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| **Water treatment: Checking for understanding (Answers)** |

Refer to the following flow chart representing the steps in water treatment:

Untreated water is pumped from source, through a trash screen to remove leaves and sticks.

Coagulant added to make organic matter, clay and silt clump together or flocculate.

Floc sinks to bottom and is vacuumed out.

Air pumped in and bubbles attach to fine floc particles still in the water, causing them to float to the surface.

Floating floc ‘blanket’ is skimmed off the top.

Water passes through fine sand filter layers to remove any remaining fine particles.

Sand filter is cleaned.

Chlorine and lime added to disinfect and adjust pH of water. Water sent to storage reservoirs.

Waste water treatment: Mud and residue in wastewater is thickened and allowed to settle on bottom. Water flows off the top and is piped back into treatment plant for reuse. Thickened mud is pumped into centrifuge to extract more water. Solid waste is allowed to dry before being spread on surrounding land.

Further disinfection and fluoridation occurs before water is made available in homes and industries.

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1. With reference to the treatment process represented above, what do the following terms mean?

Coagulation — a chemical, such as alum, is added to the untreated water, which causes the organic matter, clay and silt to clump together or coagulate.

Aeration — air is pumped into the tanks where the treated water is held. The air bubbles attach to fine suspended particles in the water, causing them to float to the surface where they can be skimmed off.

Flocculation — addition of a coagulant to form clumps or ‘flocs’. The floc sinks to the bottom, where it can be vacuumed out.

Chlorination — addition of chlorine to destroy micro-organisms in the treated water.

Disinfection — addition of chemicals, such as chlorine and lime, to destroy microorganisms in the treated water, making it safe for drinking.

1. Explain how and why particular separation techniques are applied in the water treatment process.

Filtration — in the first step, untreated water passes through a 25 mm screen mesh. This traps larger debris, such as leaves and sticks, and prevents this material from entering the treatment plant. In the fourth step, the treated water filters through layers of fine sand. Fine particles, still suspended in the treated water, are trapped by the sand grains.

Sedimentation — During the second step of flocculation a coagulant causes suspended organic matter, clay and silt to clump together. These clumps are denser than the water and settle to the bottom forming a layer of sediment, which can then be separated from the treated water. Sedimentation is also used in treatment of the waste produced during water treatment. Mud and residue are thickened and allowed to settle to the bottom.

Decanting — during treatment of waste water, the thickened mud and residue settle to the bottom and the water is drained off the top. During aeration in the third step, the floating floc of fine particles is skimmed off the top, leaving the treated water behind.

1. Outline ways in which different areas of science contribute collaboratively to the production of safe drinking water through treatment processes.

Engineering — design, construction and maintenance of equipment, machinery, pipelines, water-holding tanks, dams, weirs; improving efficiency of equipment and processes; monitoring energy requirements to power treatment plant; utilising renewable forms of energy.

Geology, hydrology, meteorology — determining location of site for treatment plant and water-holding facilities, such as dams and weirs, to maximise water collecting capabilities, take advantage of natural overland water flow; predicting rainfall and water availability; managing water release from storage facilities.

Chemistry — techniques for separating mixtures; chemicals and reactions used in coagulation, flocculation, aeration, chlorination and disinfection; testing and monitoring water quality; monitoring and reducing carbon footprint.

Biology, biochemistry; medical science — monitoring water quality in terms of microbial growth; effects on human health of different treatment processes.

Ecology and environmental science — impact of water treatment facilities and processes on natural systems, such as the natural water cycle, food chains and webs; monitoring and prevention of pollution, habitat destruction; monitoring and reducing carbon and water footprints; utilising renewable forms of energy.

1. Justify why high-quality water treatment is essential to communities across the globe. What impact does poor water quality have on communities?

High water quality is essential for drinking water, washing, agriculture and industrial processes. High-quality water used in homes and agriculture reduces the risk of disease from water-borne pathogens and micro-organisms. In communities where there is poor water quality, there is an increased occurrence of water-borne disease and death related to consumption and use of unclean water.

Industrial and chemical processes require purified water to reduce the risk of contamination during processes. Contaminated water could result in inferior products or the inability to produce goods and services, including medicine, food, electricity, plastics. This in turn could lead to more serious health and economic issues within communities.

1. Describe how science and technology have influenced the ways in which water is cleaned for human consumption and use.

Science and technology influence through:

1. improved separation techniques that remove higher quantities of contaminants, producing cleaner water
2. development of improved quality control tests to ensure cleaner water is produced
3. technological advances in machinery and scientific research into materials giving rise to design and manufacture of more efficient equipment, reducing water-treatment costs
4. technological advances becoming more common, reducing costs associated with purchase and use of equipment — processes can be made available in poorer countries that historically have low water quality
5. technological advances enabling increasing ability to make use of renewable energy forms, which means reductions in carbon emissions.