

Chemistry

כימיה

Instructions for examinees

הוראות לנבחן

א. Duration of the exam: Two hours

א. משך הבחינה: שתיים.

ב. Exam structure and breakdown of points:

ב. מבנה השאלון ומפתח ההערכה:

This exam has two parts.

בשאלון זה שני פרקים.

Part I — (6×5) — 30 points

פרק ראשון — (5×6) — 30 נקודות

Part II — (2×35) — 70 points

פרק שני — (2×35) — 70 נקודות

Total — 100 points

סה"כ — 100 נקודות

ג. Material that may be used during the exam:

ג. חומר עזר מותר בשימוש:

(1) A calculator (graphing calculators are permitted)

(1) מחשבון (כולל מחשבון גרפי).

(2) A Hebrew-foreign language/foreign language-Hebrew dictionary

(2) מילון עברי-לועזי / לועזי-עברי.

ד. Special instructions:

ד. הוראות מיוחדות:

(1) **Note:** In Part I, there are six **required** questions.

(1) **שים לב:** בפרק הראשון יש שש שאלות חובה.

In each of Questions 1-6, four possible answers are given, and you must choose the correct answer.

בכל אחת מן השאלות 1-6 מוצגות ארבע תשובות, ומהן עליך לבחור בתשובה הנכונה.

Mark the correct answers on the answer sheet found at the end of the answer booklet (page 19).

את התשובות הנכונות עליך לסמן בתשובון שבסוף מחברת הבחינה (עמוד 19).

(2) **In Part II there are three questions. You must answer two of them.**

(2) **בפרק השני יש שלוש שאלות. עליך לענות על שתיים מהן.**

Write in the answer booklet only. Write the word "טייטה" at the top of each draft page.

כתוב במחברת הבחינה בלבד. רשום "טייטה" בראש כל עמוד המשמש טייטה.

If you write draft material outside the answer booklet, your exam may be disqualified.

כתיבת טייטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Questions

There are two parts in this exam.

Answer all the questions in Part I and two questions from Part II.

Part I (30 points)

Questions 1-6 – Required

Answer all of the questions 1-6 (each question – 5 points).

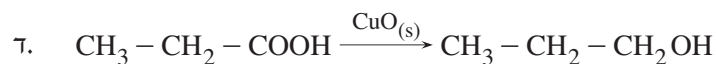
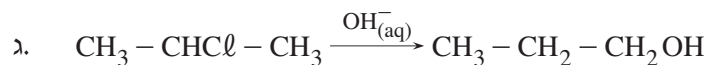
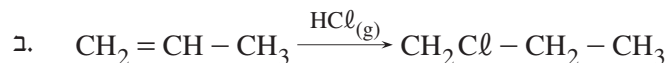
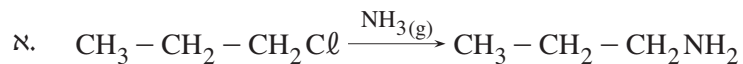
Four possible answers, א-ד, are presented for each question.

Before you answer, read each of the possible answers, and choose the correct answer.

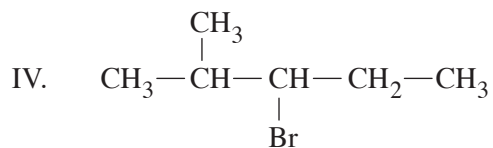
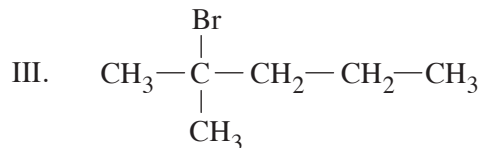
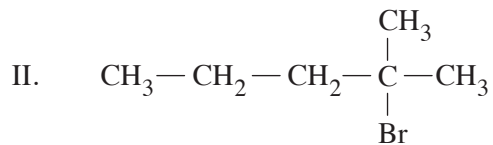
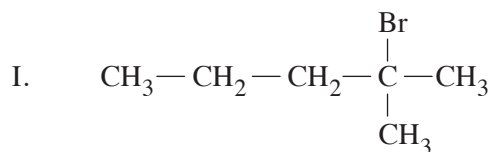
- * Mark your answer on the answer sheet printed on the back inside cover of the answer booklet (page 19).
- * For each question, mark an ×, in pen, in the box below the letter (א-ד) that corresponds to the answer you chose.
- * Mark an × in only one box for each question.
- * If you want to erase your answer, fill in the whole box like this: ■ .
- * Do **not** use White-Out to erase answers.
- * **Note: In order to limit the need to erase answers on the answer sheet, we recommend that you first mark the correct answers in the exam booklet and only later mark them on the answer sheet.**

1. Below are the equations of four reactions.

Which reaction equation shows the correct main product?



2. Shown below are four abbreviated structural formulas, I-IV, for molecules whose molecular formula is $C_6H_{13}Br$.



Which two formulas represent isomers?

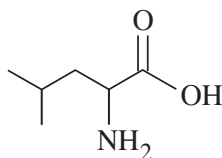
- א. I and II
- ב. I and III
- ג. II and III
- ד. III and IV

3. Read the following four statements about the relative strength of these nucleophiles: CH_3SH molecules and CH_3S^- ions.

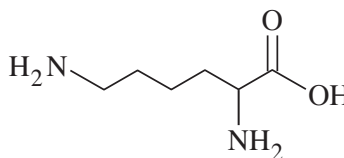
Which statement is correct?

- א. CH_3S^- ions are a weaker nucleophile than CH_3SH molecules, because the negative charge on the sulfur atom in each of the CH_3S^- ions is larger.
- ב. CH_3S^- ions are a weaker nucleophile than CH_3SH molecules, because the negative charge on the sulfur atom in each of the CH_3S^- ions is smaller.
- ג. CH_3S^- ions are a stronger nucleophile than CH_3SH molecules, because the negative charge on the sulfur atom in each of the CH_3S^- ions is larger.
- ד. CH_3S^- ions are a stronger nucleophile than CH_3SH molecules, because the negative charge on the sulfur atom in each of the CH_3S^- ions is smaller.

4. Below are the abbreviated structural formulas of two amino acids, lysine and leucine.



Leucine



Lysine

Read the following four statements, I-IV.

- I Each of the two amino acids has a hydrophilic side chain, R.
- II Both amino acids are solid at room temperature.
- III In an aqueous solution that has a pH=7, the total electric charge on each of the two amino acids is zero.
- IV A condensation reaction is possible between these two amino acids.

Which statements are correct?

- א. Only I and III.
- ב. Only I and IV.
- ג. Only II and III.
- ד. Only II and IV.

5. The following sequence of nucleotides is a codon in a mRNA chain: 5' UGC 3'.

What is the product of translation of this codon?

- א. arginine, Arg
- ב. cysteine, Cys
- ג. stop codon
- ד. DNA codon: 3' ACG 5'

6. Tetracyclines are a large family of antibiotics. These substances bind to the ribosome near the site at which tRNA is supposed to bind to the ribosome. In this way tetracyclines interfere with binding to the ribosome, and translation does not proceed.

Which bonds are not formed because the tetracyclines have bound to the ribosome?

- א. hydrogen bonds and amide bonds
- ב. phosphoester bonds
- ג. N-glycosidic bonds
- ד. ester bonds and hydrogen bonds

Part II (70 points)

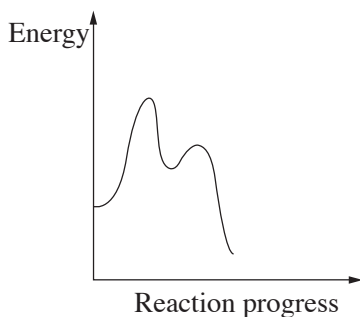
Answer two of the questions 7-9 (each question – 35 points).

7. The molecular formula of two isomers A and B is C_4H_9OH , and their molecules are branched.

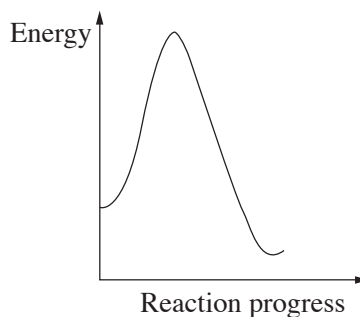
When Isomer A reacts with an aqueous solution of $KMnO_{4(aq)}$, a substance C is obtained.

An aqueous solution of Substance C has a $pH < 7$.

- א. Write the abbreviated structural formula of each of these two isomers.
- ב. Formulate the reaction in which Isomer A turns into Substance C. Use the structural formulas.
- ג. Isomer A can be obtained in a reaction of a suitable alkyl chloride with $OH^-_{(aq)}$ ions.
 - i By what reaction mechanism is Isomer A obtained from the suitable alkyl chloride? Formulate this mechanism.
 - ii Determine whether Isomer A, obtained in the reaction whose mechanism you formulated in Sub-item ג.i, is optically active. Explain.
 - iii Below are two graphs, I and II, which show the change in energy as the reaction proceeds.



I



II

Determine which graph correctly describes the progress of the reaction whose mechanism you formulated in Sub-item ג.i.

Explain.

7. Isomer B reacts with $H_2SO_{4(l)}$. Write out completely the structural formula of the product obtained in this reaction.

8. The enzyme lysozyme is present in body fluids such as tears, sweat, and saliva, and it is also present in egg white.

Lysozyme catalyzes digestion of the cell wall of bacteria.

The figures below, Figure 1 and Figure 2, show models of the lysozyme molecule.

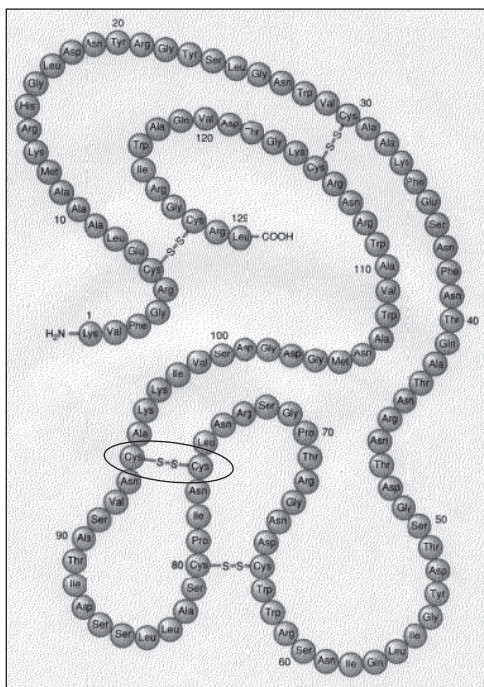


Figure 2

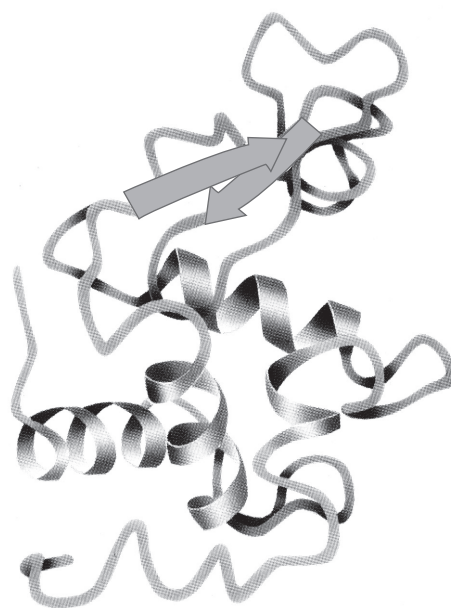
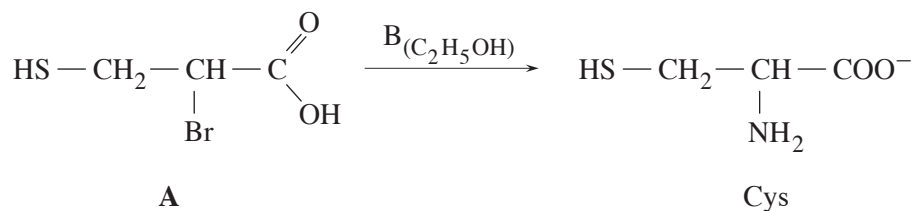


Figure 1

8. There are four disulfide bonds between the residues of the amino acid cysteine, Cys, in a lysozyme molecule.
- i The amino acid Cys can be obtained in the lab from Substance A, according to the reaction:



The solvent in this reaction is ethanol, $\text{C}_2\text{H}_5\text{OH}_{(\ell)}$.

Write out the formula of the substance B that is required in this reaction.

- ii In Figure 2 a disulfide bond between two cysteine, Cys, residues is circled. Write out the abbreviated structural formula of the circled area.

- ב. i List two types of secondary structures of which the lysozyme molecule is composed.
- ii Hydrogen bonds stabilize the secondary structures you listed in Sub-item ב.i .
Between which atoms of the lysozyme molecule are these hydrogen bonds formed?
- ג. The tertiary structure of lysozyme is spherical.
Explain how the spherical structure of lysozyme makes it soluble in body fluids.
- ד. One of the products of the partial hydrolysis of lysozyme was the following penta-peptide:
Phe – Gly – Arg – Cys – Glu
- i Write out the abbreviated structural formula of this penta-peptide at pH = 7.
Be sure to write the charge on the charged groups.
- ii Below are three nucleotide sequences, I, II, and III. Determine which of these three sequences might be a representation of the mRNA sequence that has been translated into the given penta-peptide.
- I. 5' UUU GAG AGG UGU GAA 3'
- II. 5' UUC GGA AGA UGC GAA 3'
- III. 5' UUC GGU AGA UGA GAG 3'

9. Tay-Sachs disease is a serious hereditary illness that causes brain damage as a result of the absence of the enzyme Hex A.

Below is a segment from a strand of flawed DNA of a person with Tay-Sachs:

3' ATG GGG ATT CGT 5'

- א. i Write out the nucleotide sequence of the mRNA segment that is obtained from transcription of the given segment of flawed DNA.
Mark the 3' end and the 5' end.
- ii Write out the sequence of amino acids in the segment of protein that is obtained from translation of the mRNA segment you provided.
Mark the N end and the C end.
- ב. tRNA molecules present in the cell participate in the translation process that takes place on the ribosome.
- i How many tRNA molecules are required in order to translate the segment of mRNA that you provided in your answer to Sub-item א.י ? Explain.
- ii List the two types of bonds at the two primary binding sites on tRNA.
- ג. i Explain the role of mRNA molecules and the role of tRNA molecules.
- ii The number of types of tRNA in a living cell is greater than the number of types of amino acids from which proteins of a living cell are composed. Explain why.
- ד. The DNA segment given at the beginning of this question contains a point mutation that **prevents the translation from ending** at the end of the segment.
- i Suggest a possible mRNA codon that could be obtained from the transcription of a DNA segment that **does not contain a point mutation**.
Mark the 3' end and the 5' end on the codon that you have suggested.
Explain your suggestion.
- ii Write out the nucleotide sequence of the tRNA anticodon that matches the codon you provided in your answer to Sub-item ד.י .
Mark the 3' end and the 5' end.

Good Luck!

בהצלחה!