1. A buffered solution is 0.0500 M CH₃CO₂H and 0.0400 M NaCH₃CO₂. 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, $pK_a = 4.76$

   a) 4.76   b) 4.46   c) 4.66   d) 4.86   e) 4.54

2. In each of the following titrations, the first solution is in the burette and the second solution is 
in the titration flask. For which titration would the curve illustrated be typical?

   a) Na₂CO₃ (0.05 M) / HCl (0.1 M) 
   b) NaOH (0.1 M) / HI (0.1 M) 
   c) NaOH (0.1 M) / CH₃COOH (0.1 M) 
   d) NH₃ (0.1 M) / CH₃COOH (0.1 M) 
   e) NH₃ (0.1 M) / HCl (0.1 M)

3. In which of the following are the atoms arranged in order of INCREASING first ionisation 
energy?

   a) Ne, F, O, C 
   b) Te, Se, S, O 
   c) Ca, K, Cl, Ar 
   d) He, Ne, Ar, Kr 
   e) N, P, K, Rb

4. Alongside H₂O, what are the major species present in a 1.0 M solution of HCl?

   a) HCl(aq), H₃O⁺(aq) and Cl⁻(aq) 
   b) H₃O⁺(aq) and Cl⁻(aq) 
   c) HCl(aq) 
   d) HCl(aq), H₃O⁺(aq), OH⁻(aq) and Cl(aq) 
   e) H₃O⁺(aq), OH⁻(aq) and Cl⁻(aq)
5. Which one of the following statements concerning crystal structures is correct?
   a) The arrangement of layers in the hexagonal close-packed structure (hcp) is abcabcabc….
   b) The coordination number in a body-centred cubic unit cell of iron is 8.
   c) The packing efficiency of the face-centred cubic unit cell of calcium is 68%.
   d) The packing efficiency of strontium, which has hexagonal close-packed structure, is 52%.
   e) The body-centred cubic unit cell of tungsten contains 4 atoms per unit cell.

6. The unit cell below has anions (X) at the corners and cations (M) in the centre of the cell. What is the formula of the compound?
   a) MX
   b) MX₂
   c) M₂X₃
   d) M₂X
   e) MX₃

7. The $K_{sp}$ for silver chloride is $1.8 \times 10^{-10}$ at 25 °C. What is the solubility of silver chloride (in mol L⁻¹) in 0.025 M tin(IV) chloride solution?
   a) $8.5 \times 10^{-5}$
   b) $6.7 \times 10^{-8}$
   c) $7.2 \times 10^{-9}$
   d) $1.8 \times 10^{-9}$
   e) $1.3 \times 10^{-5}$

Questions 8 & 9 refer to the solubility of lead chromate, PbCrO₄:

8. The $K_{sp}$ for PbCrO₄ is $2.0 \times 10^{-16}$ at 25 °C. What is the solubility of PbCrO₄ in mol L⁻¹?
   a) $1.4 \times 10^{-8}$
   b) $2.8 \times 10^{-8}$
   c) $2.0 \times 10^{-16}$
   d) $7.1 \times 10^{7}$
   e) $5.0 \times 10^{15}$

9. If 5.0 mL of $1.0 \times 10^{-5}$ M Pb(NO₃)₂ is added to 5.0 mL of a solution of $1.0 \times 10^{-10}$ M K₂CrO₄, which statement is correct?
   a) The ionic product is $1.0 \times 10^{-15}$ and PbCrO₄(s) precipitates.
   b) The ionic product is $2.5 \times 10^{-16}$ and PbCrO₄(s) does not precipitate.
   c) The ionic product is $1.0 \times 10^{-15}$ and PbCrO₄(s) does not precipitate.
   d) The ionic product is $2.5 \times 10^{-16}$ and PbCrO₄(s) precipitates.
   e) none of the above

10. How many different stereoisomers (i.e. geometrical and optical isomers) of the complex [Co(en)]³⁺ are possible? en = ethane-1,2-diamine = ethylenediamine = NH₂CH₂CH₂NH₂
    a) 1
    b) 2
    c) 3
    d) 4
    e) 5

Correct answers: 1B, 2B, 3B, 4B, 5B, 6A, 7D, 8A, 9D, 10B
1. A buffered solution is 0.450 M CH₃CO₂H and 0.450 M NaCH₃CO₂. If 0.0800 mol of solid NaOH is added to 1.00 L of the buffered solution, what is the final pH of the solution? For acetic acid, \( pK_a = 4.76 \) \( \text{(Hint: Use the Henderson-Hasselbalch Equation)} \)
   a) 4.58   b) 4.60   c) 4.76   d) 4.90   e) 4.92

2. In each of the following titrations, the first solution is in the titration flask and the second solution is in the burette. For which titration would the curve illustrated be typical?
   ![Graph showing pH vs. Volume added]
   a) Na₂CO₃ (0.05 M) / HCl (0.1 M)
   b) NaOH (0.1 M) / HI (0.1 M)
   c) NaOH (0.1 M) / CH₃COOH (0.1 M)
   d) NH₃ (0.1 M) / CH₃COOH (0.1 M)
   e) NH₃ (0.1 M) / HCl (0.1 M)

3. In which of the following are the ions arranged in order of DECREASING ionic radius?
   a) Sn⁴⁺, In³⁺, Sr²⁺, Rb⁺
   b) Na⁺, Mg²⁺, O²⁻, F⁻
   c) I⁻, Cl⁻, Br⁻, F⁻
   d) Cs⁺, Ba²⁺, Tl³⁺, Pb⁴⁺
   e) Mg²⁺, Al³⁺, S²⁻, Cl⁻

4. Alongside H₂O, what are the major species present in a 1.0 M solution of NaCN?
   a) NaCN(aq)
   b) HCN(aq), Na⁺(aq) and CN⁻(aq)
   c) HCN(aq), OH⁻(aq), Na⁺(aq) and CN⁻(aq)
   d) Na⁺(aq) and CN⁻(aq)
   e) CN⁻(aq), H₃O⁺(aq), OH⁻(aq) and Na⁺(aq)
5. Which one of the following statements concerning crystal structures is correct?
a) The arrangement of layers in the cubic close-packed structure (ccp) is abcabcabc….
b) The coordination number in a body-centred cubic unit cell of iron is 6.
c) The primitive cubic unit cell of polonium contains 2 atoms per unit cell.
d) The packing efficiency of the primitive cubic unit cell of polonium is 68%.
e) The packing efficiency of magnesium, which has hexagonal close-packed structure, is 68%.

6. The unit cell below has anions (X) at the corners and cations (M) in the centre of each face. What is the formula of the compound?
a) MX  
b) MX₂  
c) M₂X  
d) M₂X  
e) M₂X₃

7. The $K_{sp}$ for barium sulfate is $1.1 \times 10^{-10}$ at 25 °C. What is the solubility of barium sulfate (in mol L⁻¹) in 0.1 M iron(III) sulfate solution?
a) $1.1 \times 10^{-10}$  
b) $2.2 \times 10^{-10}$  
c) $3.7 \times 10^{-10}$  
d) $5.5 \times 10^{-10}$  
e) $1.0 \times 10^{-5}$

Questions 8 & 9 refer to the solubility of iron(II) phosphate, $\text{Fe}_3(\text{PO}_4)_2$:

$\text{Fe}_3(\text{PO}_4)_2(s) \rightleftharpoons 3\text{Fe}^{2+}(aq) + 2\text{PO}_4^{3-}(aq)$

8. The $K_{sp}$ for $\text{Fe}_3(\text{PO}_4)_2(s)$ is $1.0 \times 10^{-36}$ at 25 °C. What is the solubility of $\text{Fe}_3(\text{PO}_4)_2$ in mol L⁻¹?
a) $2.5 \times 10^{-8}$  
b) $3.1 \times 10^{-8}$  
c) $6.3 \times 10^{-8}$  
d) $1.0 \times 10^{-7}$  
e) $4.0 \times 10^{-7}$

9. If 25.0 mL of $2.0 \times 10^{-5}$ M FeSO₄ is added to 25.0 mL of a solution of $1.0 \times 10^{-10}$ M K₃PO₄, which statement is correct?
a) The ionic product is $8.0 \times 10^{-35}$ and $\text{Fe}_3(\text{PO}_4)_2(s)$ precipitates.
b) The ionic product is $2.5 \times 10^{-36}$ and $\text{Fe}_3(\text{PO}_4)_2(s)$ precipitates.
c) The ionic product is $8.0 \times 10^{-35}$ and $\text{Fe}_3(\text{PO}_4)_2(s)$ does not precipitate.
d) The ionic product is $2.5 \times 10^{-36}$ and $\text{Fe}_3(\text{PO}_4)_2(s)$ does not precipitate.
e) none of the above

10. How many different stereoisomers (i.e. geometrical and optical isomers) of the complex $[\text{Co(en)}\text{BrCl(CN)F}]^-$ are possible? en = ethylenediamine = NH₂CH₂CH₂NH₂
a) 4  
b) 6  
c) 8  
d) 12  
e) 16

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