

1. Reference: <http://firstyear.chem.usyd.edu.au/LabManual/W5.pdf>

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) $T < -200 \text{ K}$
3. 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.

- a) -353 J K⁻¹ mol⁻¹
b) -63 J K⁻¹ mol⁻¹
c) +63 J K⁻¹ mol⁻¹
d) +353 J K⁻¹ mol⁻¹
e) +377 J K⁻¹ mol⁻¹

	$\Delta_f H^\circ$ (kJ mol ⁻¹)	S° (J K ⁻¹ mol ⁻¹)
I ₂ (s)	0.00	116
I ₂ (g)	62.0	261

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) CO₂(s) → CO₂(g)
b) 1 mol H₂(g) at 10 atm → 1 mol H₂(g) at 1 atm
c) O₂(g) + 2CO(g) → 2CO₂(g)
d) C₂H₅OH(l) at 20°C → C₂H₅OH(l) at 200°C
e) C₈H₁₄(l) → C₄H₆(g) + C₄H₈(g)

Questions 5 and 6 refer to the following reaction: $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
 $K_p = 7.1$ at 25°C and $K_p = 0.31$ at 70°C with reference to a standard state of 1×10^5 Pa pressure.

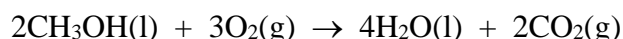
6. Which one of the following statements is true?

- 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 $\frac{1}{2}\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons \text{NO}_2(\text{g})$
- b) -3.6
- c) 0.14
- d) 0.38
- e) 0.020

8. Methanol, CH_3OH , (8.011 g) was burnt in excess oxygen to yield liquid water and $\text{CO}_2(\text{g})$. 181.8 kJ of heat energy was liberated at 298 K and 101.3 kPa. The equation for the reaction is:



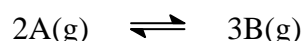
What is the heat of combustion, ΔH°_{298} (in kJ mol^{-1}) for methanol?

- 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 $\text{C}_6\text{H}_6(\text{l})$ at 298 K and 101.3 kPa?

- a) $+329 \text{ kJ mol}^{-1}$ $\text{C}_6\text{H}_6(\text{l}) + 3\text{H}_2(\text{g}) \rightarrow \text{C}_6\text{H}_{12}(\text{l})$ $\Delta H^\circ = -206 \text{ kJ mol}^{-1}$
- b) $+206 \text{ kJ mol}^{-1}$ $6\text{H}_2(\text{g}) + 6\text{C}(\text{s}) \rightarrow \text{C}_6\text{H}_{12}(\text{l})$ $\Delta H^\circ = -123 \text{ kJ mol}^{-1}$
- c) $+83 \text{ kJ mol}^{-1}$
- 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



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

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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 ΔG° 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.

	$\Delta_f H^\circ$ (kJ mol ⁻¹)	S° (J K ⁻¹ mol ⁻¹)
I ₂ (s)	0.00	116
I ₂ (g)	62	261

- 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) CO₂(g) → CO₂(s)
b) 1 mol H₂(g) at 1 atm → 1 mol H₂(g) at 10 atm
c) 2CO₂(g) → O₂(g) + 2CO(g)
d) C₂H₅OH(l) at 40 °C → C₂H₅OH(l) at 20 °C
e) C₄H₆(g) + C₄H₈(g) → C₈H₁₄(l)

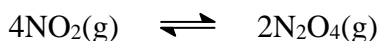
Questions 5 and 6 refer to the following reaction: $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
 $K_p = 0.14$ at $25\text{ }^\circ\text{C}$ and $K_p = 0.18$ at $70\text{ }^\circ\text{C}$ with reference to a standard state of 1×10^5 Pa pressure.

6. Which one of the following statements is true?

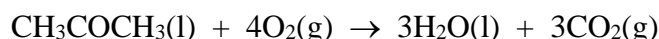
- a) $\Delta_r H^\circ > 0$ and $\Delta_r S^\circ > 0$
- b) $\Delta_r H^\circ < 0$ and $\Delta_r S^\circ > 0$
- c) $\Delta_r H^\circ < 0$ and $\Delta_r S^\circ < 0$
- d) $\Delta_r H^\circ > 0$ and $\Delta_r S^\circ < 0$
- e) There is insufficient information to work out both signs.

7. Which is closest to the value of K_p for the following reaction at $25\text{ }^\circ\text{C}$?

- a) 7.1
- b) -3.6
- c) 51
- d) 0.14
- e) 0.37



8. Acetone, CH_3COCH_3 , (5.808 g) was burnt in excess oxygen to yield liquid water and $\text{CO}_2(\text{g})$. 179.0 kJ of heat energy was liberated at 298 K and 101.3 kPa. The equation for the reaction is:

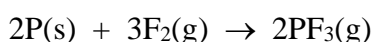


What is the heat of combustion, ΔH°_{298} (in kJ mol^{-1}) for acetone?

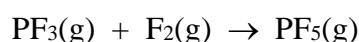
- a) -1790.
- b) -179.0
- c) -17.90
- d) +179.0
- e) +1790.

9. Given the following thermochemical data, what is the enthalpy of formation $\Delta_f H^\circ_{298}$ for $\text{PF}_5(\text{g})$ at 298 K and 100 kPa?

- a) $+582\text{ kJ mol}^{-1}$
- b) -1163 kJ mol^{-1}
- c) -1257 kJ mol^{-1}
- d) -1594 kJ mol^{-1}
- e) -2513 kJ mol^{-1}



$$\Delta H^\circ = -1838\text{ kJ mol}^{-1}$$



$$\Delta H^\circ = -675\text{ kJ mol}^{-1}$$

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

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, 6A, 7C, 8A, 9D, 10B

Quiz (ii) needs checking.