Question No. 1 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 1. Which statement below regarding the physical properties of alkyl halides is false?

(A) Alkyl halides do not have intermolecular hydrogen bonding.
(B) Alkyl halides do have dipole-dipole attractions.
(C) As the size of the halogen increases, the boiling point of the alkyl halide increases.
(D) Alkyl fluorides and most alkyl chlorides are denser than water.
(E) Alkyl bromides and iodides are more dense than water

Feedback

A. Incorrect!
Since alkyl halides do not have a hydrogen bonded to an oxygen or nitrogen, they can not participate in intermolecular hydrogen bonding.

B. Incorrect!
The carbon-halogen bond in alkyl halides has a dipole due to the difference in electronegativities of carbon and the halogens. As a result, alkyl halides do have dipole-dipole attractions.

C. Incorrect!
The boiling points of alkyl halides do increase with the increasing size of the halogen atom.

D. Correct!
Alkyl fluorides and most of alkyl chlorides are actually less dense than water.

E. Incorrect!
Alkyl bromides and iodides are more dense than water.

Solution

(1) Recall the physical properties of alkyl halides discussed in the tutorial.

We learned in the tutorial that alkyl halides experience dipole-dipole attractions but not hydrogen bonding attractions. In addition, we read that the boiling points of alkyl halides increase as the size of the halogen increases. And lastly, we learned that alkyl fluorides and chlorides are less dense than water while alkyl bromides and iodides are more dense than water.

(2) Read each statement carefully and choose the one that is incorrect.

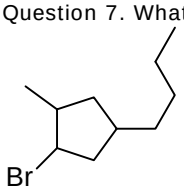
Therefore, the correct answer is (D).

Question No. 2 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 7. What is the correct IUPAC name for the compound below?



(A) 3-bromo-1-butyl-4-methylcyclopentane
(B) 1-bromo-4-butyl-2-methylcyclopentane
(C) 1-(3-bromo-4-methylcyclopentyl)butane
(D) 4-bromo-1-butyl-3-methylcyclopentane
(E) 4-butyl-1-bromo-2-methylcyclopentane

Feedback

A. Incorrect!
The cycloalkane should be numbered to give the lowest possible combination of numbers to the substituents. Review your numbering of the cycloalkane and see if you can find an even lower combination of numbers.

B. Correct!
The molecule is correctly named as a cycloalkane since the ring contains more carbons than any of the straight chains. By numbering the carbon attached to the bromine atom as carbon 1, you obtain the lowest combination of numbers by continuing to number clockwise around the ring

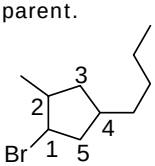
C. Incorrect!
Since there are more carbons in the ring then in the longest straight chain, the molecule should be named as a cycloalkane. Go back and review the IUPAC rules for naming cycloalkanes and alkyl halides.

D. Incorrect!
The cycloalkane should be numbered to give the lowest possible combination of numbers to the substituents. Review your numbering of the cycloalkane and see if you can find an even lower combination of numbers.

E. Incorrect!
The substituents should be listed in alphabetical order. Go back and review the IUPAC rules for naming cycloalkanes and alkyl halides.

Solution

(1) Find the longest carbon chain and the main functional group in the molecule to determine the parent.



The longest carbon chain is the 5 carbon ring. There is a four carbon chain however, if the ring contains more carbons than any of the chains, the molecule is named as a cycloalkane. Since there are 5 carbons in the ring, it is a cyclopentane.

(2) Determine the substituents and their correct location numbers.

There are three substituents: a methyl group, a butyl group, and a bromine atom.

The cycloalkane is numbered to give the lowest possible combination of numbers to the substituents. By numbering the carbon attached to the bromine atom as carbon 1, you obtain the lowest combination of numbers by continuing to number clockwise around the ring. The methyl group is on carbon 2 and the butyl group is on carbon 4.

(3) Put the substituents in alphabetical order (ignoring any numerical prefixes) and place in front of the parent name.

1-bromo-4-butyl-2-methylcyclopentane

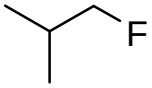
Therefore, the correct answer is (B).

Question No. 3 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 3. What is the common name for the alkyl halide below?



(A) *sec*-butyl fluoride
(B) isopropyl fluoride
(C) isobutyl fluoride
(D) *tert*-butyl fluoride
(E) neobutyl fluoride

Feedback

A. Incorrect!
In a sec-butyl group, the halide would be attached to the sec-butyl group via a secondary carbon. Here, the fluoride is attached to a primary carbon.

B. Incorrect!
Isopropyl indicates only three carbons. There are a total of 4 carbons in this molecule.

C. Correct!
There are a total of 4 carbons in the alkyl portion of the molecule. Two methyl groups are attached to a –CH on one end of the chain while the halide is attached to the other end of the chain.

D. Incorrect!
In a tert-butyl group, the halide would be attached to a tertiary carbon. Here, the fluoride is attached to a primary carbon.

E. Incorrect!
In a neo group, there would be four primary carbons attached to a quaternary carbon for a total of five carbons. Here, there are only a total of four carbons in the molecule. Go back and review the common nomenclature for alkyl halides.

Solution

(1) When asked for common nomenclature, first determine the type of compound the given molecule is.

In this particular case, we have been given an alkyl chain with a halide attached to it. This molecule must be an alkyl halide.

(2) Recall the common nomenclature for alkyl halides.

In alkyl halide common nomenclature, the name will be in two parts: the alkyl group followed by the name of the halide. Use all the carbons in the molecule to determine the alkyl name.

(3) Look for common structural motifs.

Look to see if the structure is a straight chain with no branching or if there is branching, determine where the branching occurs. You have approximately five choices to describe the structure of the alkyl group:

(I) n- is used if the chain is straight and the functional group is on one end of the chain.
(II) Iso- is used if the chain contains two methyl groups attached to a –CH with the functional group on the opposite end of the chain.
(III) Sec- is used if the functional group is attached to the secondary carbon of the chain.
(IV) Tert- is used if the functional group is attached to the tertiary carbon of the chain.
(V) Neo- is used if the functional group is attached to a carbon that has 4 other carbons attached to it.

In the above structure, the alkyl portion of the chain has a total of 4 carbons and the halide is attached to the end of the chain that has 2 methyl groups attached to a –CH at the other end. This description is indicative of an iso group.

(4) Put the alkyl name with the name of the halide.

The common name of the molecule is isobutyl fluoride.

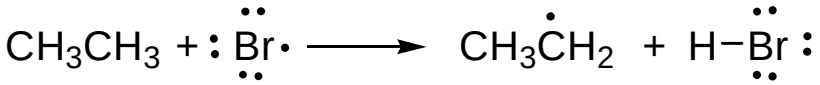
Therefore, the correct answer is (C).

Question No. 4 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 4. The following is a step from the radical bromination of ethane. What type of step is it?



(A) Initiation
(B) Propagation
(C) Termination
(D) Dehydrohalogenation
(E) Dehydration

Feedback

A. Incorrect!
In initiation steps, radicals are formed. The above step shows that while one radical is formed, another one is consumed.

B. Correct!
In propagation steps, one radical is consumed while another radical is formed. This is the first of two propagation steps in the radical bromination of ethane.

C. Incorrect!
In termination steps, radicals are consumed without new ones being made. The above step shows that while one radical is consumed, a new one is formed.

D. Incorrect!
Dehydrohalogenation is a different process than radical bromination. Go back and review the different steps involved in a radical halogenation reaction.

E. Incorrect!
Dehydration is the process where water is removed to form a carbon-carbon double bond. Go back and review the different steps involved in a radical halogenation reaction.

Solution

(1) Recall the different steps involved in radical halogenation reactions.

There are three types of mechanistic steps in the radical halogenation of alkanes: initiation, propagation, and termination. In initiation steps, radicals are formed. In propagation steps, one radical is consumed while another radical is formed. In termination steps, radicals are consumed without new ones being made.

(2) Compare the above step with these definitions. Determine what kind of mechanistic step it is.

In the step shown, a bromine radical grabs a hydrogen from ethane. The bromine radical is consumed in the process. However, a new radical, an ethyl radical, is formed. Therefore, this must be a propagation step.

Therefore, the correct answer is (B).

Question No. 5 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 5. Which of the following is not a termination step?

(I) $\cdot Br \cdot + \cdot Br \cdot \longrightarrow Br-Br$

(II) $CH_3\dot{C}H_2 + \cdot Br \cdot \longrightarrow CH_3CH_2Br$

(III) $Br_2 \longrightarrow 2\,\cdot Br \cdot$

(IV) $CH_3\dot{C}H_2 + CH_3\dot{C}H_2 \longrightarrow CH_3CH_2CH_2CH_3$

(A) I
(B) II
(C) III
(D) IV
(E) All of the above are termination steps.

Feedback

A. Incorrect!
In I, two bromine radicals are consumed by forming diatomic bromine. This is a termination step.

B. Incorrect!
In II, an ethyl radical and a bromine radical are consumed by forming bromoethane. This is a termination step.

C. Correct!
In III, diatomic bromine is split into to bromine radicals. This is an initiation step, not a termination step.

D. Incorrect!
In IV, two ethyl radicals combine to form butane. This is a termination step.

E. Incorrect!
Not all the steps shown are termination steps. Go back and review the definition of a termination step and try to determine the correct answer.

Solution

(1) Recall the different steps involved in radical halogenation reactions.

There are three types of mechanistic steps in the radical halogenation of alkanes: initiation, propagation, and termination. In initiation steps, radicals are formed. In propagation steps, one radical is consumed while another radical is formed. In termination steps, radicals are consumed without new ones being made.

(2) Determine if each choice meets the criteria of a termination step. Are all radicals consumed?

In I, II, and IV, radicals are consumed and stable, neutral molecules are formed. No new radicals are formed. However, in III, a stable, neutral molecule is split to form two bromine radicals. This is not a termination step but an initiation step.

Therefore, the correct answer is (C).

Question No. 6 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 6. What is the product of the reaction of an alkyne with an excess of X_2?

(A) A haloalkene
(B) A dihaloalkene
(C) A dihaloalkane
(D) A tetrahaloalkene
(E) A tetrahaloalkane

Feedback

A. Incorrect!
A haloalkene would not be obtained under these conditions. Go back and review the reactions used to synthesize alkyl halides.

B. Incorrect!
A dihaloalkene would not be obtained under these conditions. Go back and review the reactions used to synthesize alkyl halides.

C. Incorrect!
A dihaloalkane would not be obtained under these conditions. Go back and review the reactions used to synthesize alkyl halides.

D. Incorrect!
A tetrahaloalkene would not be obtained under these conditions. Go back and review the reactions used to synthesize alkyl halides.

E. Correct!
A tetrahaloalkane is formed under these conditions. Both bonds of the alkyne react with an equivalent of X_2 to give the final product.

Solution

(1) Recall the reactions covered in this tutorial.

The tutorial covered reactions that form alkyl halides and reactions that alkyl halides undergo.

(2) Determine what kind of reaction is taking place.

To determine what kind of reaction is taking place, you will first need to identify the reactants being used in the reaction.

The starting material is an alkyne. The other reactant is an excess of X_2. You may have already recognized this reaction as a halogenation of an alkyne. If you did not, go back and review the reactions in this tutorial.

(3) Predict the product(s).

In this reaction, X_2 adds over both pi bonds of the alkyne. The first equivalent adds over the first pi bond to yield a dihaloalkene. The second equivalent adds to the second pi bond to give a tetrahaloalkane.

Therefore, the correct answer is (E).

Question No. 7 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 7. Which statement below about Sn1 reactions is incorrect?

(A) Sn1 reactions are stepwise and have intermediates.
(B) The slow step in a Sn1 reaction is formation of the carbocation intermediate.
(C) Sn1 reactions have first order kinetics which means only the alkyl halide is involved in the rate limiting step.
(D) The products of a Sn1 reaction will be a pair of enantiomers.
(E) An aprotic solvent is best for Sn1 reactions as they tend to help stabilize carbocation intermediates.

Feedback

A. Incorrect!
Sn1 reactions are not concerted and are stepwise. This fact means they will have intermediates. Go back and review the theory on Sn1 reactions.

B. Incorrect!
Carbocation formation is the slow step (or the rate limiting step) of a Sn1 reaction. Go back and review the theory on Sn1 reactions.

C. Incorrect!
In a Sn1 reaction, only the halide takes part in the rate limiting step (carbocation formation) so the reaction has first order kinetics.

D. Incorrect!
Half the products of a Sn1 reaction will retain the stereochemistry of the starting materials. The other half will be inverted. This leads to the formation of a racemic mixture of enantiomers.

E. Correct!
Protic solvents are best for Sn1 reactions as they can form hydrogen bonds that help stabilize carbocation intermediates. Aprotic solvents can not form hydrogen bonds.

Solution

(1) Recall the specifics of the Sn1 type reaction.

Sn1 stands for substitution nucleophilic unimolecular. Sn1 reactions are substitution reactions of alkyl halides where the more substituted the halide is, the more reactive it will be under these conditions. The reaction is not concerted and is instead stepwise. The first step is the rate limiting step of carbocation formation. The second step where the nucleophile attacks the carbocation is the fast step. Since only the alkyl halide is present during the rate limiting step, Sn1 reactions have first order kinetics.

Since carbocations are intermediates of this reaction, rearrangements are possible. Anything that stabilizes the carbocation intermediate will speed the reaction. For this reason, protic solvents are favored in these reactions because they can form hydrogen bonds to the carbocation thereby lowering its energy.

The carbocation intermediate also influences the products obtained in these reactions. The carbocation is planar with a sp^2 hybridization. This arrangement allows the nucleophile to approach the carbocation from either side. As a result, the products produced are a pair of enantiomers.

(2) Read each statement carefully and determine which one contains incorrect information.

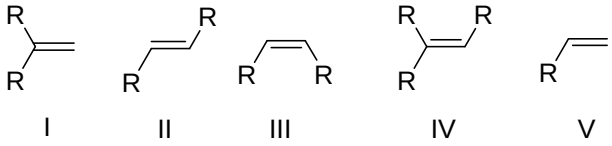
Therefore, the correct answer is (E).

Question No. 8 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 8. If the alkenes below were possible products of an elimination reaction, how would you rank their likely order of formation from most likely to least likely?



(A) I, V, III, II, IV
(B) IV, III, II, I, V
(C) V, I, III, II, IV
(D) IV, II, III, I, V
(E) III, II, I, V, IV

Feedback

A. Incorrect!
Remember that Sayteff's rule predicts the order of formation of alkene products in an elimination reaction. Go back and review which substitution patterns are favored according to the rule.

B. Incorrect!
Remember that Sayteff's rule predicts the order of formation of alkene products in an elimination reaction. Go back and review which substitution patterns are favored according to the rule.

C. Incorrect!
Remember that Sayteff's rule predicts the order of formation of alkene products in an elimination reaction. Go back and review which substitution patterns are favored according to the rule.

D. Correct!
The most substituted alkene will be favored to form first according to Sayteff's rule.

E. Incorrect!
Remember that Sayteff's rule predicts the order of formation of alkene products in an elimination reaction. Go back and review which substitution patterns are favored according to the rule.

Solution

(1) Recall Sayteff's rule.

Sayteff's rule (also spelled as Zaitsev's rule) states that in an elimination reaction, the alkene product that is most heavily substituted will be formed in higher yields.

(2) Determine the substitution of the alkenes above.

I is a disubstituted alkene where both substituents are on one carbon.
II is a trans disubstituted alkene.
III is a cis disubstituted alkene.
IV is a trisubstituted alkene.
V is a monosubstituted alkene.

(3) Determine which alkenes are more likely to be formed based on their substitution patterns.

The most substituted alkene shown is IV, a trisubstituted alkene, so it should be listed first.

Next, we were given three disubstituted alkenes. Which would be most likely to be formed first and why? Trans disubstituted alkenes have fewer steric interactions between substituents because the groups point in opposite directions. Thus, we would list it second in our list. The cis disubstituted alkene would be listed third because while there are some interactions, the substituents are bonded to separate carbons so the interactions are less compared to having the two substituents on the same carbon as in I. As a result, I would be listed fourth.

V, the monosubstituted alkene, would be least likely formed as it is not as stable as the more heavily substituted alkenes.

Therefore, the correct answer is (D).

Question No. 9 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 9. What term refers to a process that occurs all at once and not stepwise?

(A) Concerted
(B) Inversion
(C) Retention
(D) Unimolecular
(E) Bimolecular

Feedback

A. Correct!
In a concerted reaction, all the occurrences of bond breaking and bond forming occur all at once and not stepwise. There are no intermediates in a concerted reaction.

B. Incorrect!
Inversion refers to the process of inverting the original stereochemical configuration of a molecule to its opposite. Go back and review the terminology of substitution and elimination reactions.

C. Incorrect!
Retention refers to the instance where the stereochemical configuration of the product is the same as the starting material. Go back and review the terminology of substitution and elimination reactions.

D. Incorrect!
Unimolecular refers to one molecule being involved in a rate limiting step of a reaction. Go back and review the terminology of substitution and elimination reactions.

E. Incorrect!
Bimolecular refers to two molecules or species being involved in a rate limiting step of a reaction. Go back and review the terminology of substitution and elimination reactions.

Solution

(1) Recall the terminology of substitution and elimination reactions from this tutorial.

Unimolecular refers to one molecule being involved in a rate limiting step of a reaction.
Bimolecular refers to two molecules or species being involved in a rate limiting step of a reaction.

Retention refers to the instance where the stereochemical configuration of the product is the same as the starting material.
Inversion refers to the process of inverting the original stereochemical configuration of a molecule to its opposite.

Concerted refers to a process that occurs all at once and not stepwise.

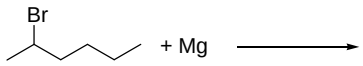
Therefore, the correct answer is (A).

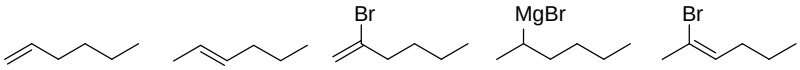
Question No. 10 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 10. What is the product of the reaction below?





I II III IV V

(A) I
(B) II
(C) III
(D) IV
(E) V

Feedback

A. Incorrect!
An alkene would not be obtained under these conditions. Go back and review the reactions of alkyl halides.

B. Incorrect!
An alkene would not be obtained under these conditions. Go back and review the reactions of alkyl halides.

C. Incorrect!
A vinyl bromide would not be obtained under these conditions. Go back and review the reactions of alkyl halides.

D. Correct!
This reaction forms a Grignard reagent via insertion of the magnesium in the carbon-bromine bond.

E. Incorrect!
A vinyl bromide would not be obtained under these conditions. Go back and review the reactions of alkyl halides.

Solution

(1) Recall the reactions covered in this tutorial.

The tutorial covered reactions that form alkyl halides and reactions that alkyl halides undergo.

(2) Determine what kind of reaction is taking place.

To determine what kind of reaction is taking place, you will first need to identify the reactants being used in the reaction.

The starting material is an alkyl bromide. The other reactant is elemental magnesium. You may have already recognized this reaction as the formation of a Grignard reagent. If you did not, go back and review the reactions in this tutorial.

(3) Predict the product(s).

In this reaction, magnesium will insert itself into the carbon-bromine bond. No elimination occurs. The final product is an organometallic compound where carbon is bonded to magnesium. The bromine is now bonded to the metal center.

Therefore, the correct answer is (D).