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UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

UNISA 
university
of south africa

CHE1502

(489355)

October/November 2015

GENERAL CHEMISTRY IB

Duration 2 Hours

100 Marks

EXAMINERS
FIRST
SECOND

PROF CA SUMMERS
MR KGLL LESENYEHO

Use of a non-programmable pocket calculator is permissible.

Closed book examination

This examination question paper remains the property of the University of South Africa and may not be removed from the examination venue.

EXAMINATION PAPER UNIQUE NUMBER: 489355

The examination paper consists of 25 pages plus 5 pages for rough work (pp 26-30) plus instructions for completion of the mark reading sheet.

The examination paper consists of **TWO** parts:

SECTION A: 60 Marks

Consisting of 30 multiple choice questions which must be answered on a marking reading sheet. Each question is allocated **TWO** marks.

The multiple choice questions have four possible answers. In each case, provide only **ONE** answer to each question

SECTION B. 40 Marks

This section consists of written questions which must be answered in spaces provided on the examination paper.

The use of molecular models is permissible

ANSWER ALL QUESTIONS IN SECTION A AND SECTION B

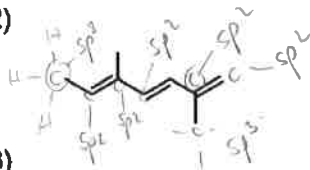
SECTION AThis section consists of **30 MULTIPLE CHOICE QUESTIONS.**Answer **ALL** the questions in this section on the **MARK READING SHEET**Unique Number **489355**1 Which of the following compounds contains **sp** hybridized carbon atoms?

(1)

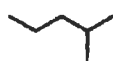


all C's have
one double bond
sp²

(2)

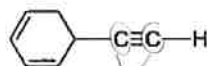


(3)



all C's have
4 x single bonds
sp³

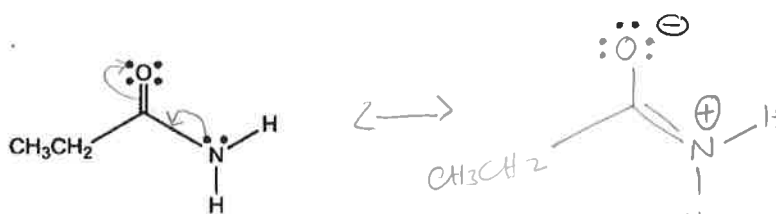
(4)



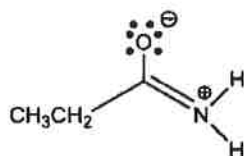
one triple bond + one single = **sp**

four single bonds = sp³
one double bond = sp²
+ 3 single
two double bonds
+ 2 single
or
one triple bond
+ 1 single
] = sp

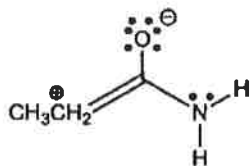
2 Select the structure that is another resonance form of the following organic molecule



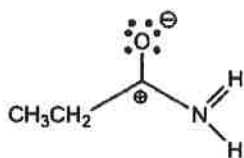
(1)

**[TURN OVER]**

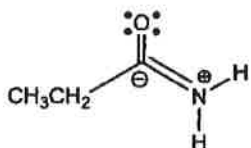
(2)



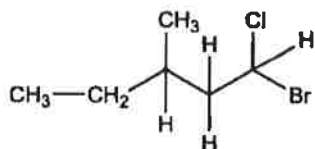
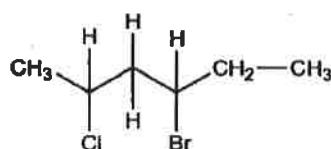
(3)



(4)



3 Consider the following two compounds

 $C_6H_{12}ClBr$  $C_6H_{12}ClBr$

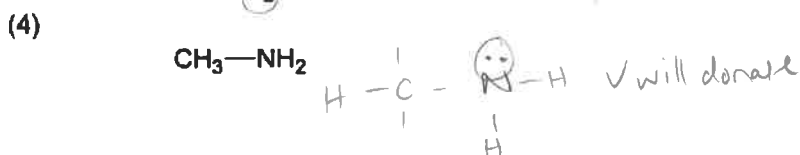
The above compounds are

(1) identical compounds \times (2) enantiomers \times mirror image(3) constitutional / structural isomers \checkmark (4) geometric isomers \times

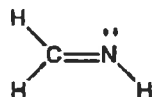
Same atoms, different bonding.

[TURN OVER]

4 Which of the following compounds WILL NOT easily donate a pair of electrons?



5 In the structure below, what is the formal charge on nitrogen?

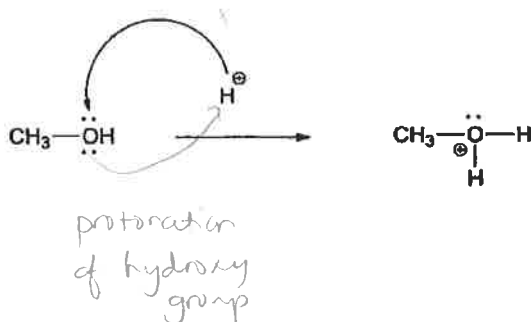


$$\begin{aligned} \text{FC} &= \# \text{ valence electrons} - \# \text{ non-bonding electrons} - \frac{1}{2} (\text{bonding electrons}) \\ &= 5 - 2 - \frac{1}{2} (6) \\ &= 5 - 5 \\ &= 0 \end{aligned}$$

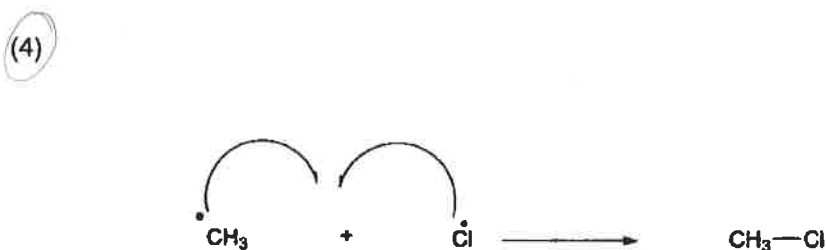
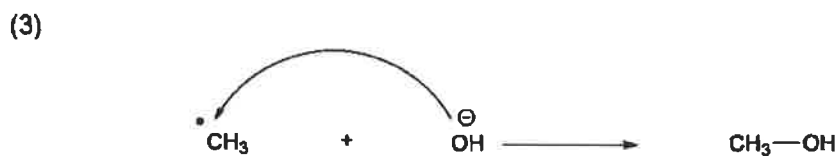
- (1) +2
(2) 0
(3) +1
(4) -1

6 Which of the following processes is a CORRECT representation of bond formation or bond breakage?

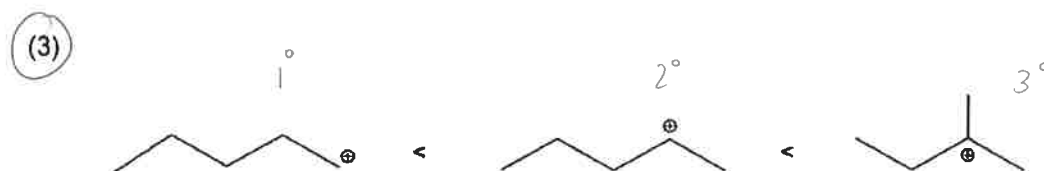
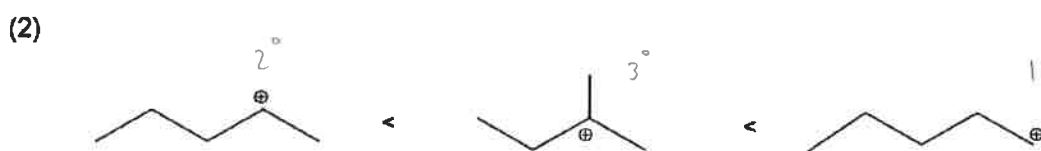
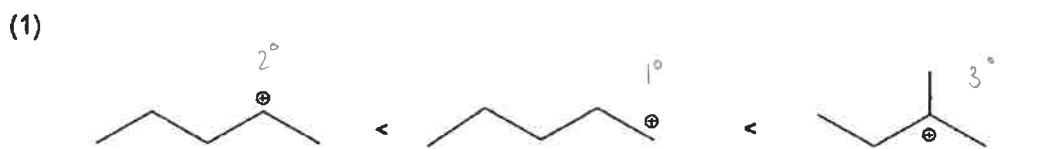
(1)



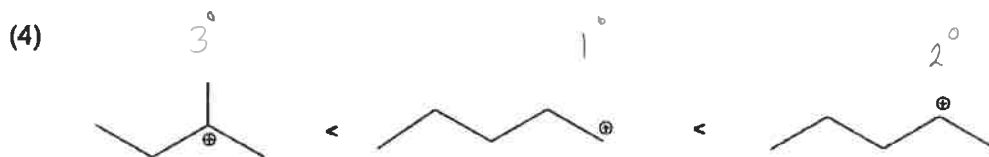
[TURN OVER]



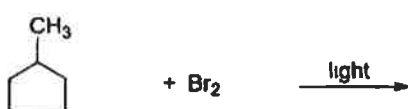
- 7 Which of the following set of carbocations represent AN ORDER OF INCREASING STABILITIES, i.e. from THE LEAST STABLE TO THE MOST STABLE *methyl < 1° < 2° < 3°*



[TURN OVER]

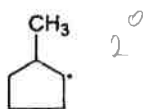


Consider the following reaction TO ANSWER questions 8 and 9 below

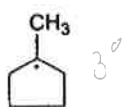


8 What is the most stable intermediate formed in the reaction?

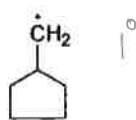
(1)



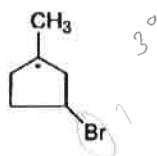
(2)



(3)



(4)

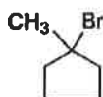


Me $1^\circ < 2^\circ < 3^\circ$
least stable most stable

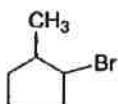
[TURN OVER]

9 What is the major organic product formed in the reaction?

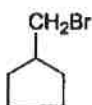
(1)



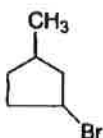
(2)



(3)



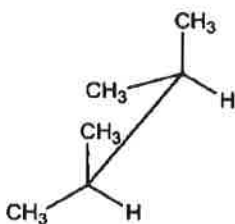
(4)



10 Which of the following structures represents an ANTI conformation?

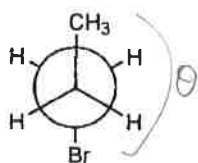
Anti = $\theta = 180^\circ$

(1)



Totally eclipsed

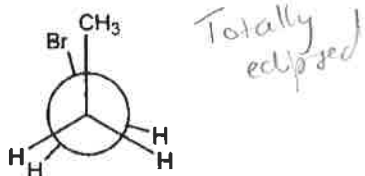
(2)



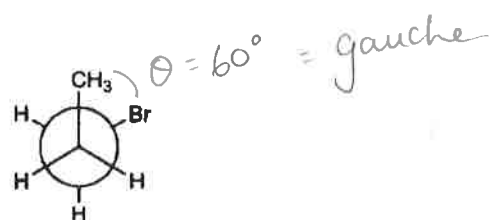
✓ $\theta = 180^\circ = \text{Anti}$

[TURN OVER]

(3)



(4)



11 Which of the following reactions is an example of an elimination reaction?

(1)



(2)

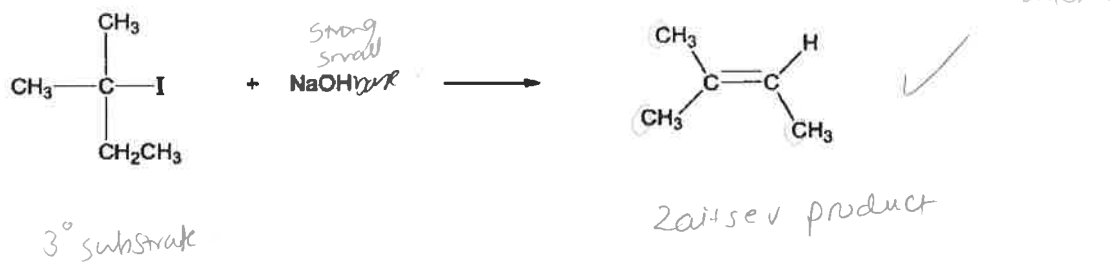


(3)



(4)

E2



most substituted alkene possible = product

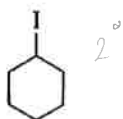
[TURN OVER]

- 12 Alkyl halides may undergo nucleophilic substitution reaction according to the following reaction

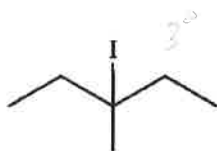


Which of the following alkyl halides reacts the FASTEST under these conditions?

(1)



(2)

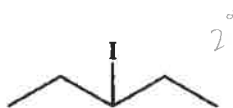


most substituted substrate
= most stable
= reacts fastest

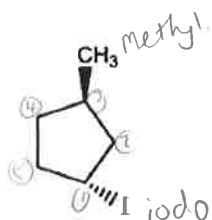
(3)



(4)



- 13 Give the correct name of the following compound



(1)

trans-1-iodo-3-methylcyclopentane

(2)

trans-3-iodo-1-methylcyclopentane

(3)

cis-1-iodo-3-methylcyclopentane

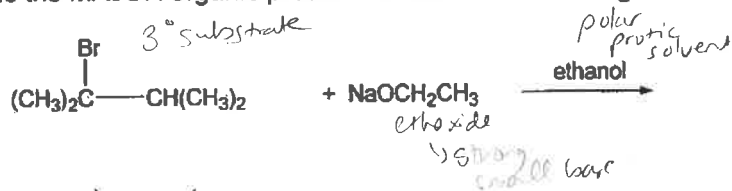
[TURN OVER]

(4) *cis*- 3-iodo-1-methylcyclopentane14 Which of the following compounds will be the BEST nucleophile to promote an S_N1-type reaction?

- (1) CH₃OH *weak nucleophile*
- (2) (CH₃)₂C=CH₂
- (3) CH₃Br
- (4) CN⁻ → *strong nucleophile - better for S_N2*

Weak nucleophile

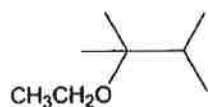
15 What is the MAJOR organic product formed in the following reaction?



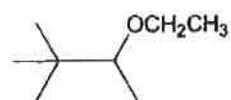
(1)



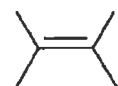
(2)



(3)



(4)

*E2 Zaitsev*
most substituted
alkene

[TURN OVER]

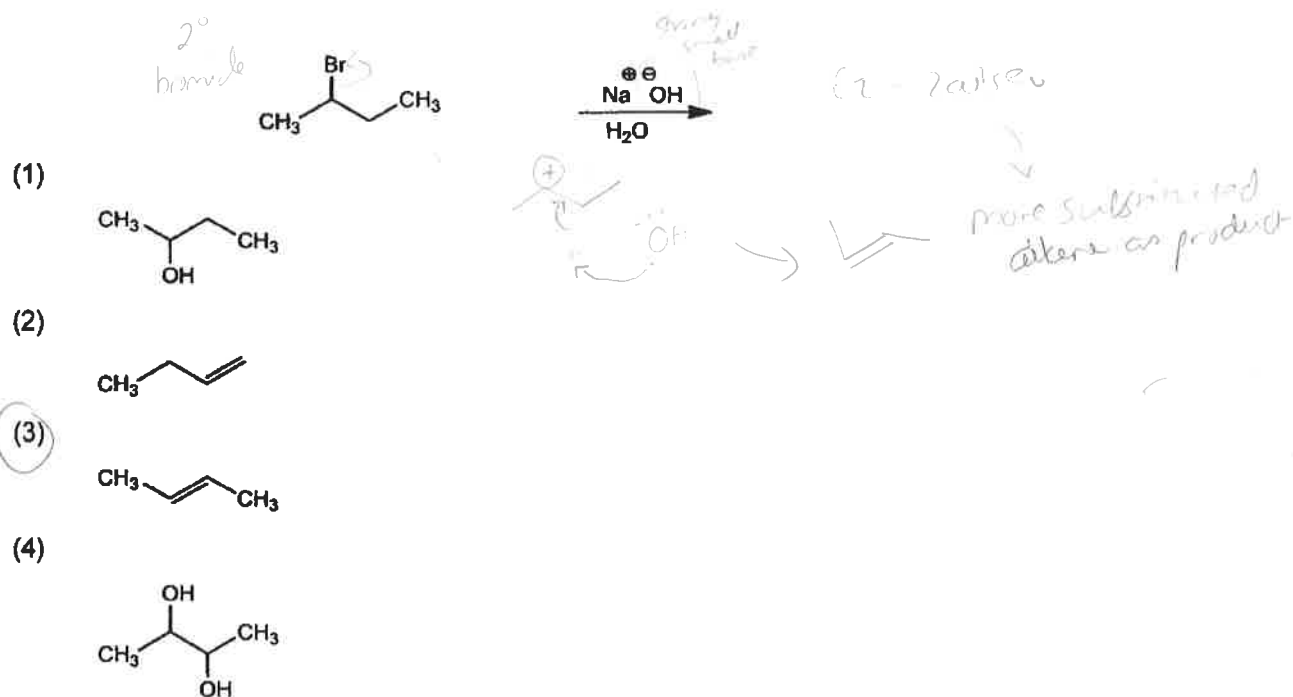
Hydroxyl (OH) group is electronegative. The negative charge of O in hydroxyl group attracts other molecules with + charged H atoms to form a hydrogen bond with those polar substances, making ethanol a good solvent.

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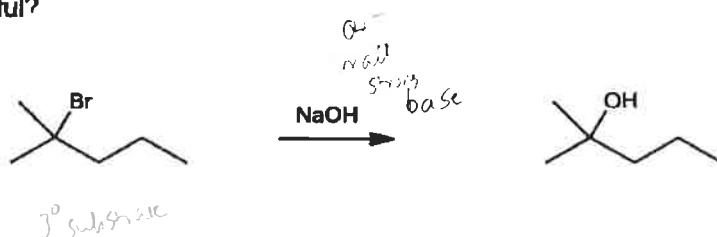
16 Ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, is a good solvent for polar substances because

- (1) it undergoes dipole-dipole interactions
- (2) it is able to form hydrogen bonds with the substances
- (3) there are weak ion-dipole interactions
- (4) the van der Waals forces cause repulsion

17 Alkyl halides may undergo nucleophilic substitution reactions. Which of the following reaction products is obtained in the following nucleophilic substitution reaction?



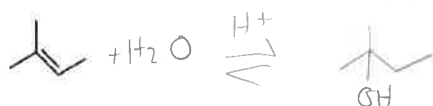
18 Which statement below best describes why the synthetic route shown below is unsuccessful?



[TURN OVER]

- (1) The tertiary bromide is too hindered to undergo an S_N2 reaction with hydroxide
- (2) Hydroxides are weak nucleophiles \times
- (3) An alkyl bromide undergoes coupling reaction with itself \times
- (4) The primary alkyl bromide is unreactive under these conditions

19 Which of the following alcohols is produced by the acid catalyzed hydration of 2-methyl-2-butene the following compound?



OH added to most substituted C, H to least substituted

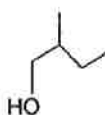
(1)



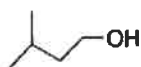
(2)



(3)

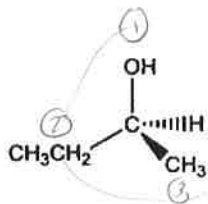


(4)



20 The absolute configuration of a chiral carbon is defined as R- or S- according to the Cahn-Ingold-Prelog rules. What is the correct structure of (R)-2-butanol?

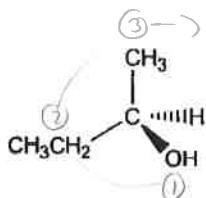
(1)



counter clockwise = (S) \times

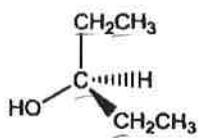
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(2)



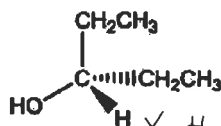
clockwise (R)-2-butanol ✓

(3)



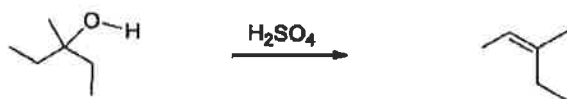
5 carbon chain = pentane not butane. x

(4)



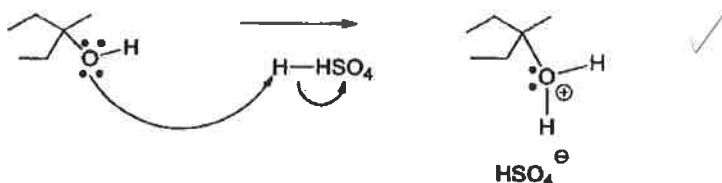
H must be oriented behind the molecule x

21 Consider the following reaction



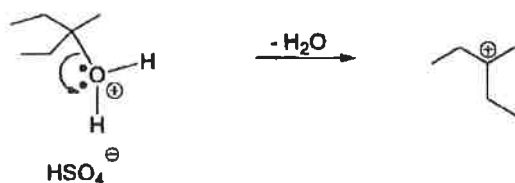
Which of the following steps represent the mechanism of the reaction?

(1)

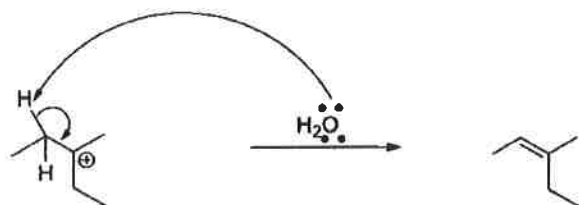


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(2)

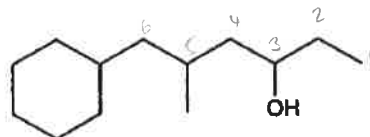


(3)



(4) The steps (1), (2) and (3)

22 What is the IUPAC name of the molecule shown below?



3-ol.
6-cyclohexyl.
5-methyl
6-cyclohexyl-5-methylhexan-3-ol

- (1) 4-hydroxy-2,5-dimethyl-1-pentylcyclohexane
 (2) 6-cyclohexyl-5-methylhexan-3-ol
 (3) 1-cyclohexyl-2-methylhexan-4-ol
 (4) 5-cyclohexyl-1,4-dimethylpentan-2-ol

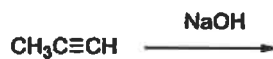
23 Terminal alkynes are very weak acids and only react with very strong bases. Which of the following reactions will NOT give an acetylide ion as product?

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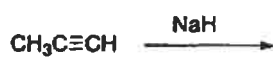
(1)



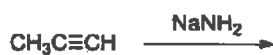
(2)



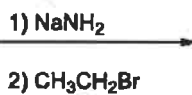
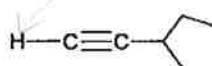
(3)



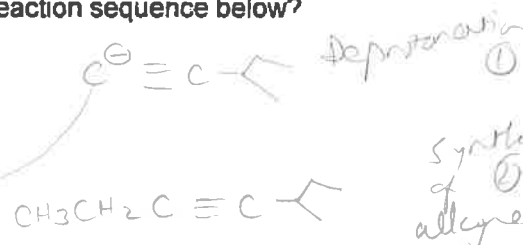
(4)



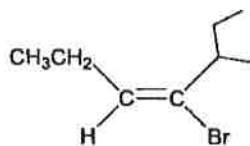
24 What is the structure of the major organic product(s) in the reaction sequence below?



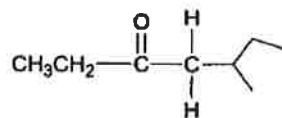
① Formation of Acetylide ion + ② Synthesis of Alkyne



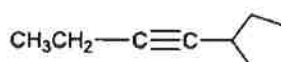
(1)



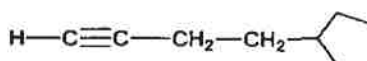
(2)



(3)



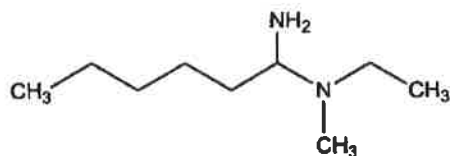
(4)



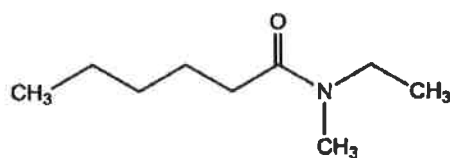
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25 The correct structure of *N*-ethyl-*N*-methyl-1-hexanamine is?

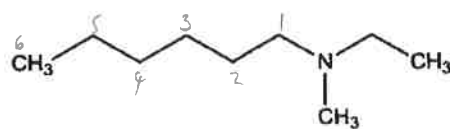
(1)



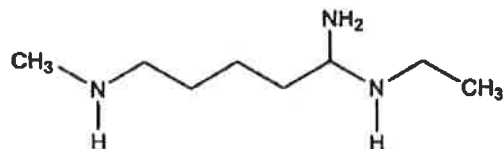
(2)



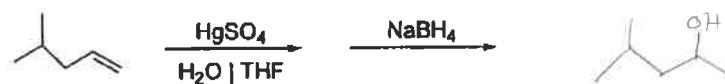
(3)



(4)

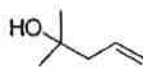


26 What is the major organic product formed in the following reaction?

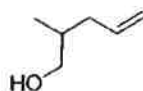


add OH to most substituted C.

(1)

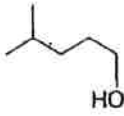


(2)

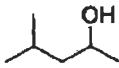


[TURN OVER]

(3)



(4)

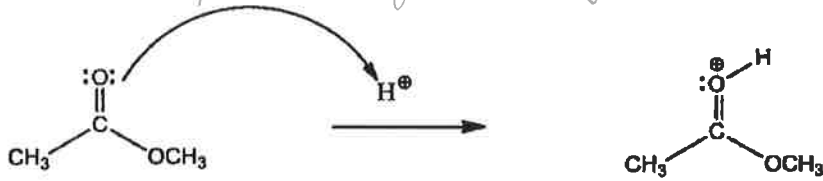


Transesterification

27 Consider the carbonyl/carboxyl group Which of the following steps is INCORRECT?

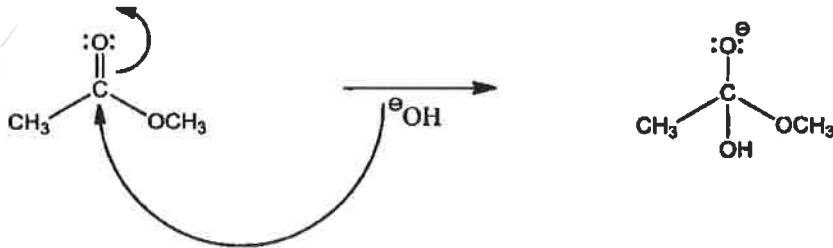
(1)

protonation of the carbonyl ✓



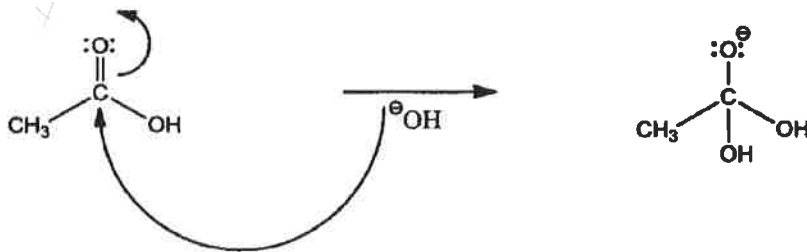
(2)

Adding of nucleophile
Ester
 $R-C(=O)-OR'$

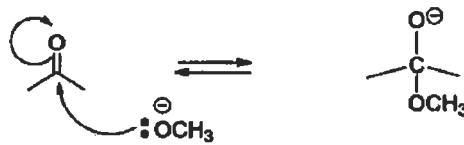


(3)

Not an ester



(4)



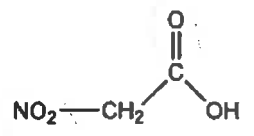
[TURN OVER]

Special case: stabilize molecule

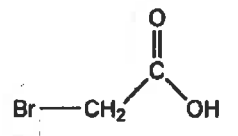
$\text{NO}_2 + \text{Cl} + \text{Br} = e^-$ withdrawing groups
 (Carbonyl groups)
 $\text{CH}_3 / \text{OCH}_3 = e^-$ donating groups
 NH₂, phenyl groups
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28 Which of the following organic molecules is the strongest acid?

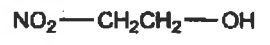
(1)



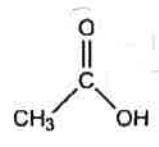
(2)



(3)



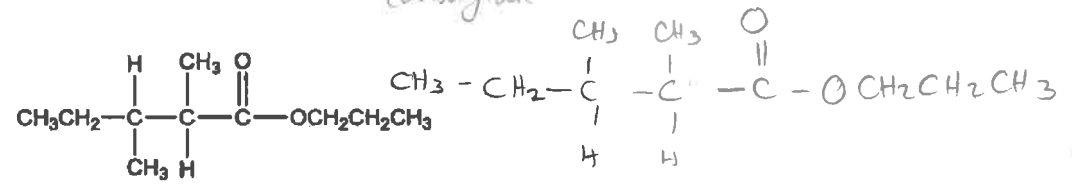
(4)



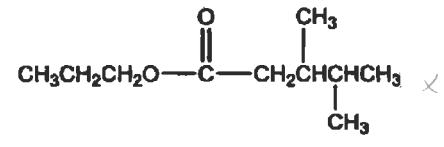
(1) nitro group has
 (2) chlor group has
 (3) - e withdrawing group
 (4) - e withdrawing group
 None is a stronger e-withdrawing group than Br.
 more acidic

29 What is the correct structure of propyl 2,3-dimethylpentanoate?

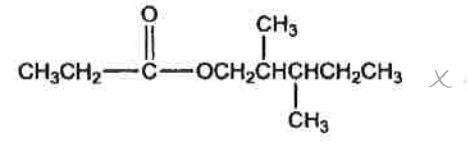
(1)



(2)



(3)

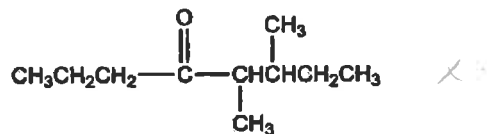


Allyl: CH₂CH₂CH₃

Carboxylate

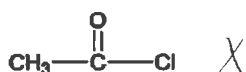
[TURN OVER]

(4)

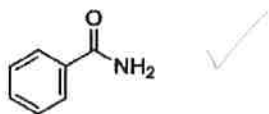


30 Which of the following compounds will form strong hydrogen bonds with water?

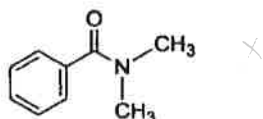
(1)



(2)



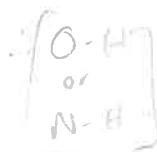
(3)



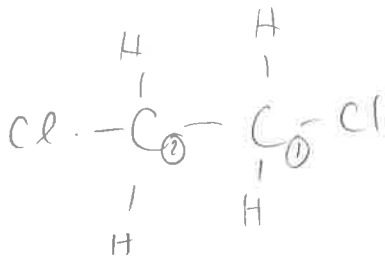
(4)



Any molecule which has a hydrogen atom attached directly to an oxygen or a nitrogen is capable of hydrogen bonding



[TURN OVER]

**SECTION B**

Answer ALL the questions this section in the SPACE PROVIDED AFTER EACH QUESTION.

Question 1 [20]

- 1.1 Draw the Newman projections of the four major conformations of $\text{CH}_2\text{ClCH}_2\text{Cl}$ and identify the most stable and least stable conformations. Label the conformations accordingly.

(6)

- Totally eclipsed ($\theta = 0^\circ$) (Least stable)
- Gauche ($\theta = 60^\circ$ or 300°)
- Eclipsed ($\theta = 120^\circ$ or 240°)
- Anti ($\theta = 180^\circ$) (Most stable)

①

Totally eclipsed = Least stable conformation
($\theta = 0^\circ$)

②

Gauche / Staggered
($\theta = 60^\circ$)

③

Eclipsed
($\theta = 120^\circ$)

④

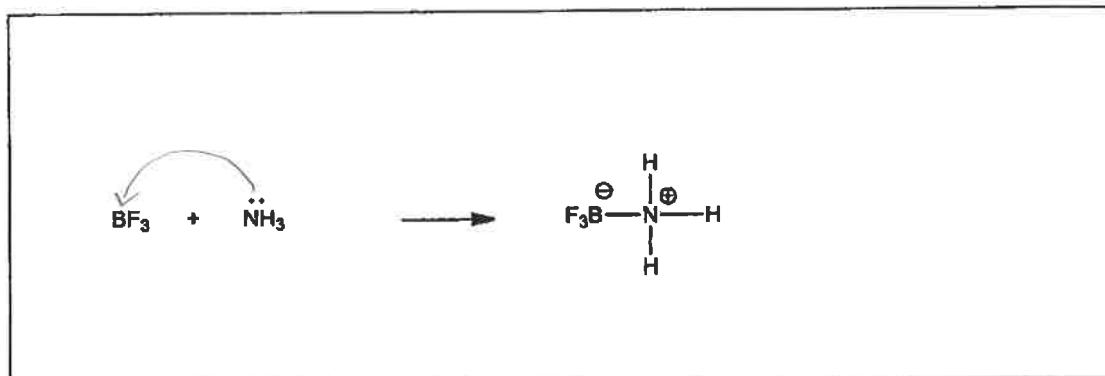
Anti = Most stable conformation
($\theta = 180^\circ$)

- 1.2 Use curved arrows to show the movement of electron pairs in the reaction shown below

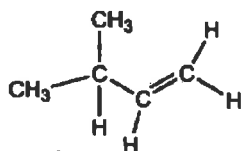


(2)

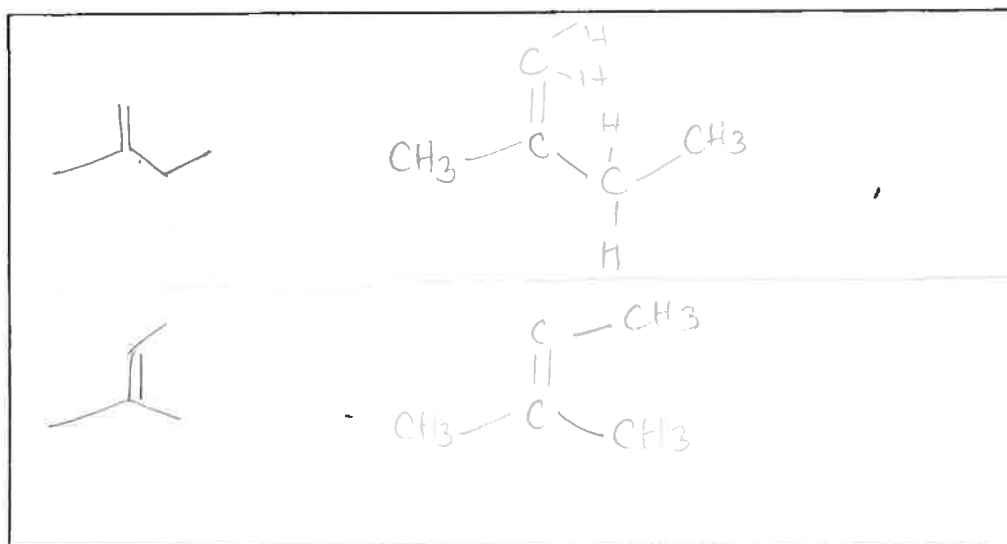
[TURN OVER]



- 13 Draw the structural formulas for two constitutional / structural isomers of the following compound

C₅H₁₀

(4)



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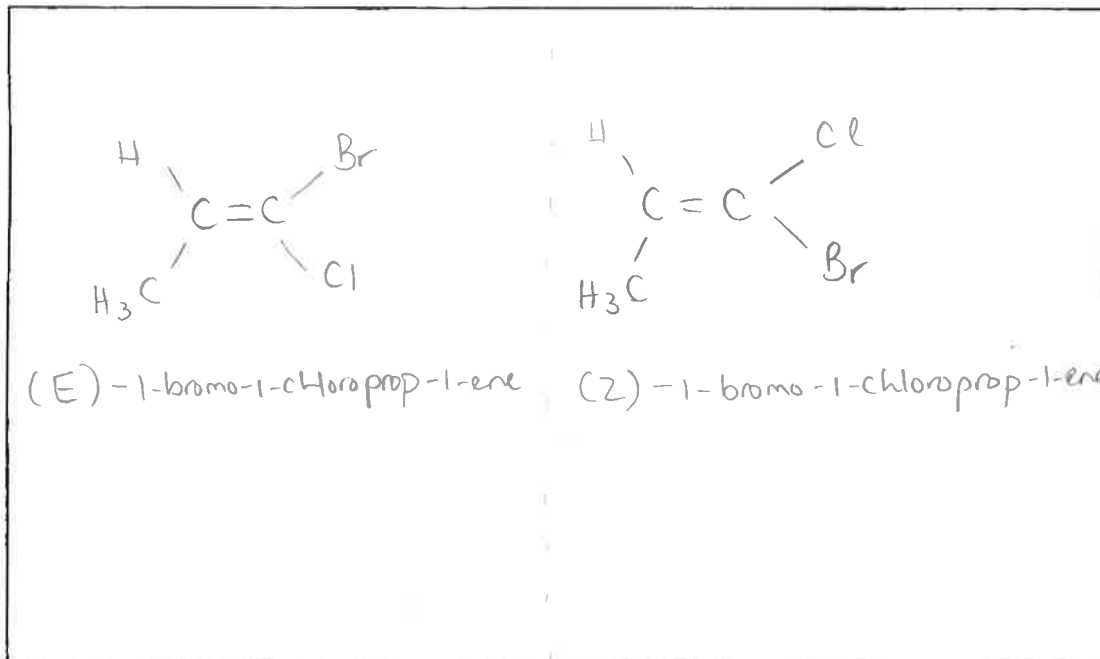


22

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- 14 Draw the geometric isomers (E- / Z-) of $CH_3HC=C(Cl)Br$ Give the IUPAC name of each isomer

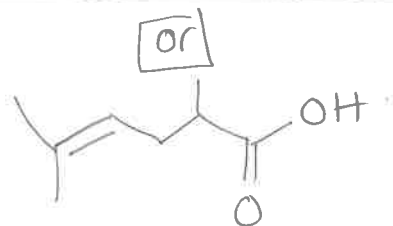
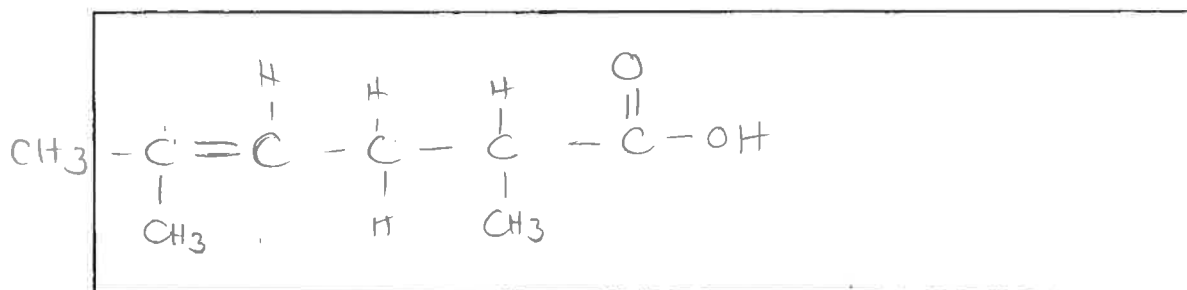
(6)



- 15 Draw the structure of 2,5-dimethylhex-4-enoic acid

carboxylic acid $R-\overset{O}{\parallel}C-OH$

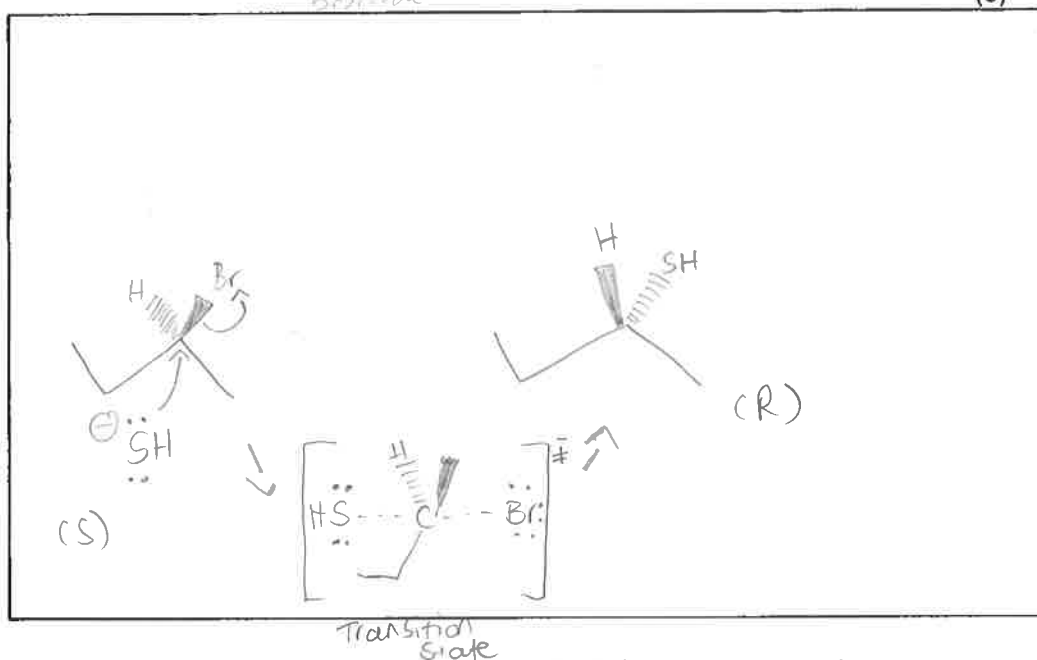
(2)



[TURN OVER]

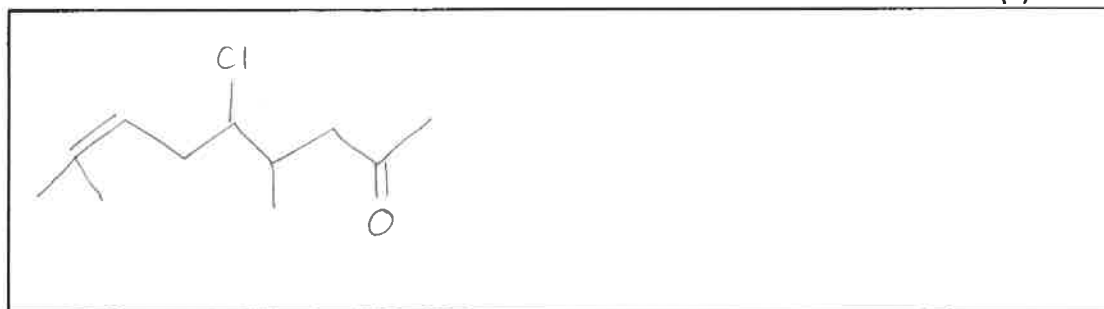
Question 2 [20]

2.1 Propose a detailed mechanism for the following reaction



2.2 (a) Draw the structure of the compound with the following proposed name
1,1,5-trimethyl-4-chlorooct-1-en-7-one

(2)



[TURN OVER]

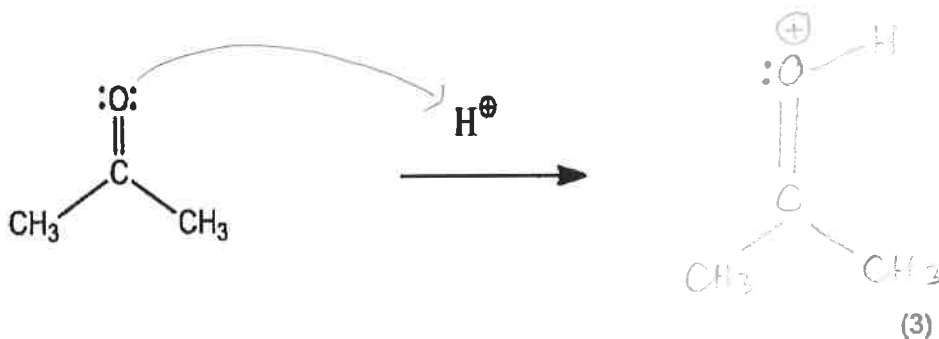
5-chloro-4,8-dimethylnon-7-en-2-one

- (b) Explain what is wrong with the name provided in (a) above (state each violation of the IUPAC nomenclature rules) and give the correct IUPAC name for the compound

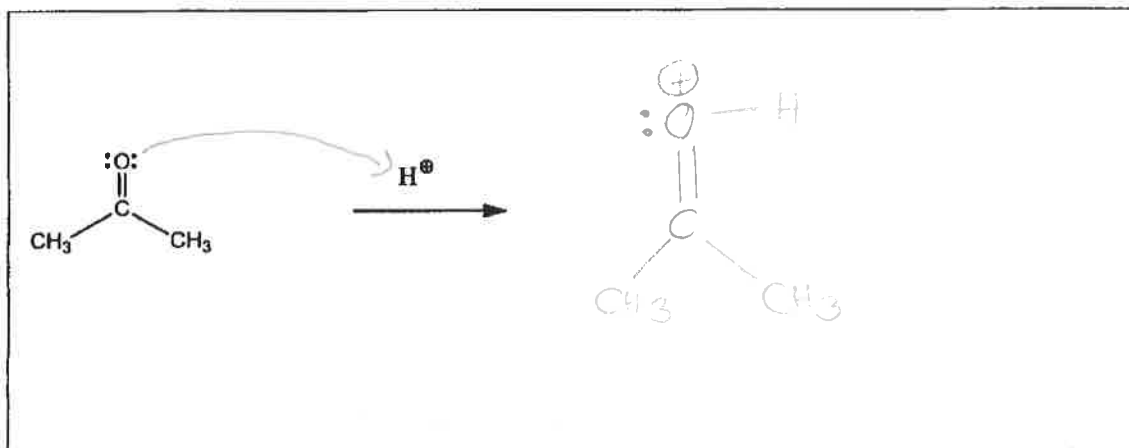
(5)

- * Numbering of the carbon chain should start from the opposite direction (closer to the ketone group, which takes priority)
- * A methyl group on the end carbon adds to the parent carbon chain \therefore it is a nonane not an octane and dimethyl not trimethyl.
- * Functional groups are not ordered alphabetically (i.e. -chloro before -methyl).
- * Due to correct renumbering, -en is on carbon 7, not carbon 1.
- 5-chloro-4,8-dimethylnon-7-en-2-one.
- Correct IUPAC name \uparrow

- 23 Complete the following reaction and use curved arrows to show the movement of electrons in the process



[TURN OVER]



2.4 Propose a detailed reaction mechanism for the formation of the major product formed in the reaction of HI with $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$

Addition of Hydrogen Halides to Alkenes

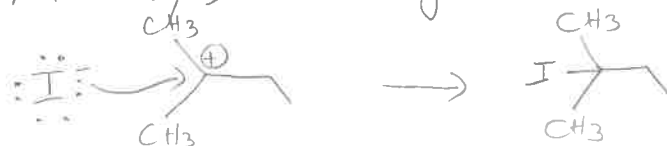


(5)

① Protonation of π bond to form a carbocation



② Attack by Iodide ion gives addition product



TOTAL MARKS [100]

[TURN OVER]

ROUGH WORK

[TURN OVER]

PART 1 (GENERAL/ALGEMEEN) DEEL 1

STUDY UNIT e.g. PSY100 X STUDIE EENHEID by PSY100-X		INITIALS AND SURNAME VOORLETTERS EN VAN	
PAPER NUMBER VRAESTELNOMMER		DATE OF EXAMINATION DATUM VAN EKSAMEN	
STUDENT NUMBER STUDENTENOMMER		EXAMINATION CENTRE (EG. PRETORIA) EKSAMENSENTRUM (BY. PRETORIA)	
UNIQUE PAPER NO UNIEKE VRAESTEL NR			

For use by examination invigilator
Vir gebruik deur eksamenopsiener

IMPORTANT

- USE ONLY AN HB PENCIL TO COMPLETE THIS SHEET
- MARK LIKE THIS
- CHECK THAT YOUR INITIALS AND SURNAME HAS BEEN FILLED IN CORRECTLY
- ENTER YOUR STUDENT NUMBER FROM LEFT TO RIGHT
- CHECK THAT YOUR STUDENT NUMBER HAS BEEN FILLED IN CORRECTLY
- CHECK THAT THE UNIQUE NUMBER HAS BEEN FILLED IN CORRECTLY
- CHECK THAT ONLY ONE ANSWER PER QUESTION HAS BEEN MARKED
- DO NOT FOLD

BELANGRIK

- GEBUIK SLEGS 'N HB POTLOOD OM HIERDIE BLAD TE VOLTOOI
- MERK AS VOLG
- KONTROLEER DAT U VOORLETTERS EN VAN REG INGEVUL IS
- VUL U STUDENTENOMMER VAN LINKS NA REGS IN
- KONTROLEER DAT U DIE KORREKTE STUDENTENOMMER VERSTREK HET
- KONTROLEER DAT DIE UNIEKE NOMMER REG INGEVUL IS
- MAAK SEKER DAT NET EEN ALTERNATIEF PER VRAAG GEMERK IS
- MOENIE VOU NIE

PART 2 (ANSWERS/ANTWOORDE) DEEL 2

1	(1) (2) (3) (4) (5)	36	(1) (2) (3) (4) (5)	71	(1) (2) (3) (4) (5)	106	(1) (2) (3) (4) (5)
2	(1) (2) (3) (4) (5)	37	(1) (2) (3) (4) (5)	72	(1) (2) (3) (4) (5)	107	(1) (2) (3) (4) (5)
3	(1) (2) (3) (4) (5)	38	(1) (2) (3) (4) (5)	73	(1) (2) (3) (4) (5)	108	(1) (2) (3) (4) (5)
4	(1) (2) (3) (4) (5)	39	(1) (2) (3) (4) (5)	74	(1) (2) (3) (4) (5)	109	(1) (2) (3) (4) (5)
5	(1) (2) (3) (4) (5)	40	(1) (2) (3) (4) (5)	75	(1) (2) (3) (4) (5)	110	(1) (2) (3) (4) (5)
6	(1) (2) (3) (4) (5)	41	(1) (2) (3) (4) (5)	76	(1) (2) (3) (4) (5)	111	(1) (2) (3) (4) (5)
7	(1) (2) (3) (4) (5)	42	(1) (2) (3) (4) (5)	77	(1) (2) (3) (4) (5)	112	(1) (2) (3) (4) (5)
8	(1) (2) (3) (4) (5)	43	(1) (2) (3) (4) (5)	78	(1) (2) (3) (4) (5)	113	(1) (2) (3) (4) (5)
9	(1) (2) (3) (4) (5)	44	(1) (2) (3) (4) (5)	79	(1) (2) (3) (4) (5)	114	(1) (2) (3) (4) (5)
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12	(1) (2) (3) (4) (5)	47	(1) (2) (3) (4) (5)	82	(1) (2) (3) (4) (5)	117	(1) (2) (3) (4) (5)
13	(1) (2) (3) (4) (5)	48	(1) (2) (3) (4) (5)	83	(1) (2) (3) (4) (5)	118	(1) (2) (3) (4) (5)
14	(1) (2) (3) (4) (5)	49	(1) (2) (3) (4) (5)	84	(1) (2) (3) (4) (5)	119	(1) (2) (3) (4) (5)
15	(1) (2) (3) (4) (5)	50	(1) (2) (3) (4) (5)	85	(1) (2) (3) (4) (5)	120	(1) (2) (3) (4) (5)
16	(1) (2) (3) (4) (5)	51	(1) (2) (3) (4) (5)	86	(1) (2) (3) (4) (5)	121	(1) (2) (3) (4) (5)
17	(1) (2) (3) (4) (5)	52	(1) (2) (3) (4) (5)	87	(1) (2) (3) (4) (5)	122	(1) (2) (3) (4) (5)
18	(1) (2) (3) (4) (5)	53	(1) (2) (3) (4) (5)	88	(1) (2) (3) (4) (5)	123	(1) (2) (3) (4) (5)
19	(1) (2) (3) (4) (5)	54	(1) (2) (3) (4) (5)	89	(1) (2) (3) (4) (5)	124	(1) (2) (3) (4) (5)
20	(1) (2) (3) (4) (5)	55	(1) (2) (3) (4) (5)	90	(1) (2) (3) (4) (5)	125	(1) (2) (3) (4) (5)
21	(1) (2) (3) (4) (5)	56	(1) (2) (3) (4) (5)	91	(1) (2) (3) (4) (5)	126	(1) (2) (3) (4) (5)
22	(1) (2) (3) (4) (5)	57	(1) (2) (3) (4) (5)	92	(1) (2) (3) (4) (5)	127	(1) (2) (3) (4) (5)
23	(1) (2) (3) (4) (5)	58	(1) (2) (3) (4) (5)	93	(1) (2) (3) (4) (5)	128	(1) (2) (3) (4) (5)
24	(1) (2) (3) (4) (5)	59	(1) (2) (3) (4) (5)	94	(1) (2) (3) (4) (5)	129	(1) (2) (3) (4) (5)
25	(1) (2) (3) (4) (5)	60	(1) (2) (3) (4) (5)	95	(1) (2) (3) (4) (5)	130	(1) (2) (3) (4) (5)
26	(1) (2) (3) (4) (5)	61	(1) (2) (3) (4) (5)	96	(1) (2) (3) (4) (5)	131	(1) (2) (3) (4) (5)
27	(1) (2) (3) (4) (5)	62	(1) (2) (3) (4) (5)	97	(1) (2) (3) (4) (5)	132	(1) (2) (3) (4) (5)
28	(1) (2) (3) (4) (5)	63	(1) (2) (3) (4) (5)	98	(1) (2) (3) (4) (5)	133	(1) (2) (3) (4) (5)
29	(1) (2) (3) (4) (5)	64	(1) (2) (3) (4) (5)	99	(1) (2) (3) (4) (5)	134	(1) (2) (3) (4) (5)
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31	(1) (2) (3) (4) (5)	66	(1) (2) (3) (4) (5)	101	(1) (2) (3) (4) (5)	136	(1) (2) (3) (4) (5)
32	(1) (2) (3) (4) (5)	67	(1) (2) (3) (4) (5)	102	(1) (2) (3) (4) (5)	137	(1) (2) (3) (4) (5)
33	(1) (2) (3) (4) (5)	68	(1) (2) (3) (4) (5)	103	(1) (2) (3) (4) (5)	138	(1) (2) (3) (4) (5)
34	(1) (2) (3) (4) (5)	69	(1) (2) (3) (4) (5)	104	(1) (2) (3) (4) (5)	139	(1) (2) (3) (4) (5)
35	(1) (2) (3) (4) (5)	70	(1) (2) (3) (4) (5)	105	(1) (2) (3) (4) (5)	140	(1) (2) (3) (4) (5)

