

HAS University of Applied science

Chemistry - deficiency for HBM

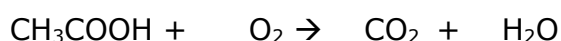
Trial exam exercises 2022

- For a pass, you need 10 or more (out of 18) correct answers.
- The correct answers are on the final page, including short explanations.
- The use of a calculator is allowed. Two tables are annexed:
 - Periodic Table of the Elements, Appendix 1
 - Redox table, Appendix 2.

1. A fertilizer consists for 80% of its weight of $(\text{NH}_4)_2\text{SO}_4$.
What is the N-percentage (weight) of this fertilizer?

- a. 8,5% (or 0,085)
- b. 10% (or 0,10)
- c. 17% (or 0,17)
- d. 21% (or 0,21)

2. Balance the following equation:



- a. $\text{CH}_3\text{COOH} + \text{O}_2 \rightarrow \text{C}_2\text{O}_2 + 2 \text{H}_2\text{O}$
- b. $\text{CH}_3\text{COOH} + \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2\text{O}$
- c. $\text{CH}_3\text{COOH} + 2 \text{O}_2 \rightarrow 2 \text{CO}_2 + \text{H}_2\text{O}$
- d. $\text{CH}_3\text{COOH} + 2 \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2\text{O}$

3. What is the number of electrons and the number of protons in a Ca^{2+} -ion?

- a. 18 electrons, 20 protons and 20 neutrons
- b. 18 electrons, 20 protons and 40 neutrons
- c. 20 electrons, 20 protons and 20 neutrons
- d. 20 electrons, 40 protons and 20 neutrons

4. What is the number of electrons and the number of protons in $^{62}_{28}\text{Ni}$?
- 28 electrons, 28 protons and 34 neutrons
 - 28 electrons, 28 protons and 62 neutrons
 - 28 electrons, 34 protons and 28 neutrons
 - 34 electrons, 28 protons and 62 neutrons
5. What is the official chemical name of $(\text{NH}_4)_2\text{SO}_4$?
- ammonium sulphate
 - ammonium sulphide
 - diammonium sulphate
 - sulfuric acid
6. Which of the following compounds are all soluble in water?
- C_2H_4 , H_2SO_4 , NaOH
 - $\text{C}_2\text{H}_5\text{OH}$, H_2O_2 , C_6H_6
 - CH_4 , KOH , $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
 - NH_3 , $\text{C}_6\text{H}_{12}\text{O}_6$, CH_3COOH
7. What is the correct (balanced) equation for the formation of a precipitate of barium carbonate?
- $\text{Ba}(\text{aq}) + \text{CO}_3(\text{aq}) \rightarrow \text{BaCO}_3(\text{s})$
 - $\text{Ba}^{2+}(\text{aq}) + \text{CO}_3^-(\text{aq}) \rightarrow \text{Ba}_2\text{CO}_3(\text{s})$
 - $\text{Ba}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{BaCO}_3(\text{s})$
 - $\text{Ba}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{Ba}^{2+}\text{CO}_3^{2-}(\text{s})$
8. What is the amount of barium carbonate (mmol) that is formed if 60 mL 0,23 M $\text{Ba}(\text{CH}_3\text{COO})_2$ solution is added to 40 mL 0,25 M Na_2CO_3 solution?
- 3,8 mmol
 - 10 mmol
 - 14 mmol
 - 24 mmol
9. How much mmol equals 15 g of barium carbonate?
- 13 mmol
 - 76 mmol
 - 91 mmol
 - 197 mmol

10. Calculate the pH of a solution of 0,15 M HCl.

- a. pH = 0,15
- b. pH = 0,74
- c. pH = 0,82
- d. pH = 3,82

11. Calculate the pH of a solution of 5,00 g/L Ba(OH)₂.

- a. pH = 1,23
- b. pH = 12,5
- c. pH = 12,8
- d. pH = 14,7

12. What is the correct equation for the redox reaction between Au³⁺ and Ag (see Appendix 2)?

- a. $Au^{3+} + Ag \rightarrow Au + Ag^+$
- b. $Au^{3+} + 3 Ag \rightarrow Au + 3 Ag^+$
- c. $Au^{3+} + 2 e^- + Ag \rightarrow Au + Ag^+$
- d. no reaction

13. What is the correct equation for the redox reaction between Br₂ and Au (see Appendix 2)?

- a. $Br_2 + Au \rightarrow 2 Br^- + Au^{3+}$
- b. $Br_2 + Au \rightarrow 2 Br^- + Au^{3+} + e^-$
- c. $3 Br_2 + 2 Au \rightarrow 6 Br^- + 2 Au^{3+}$
- d. no reaction

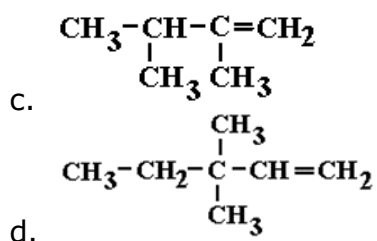
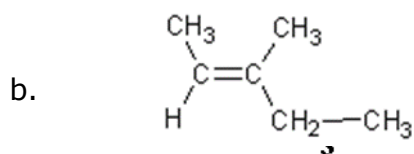
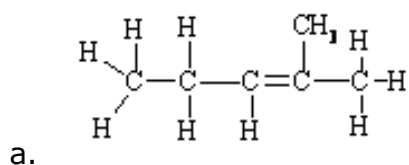
14. What is the correct equation for the redox reaction between MnO₄⁻ and H₂SO₃ in acidic conditions (see Appendix 2)?

- a. $MnO_4^- + H_2O + H_2SO_3 \rightarrow 2 MnO_4^{2-} + SO_4^{2-} + 4 H^+$
- b. $MnO_4^- + H_2SO_3 \rightarrow MnO_2 + 2 H_2O$
- c. $2 MnO_4^- + 5 H_2SO_3 \rightarrow 2 Mn^{2+} + 5 SO_4^{2-} + 4 H^+ + 3 H_2O$
- d. no reaction

15. For the titration of 25,00 mL sulfuric acid (H_2SO_4 solution) 23,86 mL 0,1005 M NaOH solution is needed.
Calculate the concentration of sulfuric acid in mole per liter.

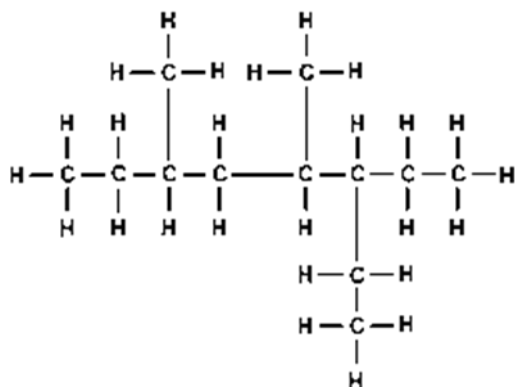
- a. 0,01187 M
- b. 0,04796 M
- c. 0,09592 M
- d. 0,1918 M

16. What is the correct structural formula of 2-methylpent-2-ene?

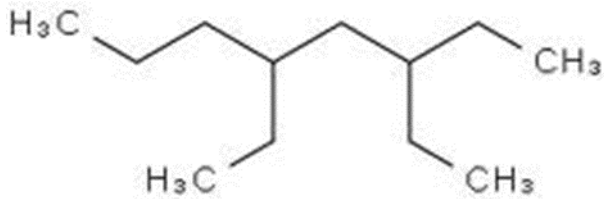


17. What is the correct structural formula of 3,5-diethyloctane?

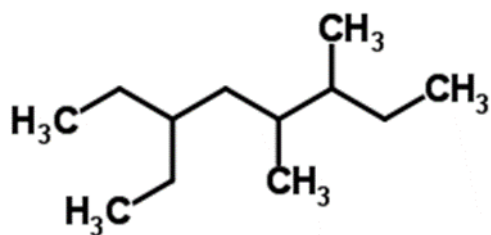
a.



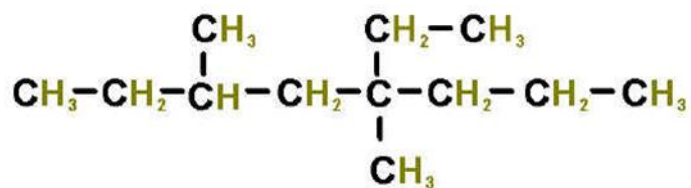
b.



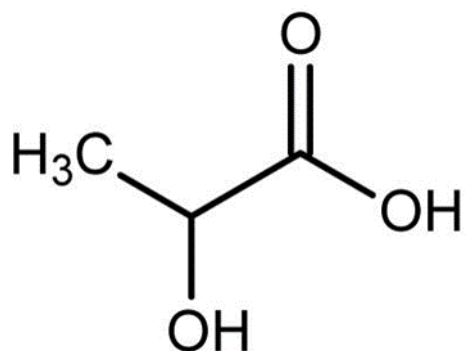
c.



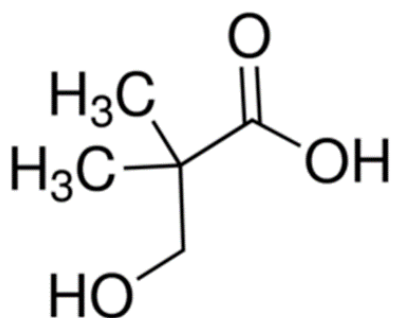
d.



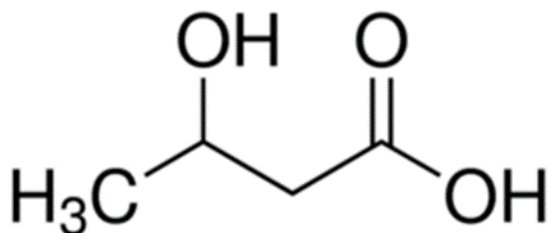
18. What is the correct structural formula of 2-hydroxypropanoic acid?



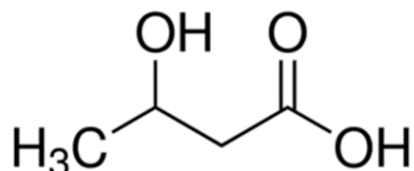
a.



b.



c.



d.

The correct answers are:

- | | |
|---|---|
| 1 | c. 17% (or 0,17) |
| 2 | d. $\text{CH}_3\text{COOH} + 2 \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2\text{O}$ |
| 3 | a. 18 electrons, 20 protons and 20 neutrons |
| 4 | a. 28 electrons, 28 protons and 34 neutrons |

- 5 a. ammonium sulphate
- 6 d. NH_3 , $\text{C}_6\text{H}_{12}\text{O}_6$, CH_3COOH
- 7 c. $\text{Ba}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{BaCO}_3(\text{s})$
- 8 b. 10 mmol
- 9 b. 76 mmol
- 10 c. pH = 0,82
- 11 c. pH = 12,8
- 12 b. $\text{Au}^{3+} + 3 \text{Ag} \rightarrow \text{Au} + 3 \text{Ag}^+$
- 13 d. no reaction
- 14 c. $2 \text{MnO}_4^- + 5 \text{H}_2\text{SO}_3 \rightarrow 2 \text{Mn}^{2+} + 5 \text{SO}_4^{2-} + 4 \text{H}^+ + 3 \text{H}_2\text{O}$
- 15 b. 0,04796 M
- 16 a
- 17 b
- 18 a

Explanations

Question 1

$$\% N = \frac{Mw N}{Mw (\text{NH}_4)_2\text{SO}_4} \times 100\%$$

Molecular weight of $(\text{NH}_4)_2\text{SO}_4$ is (see Periodic Table of the Elements, appendix 1):

$$\begin{aligned} 2 \times N &= 2 \times 14,0 = 28,0 \\ 8 \times H &= 8 \times 1,0 = 8,0 \\ 1 \times S &= 1 \times 32,1 = 32,1 \\ 4 \times O &= 4 \times 16,0 = 64,0 + \\ & \underline{\hspace{1.5cm}} \\ & 132,1 \text{ g/mol} \end{aligned}$$

$$\% N = \frac{2 \times 14,0}{132,1} \times 100\% = 21,2\% \quad \text{if 100\% of the fertilizer consists of } (\text{NH}_4)_2\text{SO}_4.$$

Only 80% of the weight of the fertilizer is $(\text{NH}_4)_2\text{SO}_4$.

$$\% N = \frac{21,2\%}{100} \times 80 = 16,96\% \quad (\text{Significance is 2}) \quad \% N = 17\%$$

because of the presence of O-H, formation of H-bonds
CH₄, C₂H₄, C₆H₆: insoluble in water because it is nonpolar.

Question 7

The salt barium carbonate consists of a Ba²⁺-ion and a CO₃²⁻-ion. The molecule barium carbonate has no net charge, so the molecular formula of barium carbonate is BaCO₃ (s). The law of conservation of mass dictates that the quantity of each element does not change in a chemical reaction.

Question 8

There is 60 mL × 0,23 mol/L = 13,8 mmol Ba²⁺
There is 40 mL × 0,25 mol/L = 10 mmol CO₃²⁻
The amount of CO₃²⁻ is limiting, so the mixture will yield 10 mmol BaCO₃ (s).
(significance of 2)

Question 9

Molecular weight of BaCO₃ is (see Periodic Table of the Elements, appendix 1):

$$\begin{array}{r} 1 \times \text{Ba} = 1 \times 137,3 = 137,3 \\ 1 \times \text{C} = 1 \times 12,0 = 12,0 \\ 3 \times \text{O} = 3 \times 16,0 = 48,0 + \\ \hline 197,3 \text{ g/mol} \end{array}$$

$$15 \text{ g BaCO}_3 = \frac{15}{197,3} = 0,0760 \text{ mol} = 76 \text{ mmol (significance of 2)}$$

Question 10

HCl is a strong acid: HCl (g) → H⁺(aq) + Cl⁻(aq)
[H⁺] = 0,15 mol/liter
pH = -log [H⁺] , pH = -log (0,15) = 0,82

Question 11

Molecular weight of Ba(OH)₂ is (see Periodic Table of the Elements, appendix 1):

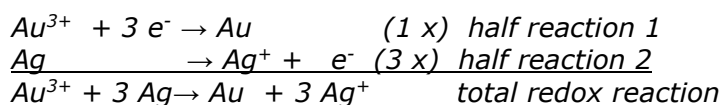
$$\begin{array}{r} 1 \times \text{Ba} = 1 \times 137,3 = 137,3 \\ 2 \times \text{H} = 2 \times 1,0 = 2,0 \\ 2 \times \text{O} = 2 \times 16,0 = 32,0 + \\ \hline 171,3 \text{ g/mol} \end{array}$$

$$5,00 \text{ g Ba(OH)}_2 = \frac{5,00}{171,3} = 0,0292 \text{ mol Ba(OH)}_2$$
$$\text{Ba(OH)}_2 \text{ (s)} \rightarrow \text{Ba}^{2+} \text{ (aq)} + 2 \text{ OH}^- \text{ (aq)}$$
$$0,029 \text{ mol Ba(OH)}_2 \text{ yields } 2 \times 0,0292 = 0,0584 \text{ mol OH}^-$$

$$\text{pOH} = -\log [\text{OH}^-] , \text{pOH} = -\log (0,0584) = 1,23$$
$$\text{pH} = 14 - \text{pOH}; \text{pH} = 14 - 1,23 = 12,77$$
$$\text{pH} = 12,8 \text{ (significance is 3)}$$

Question 12

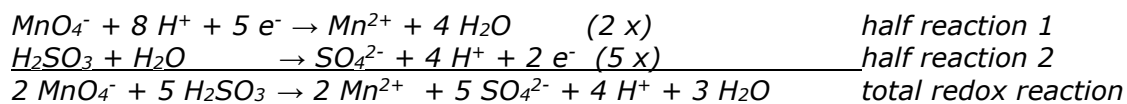
Au^{3+} is a stronger oxidator than Ag^+ , so a redox reaction is possible.



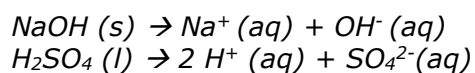
Question 13

Au^{3+} is a stronger oxidator than Br_2 . No reaction.

Question 14



Question 15



$23,86 \text{ mL} \times 0,1005 \text{ mol/L} = 2,398 \text{ mmol NaOH}$ is needed.
That means also $2,398 \text{ mmol OH}^-$.

This reacts with $2,398 \times 0,5 = 1,199 \text{ mmol H}_2\text{SO}_4$.
(1 mol H_2SO_4 reacts with 2 mol H^+)
 $1,199 \text{ mmol} / 25,00 \text{ mL} = 0,04796 \text{ mmol/mL} = 0,04796 \text{ mol/L}$