delta_{\text{universe}} S^\circ \) for the sublimation of iodine at 298 K.

<table>
<thead>
<tr>
<th></th>
<th>( \Delta H^\circ ) (kJ mol(^{-1}))</th>
<th>( S^\circ ) (J K(^{-1}) mol(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>I(_2)(s)</td>
<td>0.00</td>
<td>116</td>
</tr>
<tr>
<td>I(_2)(g)</td>
<td>62</td>
<td>261</td>
</tr>
</tbody>
</table>

a) −353. J K\(^{-1}\) mol\(^{-1}\)
b) −63.1 J K\(^{-1}\) mol\(^{-1}\)
c) +63.1 J K\(^{-1}\) mol\(^{-1}\)
d) +353 J K\(^{-1}\) mol\(^{-1}\)
e) +377 J K\(^{-1}\) mol\(^{-1}\)

5. In which one of the following processes does the entropy of the system increase? Assume constant temperature and pressure unless specifically indicated otherwise.

a) \( \text{CO}_2(g) \rightarrow \text{CO}_2(s) \)
b) 1 mol H\(_2\)(g) at 1 atm \rightarrow 1 mol H\(_2\)(g) at 10 atm
c) 2CO\(_2\)(g) \rightarrow O\(_2\)(g) + 2CO(g)
d) C\(_2\)H\(_5\)OH(l) at 40 °C \rightarrow C\(_2\)H\(_5\)OH(l) at 20 °C
e) C\(_4\)H\(_6\)(g) + C\(_4\)H\(_8\)(g) \rightarrow C\(_8\)H\(_{14}\)(l)
Questions 5 and 6 refer to the following reaction: \( \text{N}_2\text{O}_4(g) \rightleftharpoons 2\text{NO}_2(g) \)

\( K_p = 0.14 \) at 25 °C and \( K_p = 0.18 \) at 70 °C with reference to a standard state of \( 1 \times 10^5 \) Pa pressure.

6. Which one of the following statements is true?
   a) \( \Delta r H^\circ > 0 \) and \( \Delta r S^\circ > 0 \)
   b) \( \Delta r H^\circ < 0 \) and \( \Delta r S^\circ > 0 \)
   c) \( \Delta r H^\circ < 0 \) and \( \Delta r S^\circ < 0 \)
   d) \( \Delta r H^\circ > 0 \) and \( \Delta r S^\circ < 0 \)
   e) There is insufficient information to work out both signs.

7. Which is closest to the value of \( K_p \) for the following reaction at 25 °C?
   a) 7.1
   b) -3.6
   c) 51
   d) 0.14
   e) 0.37

8. Acetone, \( \text{CH}_3\text{COCH}_3 \), (5.808 g) was burnt in excess oxygen to yield liquid water and \( \text{CO}_2 \). 179.0 kJ of heat energy was liberated at 298 K and 101.3 kPa. The equation for the reaction is:
   \( \text{CH}_3\text{COCH}_3(l) + 4\text{O}_2(g) \rightarrow 3\text{H}_2\text{O}(l) + 3\text{CO}_2(g) \)

   What is the heat of combustion, \( \Delta H^\circ_{298} \) (in kJ mol\(^{-1}\)) for acetone?
   a) –1790.
   b) –179.0
   c) –17.90
   d) +179.0
   e) +1790.

9. Given the following thermochemical data, what is the enthalpy of formation \( \Delta f H^\circ_{298} \) for \( \text{PF}_5 \) at 298 K and 100 kPa?
   a) +582 kJ mol\(^{-1}\)
   b) –1163 kJ mol\(^{-1}\)
   c) –1257 kJ mol\(^{-1}\)
   d) –1594 kJ mol\(^{-1}\)
   e) –2513 kJ mol\(^{-1}\)

10. Samples of A (4.0 mol) and B (2.0 mol) are placed in a 5.0 L container and the following reaction takes place
    \( 3\text{A}(g) \rightleftharpoons 2\text{B}(g) \)

    At equilibrium, the concentration of A is 0.82 M. What is the value of \( K_c \)?
    a) 0.27
    b) 0.31
    c) 2.4
    d) 4.0
    e) 30.

Correct answers: 1D, 2A, 3B, 4B, 5C, 6F, 7C, 8A, 9D, 10B

Quiz (ii) needs checking.