ANSWERS: Polymers

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| **2019** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (i)  (ii) | Nylon 6,6 is referred to as a condensation polymer because small  organic molecules/ monomers join together to make a larger  organic molecule / polymer, with the release of a small molecule,  H2O (for each amide link formed). | Shows amide linkage in polymer chain.  One correct statement about condensation polymerisation. | Correctly draws TWO repeating units  AND  explains how a condensation polymer forms. |  |

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| **2018** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (i)  (ii) | –O–CH2–COO–CH2–COO–CH2–CO–  The formation of PGA is a condensation polymerisation reaction.  In a condensation reaction, small monomers join together releasing water.  Water is released for each ester linkage formed / because the monomers have two functional groups they react at both ends | Shows ester linkage in polymer chain.  Identifies reaction as condensation /  esterification.  OR  Water / H & OH is removed. | Draws THREE repeating units.  Explains condensation or  polymerisation process. | Draws THREE repeating  units of polymer chain and  full explanation of  condensation polymerisation. |

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| **2017** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (a)  (b) | Nomex® has an amide linkage – see (a)(ii) above.  Monomers:    This is a condensation polymer / polyamide, as monomers join / amide link  forms and a molecule of water or HCl is released during the reaction. | • ONE correct monomer  OR  both correct but includes careless error.  • Amide functional group named and polymer, or reaction described as condensation or a polyamide  • States condensation reaction with some explanation. | • Both monomers correct.  • Condensation reaction fully explained. | • Full evaluation of Nomex®. |

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| **2015** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (i)  (ii)  (iii)  (iv) | ass91391Q2a1  This is condensation or substitution (polymerisation), whereby the two monomers are joined together and a small molecule (HCl(*g*)) is released.  Each monomer is di-functional or has a reactive site at each end (allowing polymerisation to be ongoing.)  The sebacoyl chloride (as an acyl chloride) reacts vigorously with water forming the carboxylic acid, (however, it does not react with the non-polar solvent.)  Dilute acid will cause hydrolysis of the amide linkage.  The products formed would be (di)ammonium salt or +H3N(CH2)6NH3+  and the (di)oic acid. HOOC(CH2)8COOH  (Names not required) | * Identify the repeating unit of the polymer formed. * Identifies condensation.   OR  Identifies small molecule or HCl formed.  OR  Identifies both monomers have reactive sites or functional groups at each end.   * Sebacoyl chloride reacts with water. * Hydrolysis.   OR  One functional group | * Explains condensation polymerisation. * Hydrolysis   AND  Identifies one functional group produced (could be amine). | * Fully explains the reaction occurring.   (Note: Minor error or omission, e.g. amine or sebacoyl chloride reaction with water - E7). |

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| **2014** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | 91391assq3b1b  **Acid hydrolysis conditions:**  H2O/H+ or HCl(*aq*)  and  heat or reflux  91391assq3b2  **Basic hydrolysis conditions:**  H2O/OH¯ or NaOH(*aq*)  and  heat or reflux  91391assq3b3 | * Monomer structure contains amine or carboxylic acid or acyl chloride. * Acidic hydrolysis conditions.   OR  Basic hydrolysis conditions.  OR  ONE Structure correct. | * Correct monomer structure. * One product of hydrolysis linked to type of hydrolysis and condition.   OR  Two structures. | * Both hydrolysis products and conditions. |

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| **2012** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
| (a)  (b)  (c) | **Monomers of Polymer A:**    **Monomer of Polymer B:**    Polymer A  HOCH2CH2OH  AND  Na+ –OOCCH2COO– +Na OR –OOCCH2COO– OR NaOOCCH2COONa    The diamine is water soluble because it is a polar molecule / forms  hydrogen bonds with water / partially ionises.  • Sebacoyl chloride (acid chloride) is dissolved in the non-polar solvent, as it reacts (vigorously) with water forming acidic solutions.  • NaHCO3 is added to the solution to neutralise the HCl / neutralise the acid formed during the reaction / prevent the nylon from undergoing acid hydrolysis. | TWO of:  • At least one monomer is  correctly identified for either polymer A or polymer B.  • Identifies polymer A by  drawing the structure of ONE product.  • Draws a repeating unit.  • Outlines why the amine is  dissolved in water.  • Outlines why sebacoyl chloride is dissolved in an  organic solvent.  • Outlines why NaHCO3 is  added. | FOUR of:  • Monomer(s) correctly  identified for both polymers.  • Identifies polymer A by  drawing the structure of  BOTH products.  • Draws a repeating unit.  • Outlines why the amine is  dissolved in water.  • Outlines why sebacoyl  chloride is dissolved in an  organic solvent.  • Outlines why NaHCO3 is  added. | FIVE of:  • Monomer(s) correctly  identified for both polymers.  • Identifies polymer A by  drawing the structure of BOTH products.  • Draws a repeating unit.  Outlines why the amine is  dissolved in water.  • Outlines why sebacoyl chloride is dissolved in an organic solvent.  • Outlines why NaHCO3 is  added. |

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| **2010** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | * The repeating group is:   90698assq3c   * The monomers have functional groups at both ends, so can react to form a long chain. (mention of diacid chloride, diacid, diamine sufficent). * The acid chloride and amine react to give an amide functional group or peptide bond. * The reaction is a condensation reaction, since a small molecule (HCl or H2O) is released. * When the amine and the acid are used without heating, a proton transfer (acid-base reaction) occurs and hence polymerisation does not occur until the reaction is heated.   The acid chloride is more reactive than the carboxylic acid. | Any TWO of the bullet points. | Part discussion where at least THREE bullet points are linked. | Full accurate discussion.  (First four bullet points and either of the next two). |

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| **2009** | **Evidence** | **Achievement** | **Achievement with Merit** | **Achievement with Excellence** |
| (a)(i)  (ii) | 90698q3aass  A small molecule, such as H2O or HCl, is eliminated when the monomers join. | TWO of   * ONE monomer correct   **OR**   * Condensation polymer defined   **OR**   * Recognises a correct functional group in any of Compounds X, Y or Z.   Eg OH, carbonyl, carboxylic acid. | * Definition and TWO monomers correct   **AND**   * ONE compound of X, Y or Z correct   **OR**   * Y incorrect but a correct polymer drawn from the answer given in Y. | * Correct definition and all structures correct * All structures correct. |
| (b)(i)  (ii) | Compound Y  Compound Z  Polymer (Compound X) |

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