

כימיה

Chemistry Reform for Meaningful Learning Program

על פי תכנית הרפורמה ללמידה משמעותית

הוראות לנבחן

Instructions for examinees

א. Duration of the exam: Two hours.

ב. Exam structure and breakdown of points:

This exam has two parts.

Part I — (30×1) — 30 points

Part II — (35×2) — 70 points

Total — 100 points

ג. Material that may be used during the exam:

(1) A calculator (graphing calculators are permitted).

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

ד. Special instructions:

(1) **Note**: In Part I, there is one **required** question.

Question 1 has six items א-ו. In each item four possible answers are given and you must choose the correct answer.

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

(2) In Part II, you must answer two of the three questions.

Write all of your rough work (notes, calculations, etc.) on separate pages of the answer booklet only.

Write the word "טיוטה" on the top of each of these pages.

If you write any sort of work outside the answer booklet, your exam may be disqualified!

א. משך הבחינה: שעותיים.

ב. מבנה השאלון ומפתח ההערכה:

בשאלון זה שני פרקים.

פרק ראשון – (30×1) – 30 נקודות

פרק שני – (35×2) – 70 נקודות

סה"כ 100 נקודות

ג. חומר עזר מותר בשימוש:

(1) מחשבון (כולל מחשבון גרפי).

(2) מילון עברי-לועזי / לועזי-עברי.

ד. הוראות מיוחדות:

(1) **שים לב**: בפרק הראשון יש שאלה אחת

חובה.

בשאלה 1 יש שישה סעיפים א-ו. לכל סעיף מוצגות ארבע תשובות, ומהן עליך לבחור בתשובה הנכונה. את התשובות הנכונות עליך לסמן בתשובון שבסוף מחברת הבחינה (עמוד 19)

(2) **בפרק השני יש לענות על שתיים מבין שלוש השאלות.**

כתוב במחברת הבחינה בלבד, בעמודים נפרדים, כל מה שברצונך לכתוב בטיוטה (ראשי פרקים, חישובים וכדומה).

רשום "טיוטה" בראש כל עמוד טיוטה. רישום טיוטות כלשהן על דפים שמחוץ למחברת הבחינה עלול לגרום לפסילת הבחינה!

Good Luck!

בהצלחה!

Questions

There are two parts in this exam. Answer three questions: the required question in Part I and two questions from Part II.

Part I (30 points)

Question 1 - Required

Answer all the items א-ו (each item – 5 points).

Four possible answers, 1-4, are presented for each item.

Before you answer, read each of the possible answers, and choose the most appropriate one.

- * Mark your answer on the answer sheet printed on the back inside cover of the answer booklet (page 19).
- * For each item, draw an X, in pen, in the box below the number (1-4) that corresponds to the answer you chose.
- * Draw an X in only one box for each item.
- * 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 enter them into the answer sheet.**

א. Which compound has geometric isomerism (cis-trans)?

1. $\text{CH}_2 = \text{CHCH}_3$
2. $\text{CH}_3\text{CH} = \text{CCl}_2$
3. $\text{CHCl} = \text{CHCH}_3$
4. $(\text{CH}_3)_2\text{C} = \text{CHCl}$

ב. The four statements below refer to the compound $(\text{CH}_3)_3\text{CCH}_2\text{OH}_{(\ell)}$. Which statement is correct?

1. The compound reacts with an $\text{NaOH}_{(\text{aq})}$ solution.
2. The compound reacts immediately with an $\text{HCl}_{(\text{aq})} / \text{ZnCl}_{2(\text{aq})}$ solution.
3. The compound does not react with a $\text{KMnO}_{4(\text{aq})}$ solution.
4. The compound does not react when heated with sulfuric acid, $\text{H}_2\text{SO}_{4(\ell)}$.

ג. Three tests, I-III, that can be conducted in a lab, are given below.

I Testing for solubility in water

II Determining boiling point

III Reaction with an acid solution of $K_2Cr_2O_{7(aq)}$

Which tests can be used to distinguish between the following two compounds: $(CH_3)_3COH_{(l)}$ and $CH_3(CH_2)_8CH_2OH_{(l)}$?

1. I and II

2. I and III

3. II and III

4. I, II, and III

ד. In what pH range is the isoelectric point, pI, of the amino acid lysine, Lys, found?

1. basic

2. neutral

3. acidic

4. cannot be determined without further data

ה. Certain changes in the nucleotide sequence on a DNA strand do not result in a change in the protein's amino acid sequence obtained after transcription and translation.

What is the reason for this?

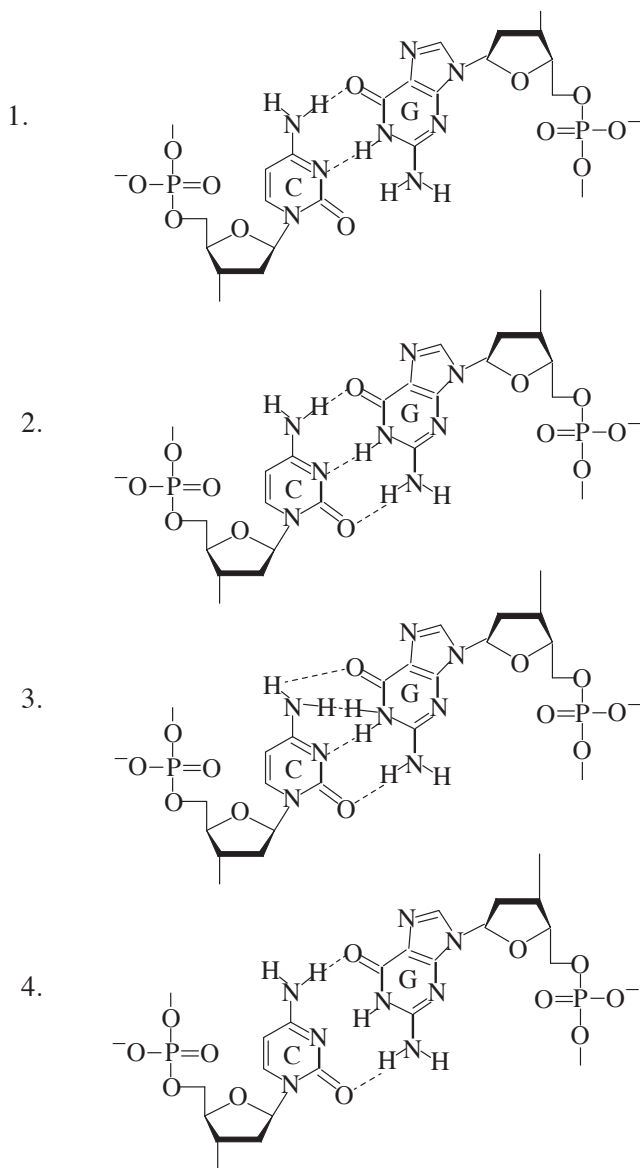
1. Each amino acid is encoded by a single codon only.

2. A single codon encodes several amino acids.

3. A single amino acid is encoded by several codons.

4. A single codon encodes several nucleotides.

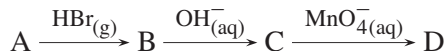
1. Cytosine (C) and guanine (G) are complementary bases.
 Which one of the figures 1-4, below, correctly describes the hydrogen bonds between cytosine and guanine in a DNA molecule?



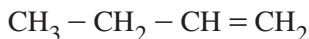
Part II (70 points)

Answer two of the questions 2-4 (each question – 35 points).

2. Here is a chain reaction. The letters A, B, C, D represent carbon compounds.



The abbreviated structural formula for Compound A is:



א. Write the abbreviated structural formula for each of the compounds B, C, D.

ב. i Compound B has two enantiomers.

For each enantiomer, draw the spatial structure around the chiral carbon atom.

ii One of the enantiomers of Compound B was reacted with a solution of sodium hydroxide, $\text{NaOH}_{(\text{aq})}$, and an optically active product was obtained.

Write the formula for the reaction mechanism.

iii Explain why the product obtained in this reaction is optically active.

ג. Compound B reacts with $\text{CH}_3\text{S}^-(\text{CH}_3\text{OH})$ ions. The solvent in this reaction is methanol, $\text{CH}_3\text{OH}_{(\ell)}$.

Determine whether the reaction rate will go up, or down, or remain unchanged after each of the following operations, i-iii.

Justify each answer.

i Replacing bromine atoms, Br, in the molecules of the attacked substance, with Iodine atoms, I.

ii Replacing the nucleophile $\text{CH}_3\text{S}^-(\text{CH}_3\text{OH})$ with the nucleophile $\text{CH}_3\text{SH}_{(\text{CH}_3\text{OH})}$.

iii Replacing the solvent $\text{CH}_3\text{OH}_{(\ell)}$ with the solvent DMSO, $(\text{CH}_3)_2\text{SO}_{(\ell)}$.

3. Bradykinin is a peptide found in blood. It causes dilation of blood vessels and in this way reduces blood pressure.

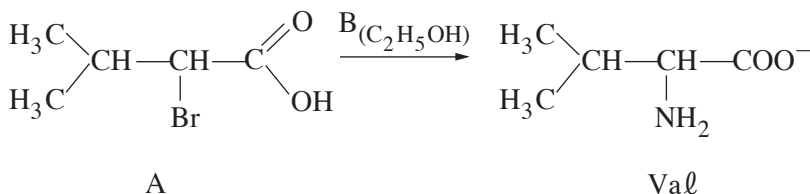
A molecule of bradykinin has nine amino acid residues.

Below is the amino acid sequence in a bradykinin molecule.

Arg—Pro—Pro—Gly—Phe—Ser—Pro—Phe—Arg

- א. Bradykinin molecules cannot form an α helix. Explain why.
- ב. A peptide, P, was prepared in the lab. The molecule of Peptide P is composed of the same amino acid residues as the bradykinin molecule, but they are arranged in the reverse order:
Arg—Phe—Pro—Ser—Phe—Gly—Pro—Pro—Arg
Peptide P does not cause blood vessel dilation. Explain this fact.
- ג. Partial hydrolysis of bradkinin produced, among other things, two tri-peptides, I and II.
- I Pro—Gly—Phe
- II Ser—Pro—Phe
- i Determine whether at pH = 7 the total charge of Tri-peptide I is equal to or different from the total charge of Tri-peptide II.
Justify your answer.
- ii Suggest an mRNA sequence of nucleotides, that will produce Tri-peptide II after translation. Mark the 3' end and the 5' end.

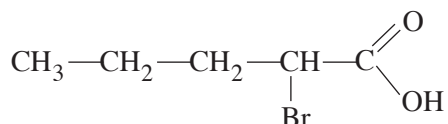
7. Under lab conditions, it is possible to obtain the amino acid valine, Val, from Substance A via the reaction:



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

- Write the formula of Substance B that this reaction requires.
- The amino acid valine is solid at room temperature. What is the reason for this fact?
- Substance C is an isomer of Substance A.

Below is the abbreviated structural formula for Substance C.



Determine whether the boiling point of Substance C is higher or lower than the boiling point of Substance A. Justify your answer.

4. א. i Write the structural formula of a nucleotide composed of adenine, 2-deoxyribose, and a phosphate group.
- ii List the types of covalent bonds that exist between the components of the nucleotide whose formula you wrote for Sub-item א i. Specify between which components these bonds are formed.
- iii A lab prepared a nucleotide composed of uracil, 2-deoxyribose, and a phosphate group.
- Determine whether this nucleotide is an RNA nucleotide.
- Justify your answer.

Below is a sequence of nucleotides on a segment of the DNA strand of a certain virus.

3' CGA TAA AAT TCA 5'

- ב. Write out the nucleotide sequence on the complementary segment to the given DNA segment.
- Mark the 3' end and the 5' end.
- ג. i Write out the nucleotide sequence of the mRNA segment that is produced by transcription of the given DNA segment.
- Mark the 3' end and the 5' end.
- ii Write out the amino acid sequence in the protein segment produced by translation of the mRNA segment that you provided in Sub-item ג i.
- ד. Histones, the proteins responsible for densely packaging the DNA molecules in the chromosomes, contain a high percentage of the amino acids lysine, Lys, and arginine, Arg.
- What type of bonds are formed between the histones and the DNA molecules? Explain.

Good Luck!

בהצלחה!