ANSWERS: **Major and minor products of addition reaction**

**2022**



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| **2021** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | In both cases it is an addition reaction because the double bond is broken and two new atoms are added (a H and a Br atom).For **Compound 1**, there are two products because the alkene is asymmetric due to the position of the double bond. There are two unique positions the H and Br can bond to, so there are two possible products. The carbon of the double bond with the most hydrogens attached gains another hydrogen atom in the major product. Thismeans that 2- bromobutane will be the major product, since C1 has two hydrogens and C2 has only one hydrogen; therefore C1 gains another H, forming 2-bromobutane.For **Compound 3**, there is only one product because the alkene is symmetrical due to the position of the double bond. This means only 3-bromohexane can be formed.  | • Identifies the type of reaction.• Identifies that two productsform from **Compound 1** andone product forms from**Compound 3**. | • Explains why it is an addition reaction.• Explains with limited detail why there are two products.ORCorrectly draws the structural formula and identifies the major / minor products of **Compound 1**. | • Fully explains the addition reaction and the possible organic products of both**Compound 1** and **Compound 3**. Structures MUST be correct. |

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| **2020** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
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| **2019** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | This is an addition reaction to an asymmetric alkene. When the HBr is added to propene when the double bond breaks, there are two possible products. The H atom is more likely to bond to the carbon with more hydrogens. In propene, the second carbon has one hydrogen and the first carbon has two hydrogens therefore the H from HBr bonds to the first carbon and the Br bonds to the second carbon making 2-bromopropane the major product. 1-bromopropane is the minor product where Br bonds to the firstcarbon. | • Recognises addition reaction.• Describes rule regardingaddition to asymmetric alkeneOR identifies propene as anasymmetric alkene.ORDescribes the placement of H orBr using Markovnikov topropene or to the C atoms in thedouble bond. | • Explains why 1-bromopropane is the minorproduct.ORExplains why 2-bromopropane is the majorproduct.ORMissing asymmetry.OROnly discusses fully onegroup for both products. | • Explains the formation of BOTH products and groups in this addition reaction. |

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| **2018** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (i)(ii) | HBr is the reagent. It is an addition reaction because the double bond is broken to form a single C–C bond allowing the H and Br to bond to the carbon atoms forming the haloalkane.There are two products because the reagent, HBr is asymmetric, and the alkene is asymmetric due to the position of the double bond. There are two carbons forming a double bond that the H and Br can bond to so there are two possible combinations. The carbon with the most hydrogens will gain more hydrogens. This means that 2-bromobutane will be the major product since the carbon at the end has two hydrogens and the middle carbon has only one hydrogen; therefore the H atom will preferentially bond to the end carbon. 1-bromobutane will be the minor product.*(The term “Markovnikov’s rule” is not required.)* | Identifies the reagent.Identifies the type of reaction. | Explains why it is an additionreaction.Explains with limited detailwhy there are two products **OR**states the 2 products arise from an asymmetric alkene | Uses drawings of the organic substances to elaborate on both the addition reaction and the possible organic products. Structures MUST be correct |

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| **2016** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (i)(ii) | ass91165aQ3c1_1Two products are formed in this reaction because propene is an asymmetric alkene. When another asymmetric molecule such as hydrogen chloride, HCl, is added to it, there are two possible products. One product is produced in greater quantities (the major product) than the other (minor product).The rule for determining which is the major product (called the Markovnikov’s rule) states that the C in the double bond with the most H atoms directly attached to it is most likely to gain another H atom (‘rich get richer’ concept). The most common product, the major product, is therefore 2-chloropropane, and 1-chloropropane is the minor product.(*The term Markovnikov’s rule is not required.*) | * Both major and minor products are correct (indicated by either structure or name).

ORStates the definition of Markovnikov’s rule (NOT just the ‘rich get richer’).ORIdentifies propene as an asymmetric alkene. | * Explains why there are two products formed in this reaction.

ORExplains why 2-chloropropane is the major product. OR Explains why  1-chloropropane is theminor product. | Elaborates on the reaction by explaining why two products form and how the major and minor products are determined. |

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| **2015** | To convert propan-2-ol to propene, add concentrated sulfuric acid (which is a dehydrating agent). It is an elimination reaction because OH and H are removed from adjacent carbon atoms and a double bond is created to form an alkene. To convert propene to propan-2-ol, add dilute (sulfuric) acid. This is an addition reaction because the double bond is broken forming a C-C (single) bond, allowing H and OH from water to bond to the C atoms that were double bonded together. Reaction 1 forms only one product because the carbon atom from which the H is removed (C1 or C3) does not affect the structure of the product as propan-2-ol is symmetrical. Reaction 2 produces two products because an asymmetric reagent (H-OH) adds onto an asymmetric alkene (CH3CH=CH2). There are two carbons that the H or OH can bond with (C1 and C2), so there are two possible combinations. We can predict which will be the major product by using Markovnikov’s rule, which states that the carbon with the most hydrogens gains more hydrogens. This means that most of the time, C1 will get another hydrogen while C2 will get the OH in this reaction. Propan-2-ol will be the major product and propan-1-ol the minor product. | * Identifies elimination and addition reactions.
* Identifies a reagent for one reaction.
 | * Links reagents for both reactions to the reaction type.
* Explains why there is only one product for Reaction 1 OR why there are two products for Reaction 2

ANDExplains why Reaction 1 is an elimination reactionOR Reaction 2 is an addition reaction. | * Analyses both reactions by explaining why each reaction is a different type and has a different number of products.
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| **2014** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (i)(ii) | It is an addition reaction because the double bond is breaking and an H and a Cl are being added to each of the carbons that were in the double bond.It is the major product because the hydrogen atom from HCl more often adds onto the carbon atom in the double bond which already contains the most hydrogen atoms; in this case, C1. Therefore the Cl atom from the HCl joins onto the carbon atom in the double bond which had the least number of hydrogen atoms; in this case, C2. | * Recognises that atoms are being added across the double bond.

• States Markovnikov's rule. | * Because the double bond is breaking and an H and a Cl are being added to each of the carbons that were in the double bond.
* Explains why the major product forms in Reaction 1.
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