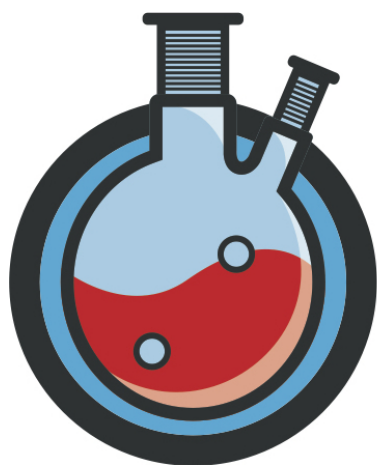




**CHEMISTRY.
OLYMPIAD.CH**

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SwissChO 2019 - First Round

SOLUTIONS

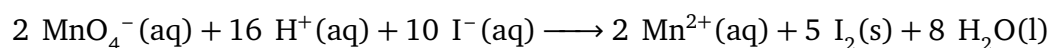
Important Informations

- This exam should be solved within one hour, using only books and a calculator. The answers should be copied to the separate answer sheet using a dark felt tip pen or ballpoint pen. You may not use a pencil.
- It is possible that more than one answer is correct.
- Following the IChO regulations, everybody is eligible to participate who:
 - was born on July 1st 1999 or later,
 - is not enrolled at a university,
 - is or has been attending a Swiss school.
- Answers have to be submitted until October 31st 2018.

1. In which one of the following compounds does manganese exist in the lowest oxidation state?

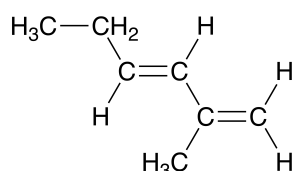
A. Mn_2O_7
B. $\text{Mn}(\text{CH}_3\text{COO})_2 \cdot 4\text{H}_2\text{O}$
 C. KMnO_4
 D. MnO_2F
 E. K_2MnO_4

2. How many electrons are transferred from 10 I^- ions to 2 MnO_4^- ions in the following redox reaction?

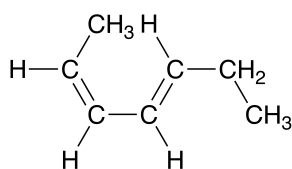


A. 2 B. 5 C. 8 **D. 10** E. 16

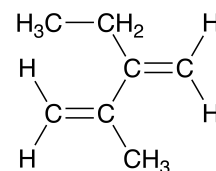
3. Which one of the following is NOT an isomer of the diene depicted below?



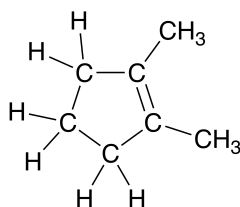
Diene, diène, diene



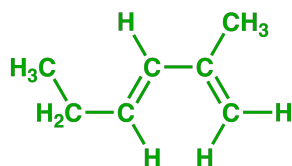
A.



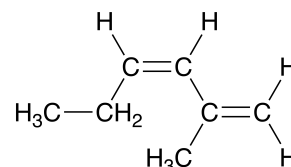
B.



C.



D.



E.

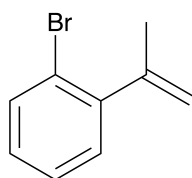
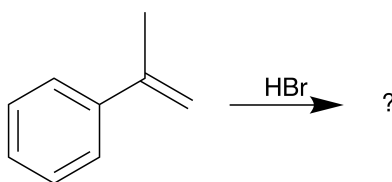
4. N,N-dimethylhydrazine, $(\text{CH}_3)_2\text{NNH}_2$, and dinitrogen tetroxide, N_2O_4 , (both liquids) are commonly used as a fuel-oxidant system for space vehicle propulsion. The components are mixed stoichiometrically so that N_2 , CO_2 and H_2O , all gases under the reaction conditions, are the only products. How many moles of gas are produced from 1 mol of $(\text{CH}_3)_2\text{NNH}_2$?

A. 3 B. 6 **C. 9** D. 12 E. 18

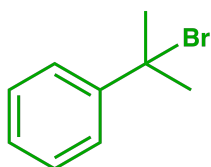
5. Which of the following molecules is not tetrahedral?

A. CF_4 B. NF_4^+ C. SiF_4 **D. SF_4** **E. SeF_4**

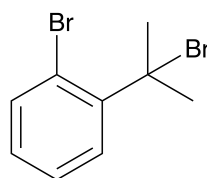
6. What is the major product of the following reaction?



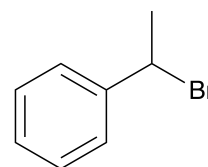
A.



B.



C.



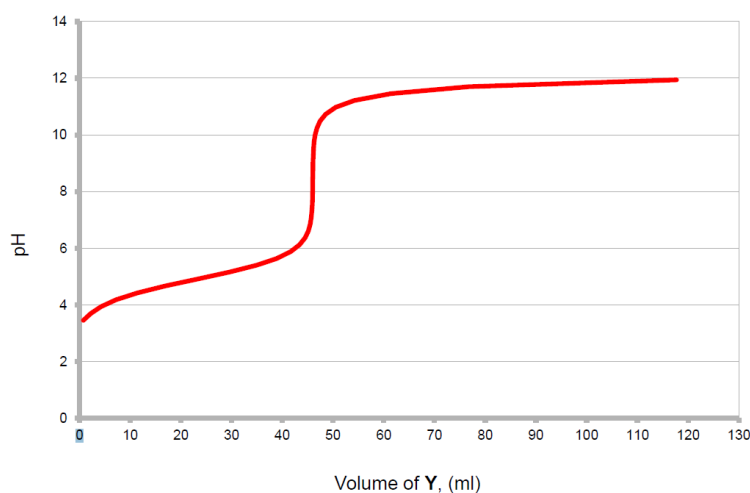
D.

E. No reaction, keine Reaktion, aucune réaction, nessuna reazione

7. The density of liquid nitrogen is 0.807 g/mL. If a person accidentally swallowed a 0.025 mL drop of liquid nitrogen, what volume of nitrogen gas would be evolved in their body at 100.0 kPa and 37 °C?

- A. 0.018 ml B. 0.025 ml **C. 19 ml** D. 23 ml E. 37 ml

8. 46 mL of solution X was pipetted into a conical flask and titrated with solution Y from a burette. The pH was monitored with a pH meter throughout the experiment, and was plotted against the volume of solution Y added to give the graph below.



Which one of the following alternatives is most likely the identity of solutions X and Y?

- A. X: $\text{CH}_3\text{CH}_2\text{COOH}$, Y: KOH
 B. X: HBr, Y: NaHCO_3
 C. X: NaHCO_3 , Y: $\text{CH}_3\text{CH}_2\text{COOH}$
 D. X: HBr, Y: KOH
 E. X: NaHCO_3 , Y: HBr

9. Which of the following acids is the strongest?

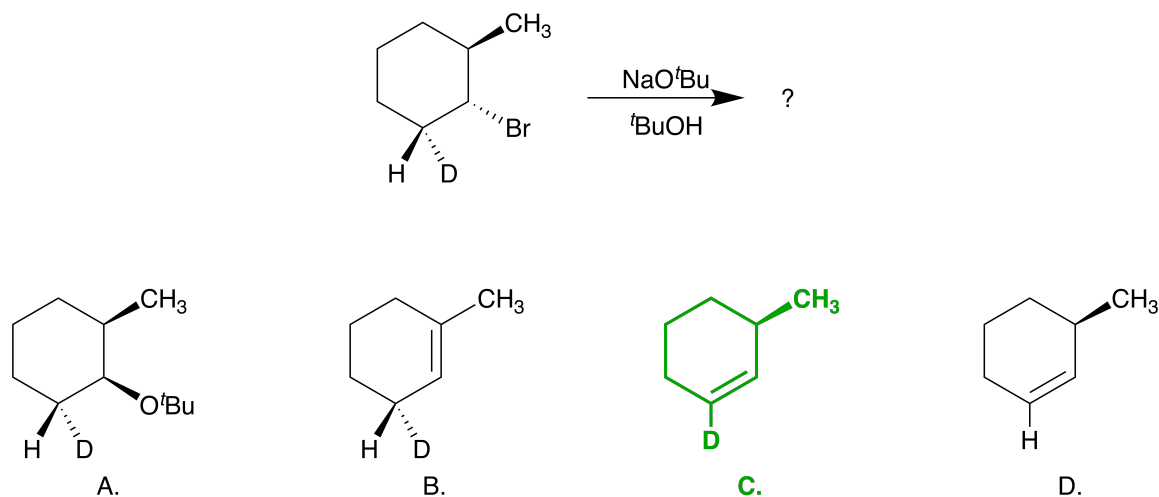
- A. perchloric acid, HClO_4
 B. chloric acid, HClO_3
 C. chlorous acid, HClO_2
 D. hypochlorous acid, HClO
 E. This cannot be determined because not all the acids listed above exist.

10. What is the oxidation state of chlorine in the aforementioned compounds? (cf. Task 9)

U: HClO_4 V: HClO_3 W: HClO_2 X: HClO

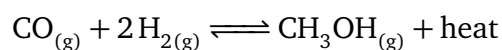
- A. U: VII V: VI W: IV X: II
 B. U: VII V: V W: III X: I
 C. U: IV V: III W: II X: I
 D. U: VI V: IV W: III X: I
 E. U: IV V: III W: II X: I

11. What is the major product of the following reaction?



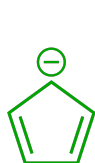
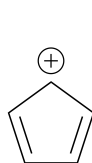
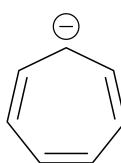
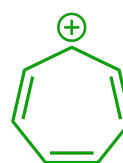
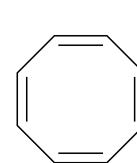
E. No reaction, keine Reaktion, aucune réaction, nessuna reazione

12. $^{208}_{84}\text{Po}$ has a half-life of 2.898 years. Given a pure sample of 50 g of $^{208}_{84}\text{Po}$, how long would you have to wait until there are only 5 g of $^{208}_{84}\text{Po}$ left in the sample?
- A. 0.441 years B. 1.203 years C. 5.796 years **D. 9.627 years** E. 19.25 years
13. Which of the following elements is solid at room temperature?
- A. H_2 B. F_2 C. Cl_2 D. Br_2 **E. I_2**
14. What happens to an aquatic solution if you add $\text{B}(\text{OH})_3$ to it?
- A. The solution turns green.
B. The solution becomes more acidic.
C. The solution becomes more basic.
D. $\text{B}(\text{OH})_3$ acts as a reducing agent, producing H_2 .
E. $\text{B}(\text{OH})_3$ acts as an oxidising agent, producing O_2 .
15. An 1.0 M solution of $\text{Pb}(\text{NO}_3)_2$ is added to 20 ml of an 0.4 M NaCl-solution. A precipitate is immediately formed that begins to redissolve with further addition. Addition is terminated, when no precipitate remains. What is the final volume of the solution? (K_{sp} of PbCl_2 : $1.7 \times 10^{-5} \text{ mol}^3 \text{ L}^{-3}$)
- A. 613 mL **B. 1.94 L** C. 48.5 L D. 194 L E. 485 L
16. It is known that carbon monoxide reacts exothermically with hydrogen gas to form methanol at 400°C , in the presence of a catalyst.



A mixture of carbon monoxide, hydrogen gas and methanol placed under conditions described above achieves equilibrium in a closed container. If the reaction temperature is changed to 450°C , which of the following statements is correct?

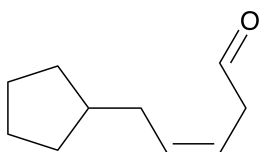
- A. The total number of molecules in the container decreases.
B. The reaction rates of both the forward and reverse reactions remain constant.
C. The average molecular mass of the gaseous mixture decreases.
D. Rate of formation of hydrogen decreases while the rate of decomposition of methanol increases.
E. Total pressure within the container decreases.
17. Which of the following compounds are aromatic?

**A.****B.****C.****D.****E.**

18. Prussian blue is a deep blue pigment containing Fe^{2+} , Fe^{3+} and CN^- ions. It has the formula $\text{Fe}_7(\text{CN})_{18}$. How many Fe^{2+} and Fe^{3+} ions are there per formula unit?

- A. 0 Fe^{2+} and 7 Fe^{3+}
B. 3 Fe^{2+} and 4 Fe^{3+}
C. 4 Fe^{2+} and 3 Fe^{3+}
D. 5 Fe^{2+} and 2 Fe^{3+}
E. 7 Fe^{2+} and 0 Fe^{3+}

19. What is a correct IUPAC name for the following structure?



- A. (Z)-5-cyclopentyl-3-pentenal**
B. (E)-5-cyclopentyl-3-pentenal
C. (Z)-1-cyclopentyl-3-pentenal
D. (Z)-5-cyclopentyl-3-pentenol
E. (E)-5-cyclopentyl-3-pentenol

20. Which of the following compounds is a molecule?

- A. H_2S** B. BeF_2 **C. SF_4** D. CaCl_2 E. Ag_2O

21. A solution with a molar extinction coefficient of $1.5 \times 10^4 \text{ L/mol/cm}$ was placed into a cell with length of 1.5 cm. The solution showed 70 % absorption. What is the concentration of the solution?

- A. $1.5 \times 10^{-6} \text{ M}$
B. $2.3 \times 10^{-6} \text{ M}$
C. $6.9 \times 10^{-6} \text{ M}$
D. $1.5 \times 10^{-5} \text{ M}$
E. $2.3 \times 10^{-5} \text{ M}$

22. Which of the following compounds contains the bond with the highest polarity?

- A. BH_3 B. H_2O C. H_2S D. H_2SO_4 **E. SiF_4**

23. Which of the following species does NOT have eight electrons around the central atom?

- A. NH_3 B. NH_4^+ C. CO_2 **D. BCl_3** E. CCl_4

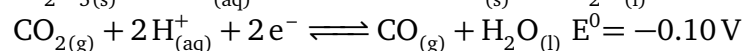
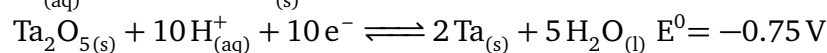
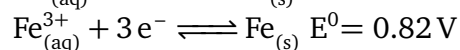
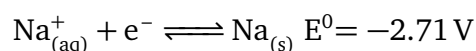
24. Equal masses of each of the following compounds were treated with excess hydrochloric acid. Which produced the greatest volume of carbon dioxide gas?

- A. sodium carbonate
- B. magnesium carbonate**
- C. potassium carbonate
- D. calcium carbonate
- E. rubidium carbonate

25. What is the pH of a 0.50 M solution of propionic acid ($\text{pK}_a = 4.87$)?

- A. 0.7
- B. 1.8
- C. 2.6**
- D. 7.0
- E. 11.4

26. Sodium metal is produced industrially by the electrolysis of molten NaCl, while steel is produced by CO reduction of ores containing Fe(III) in a blast furnace. Tantalum is another useful metal, often used surgically to repair bone because of its high resistance to corrosion. Which of the following methods could be used industrially to produce tantalum from naturally occurring Ta(V)?



- A. Electrolysis only.
- B. Reduction in a blast furnace only.
- C. Reduction with sodium metal only.
- D. Either reduction with sodium metal or reduction in a blast furnace.
- E. Either electrolysis or reduction with sodium metal.**

27. Which of the following structures has the greatest bond angle?

- A. CH_4**
- B. NH_3
- C. H_2O
- D. PH_3
- E. H_2S

Questions without influence on the result

28. How did you get to know the Swiss Chemistry Olympiad?

A. Professor

B. Friends

C. Media

D. Other

29. Do you want to participate at the Central Exam on January 11 and January 12, 2019 if you qualify?

A. Yes

B. No