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

2. A buffered solution is 0.0500 M CH$_3$CO$_2$H and 0.0400 M NaCH$_3$CO$_2$. If 0.0100 mol of gaseous HCl is added to 1.00 L of the buffered solution, what is the final pH of the solution? For acetic acid, $pK_a = 4.74$ (Hint: Use $\text{pH} = pK_a + \log\left(\frac{[A^-]}{[HA]}\right)$)
   a) 4.74
   b) 4.44#
   c) 4.64
   d) 4.84
   e) 4.56

3. What is the pH of a 0.20 M solution of boric acid? The $pK_a$ of boric acid is 9.24.
   a) 0.70
   b) 2.73
   c) 4.97#
   d) 5.12
   e) 5.87

4. Consider the following galvanic cell and standard reduction potentials:

   $\text{Au}^{3+}(aq) + 3e^- \rightarrow \text{Au}(s)$ \hspace{1cm} $E^\circ = 1.50 \text{V}$
   $\text{Ag}^+(aq) + e^- \rightarrow \text{Ag}(s)$ \hspace{1cm} $E^\circ = 0.80 \text{V}$

Which one of the following statements is FALSE?
   a) The cell on the left containing Au$^{3+}$(aq) is the cathode.
   b) Electrons flow from the cell on the right to the cell on the left.
   c) Oxidation occurs in the cell on the right containing Ag$^+(aq)$.
   d) Negative charges will flow through the salt bridge from right to left. #
   e) Metallic gold will deposit on the electrode in the left hand cell.

5. What is $E^\circ$ for the cell in Q4.
   a) 0.70 V#
   b) 1.50 V
   c) 2.30 V
   d) 0.90 V
   e) 0.00 V
6. 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

\[ 2A(g) \rightleftharpoons 3B(g) \]

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

7. What is the molecular formula of the following compound?

a) \( C_9H_9NO \)

b) \( C_9H_{10}NO \)

c) \( C_{10}H_{10}NO \)

d) \( C_{10}H_{11}NO \# \)

e) \( C_{10}H_{12}NO \)

8. Which one of the following functional groups is incorrectly labelled?

a) alkene

b) amine

c) aldehyde#  

d) ketone

e) carboxylic acid

9. What is the hybridisation of the designated atoms in the following compound?

a) \( P = sp^2, Q = sp^3, R = sp \)

b) \( P = sp^3, Q = sp^2, R = sp^2 \)

c) \( P = sp^2, Q = sp^3, R = sp^3 \# \)

d) \( P = sp^3, Q = sp^3, R = sp^3 \)

e) \( P = sp^2, Q = sp^3, R = sp^2 \)

10. What is the major product from the addition of HBr to 1-butene? #d

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