Section 1: Waves

• How do waves form?

Waves are generated by the competing forces of surface friction. The wind transfers energy from air to water and forms waves, which are brought back to the surface by gravity. The size of the waves depends on several factors, including wind speed and the distance the wind has traveled over the water (known as the fetch).

Waves are created by wind blowing over the water’s surface

• Suggested Film
  - Coastal Processes: Waves

• What happens as waves approach the shore?

The depth of water affects the motion of waves, as the water becomes shallower the wave begins to slow down. This causes the height of the wave to increase until the surface tension is no longer able to hold the wave together, allowing the top of the wave to collapse; this phenomenon is known as the wave breaking. Waves can also refract, change direction and bend as they approach the shore. The breaking wave moves up the beach as swash, and runs back down the beach as backwash.

Surfers like to ride constructive waves

• Suggested Film
  - Coastal Processes: Waves

• What are the different types of waves?

There are two distinct types of wave at the coastline: constructive and destructive waves.

Constructive waves are waves that surge up the beach with a powerful swash and a weaker backwash. They carry large amounts of sediment and are able to build up the beach. They are usually formed by storms, far out in the ocean. Constructive waves are evenly spaced and have significant power when they finally reach the coast. Surfers ride this type of wave.

Destructive waves are formed by local winds closer to the coast. They are so named because they are able to take away beach sediment. Destructive waves arrive at irregular intervals. They tend to be close together, and often merge and interfere with each other as a result, producing a chaotic mass of water. They tend to crash down steeply on to the beach meaning there is little swash but a powerful backwash. This explains the removal of sediment.
Section 2: Shaping the Coastline

How does marine erosion shape the coastline?

The sea can wear away the coastline in many ways, and waves play a large part in coastal erosion. The energy released by waves breaking onshore can move sediment, as they advance and retreat up the shoreline. Waves can break down or grind down the rock exposed in cliffs in a process called abrasion. The waves can also cause sediment on the shore to erode through attrition, by causing rocks, pebbles and sand to crash into each other and break apart. In addition, seawater can chemically attack rocks and sediments, in a process called solution. These processes work together, driven on by the relentless energy of the waves.

Suggested Films
- Coastal Processes: Erosion, Deposition and Transportation
- Weathering

Extension Question
Q1. What affects the rate of coastal erosion?

Coastal erosion can be affected by the geology of the shoreline (particularly the strength and structure of cliff faces), by the geometry of the seabed offshore and by the energy of the waves, and by the rate at which sand is added to and removed from the beach. A shallow offshore gradient generally means lower wave energy, and more depositional features. Coasts that face the open ocean will generally have to withstand higher wave energy, and cliffs are more likely to form here. The rate of erosion is also influenced by the nature of human management of the coastline.
How does marine transport operate?

Most of the rock and sediment present on beaches is created on land by weathering, and has been deposited over many centuries by rivers flowing into the sea. Further beach sediment is added through the action of marine erosion on the coastline. The sediment is moved by various erosion processes. When waves break they travel up the beach in a process known as swash, and retreat in a process known as backwash. Waves generally approach the shoreline at an angle because they are refracted (or bent) as they head towards the coast and enter shallower water. Beach sand tends to be moved sideways along the coast by a process known as longshore drift. This will have a particular direction of movement depending on the prevailing wind direction.

When does deposition occur at the coastline and what features does it create?

Deposition of sediment can occur in any body of water when the water loses some of its energy. Deposition of rock, sand and pebbles along coastlines is likely to occur when the wave energy is reduced, such as when waves enter an area of shallower water, or when wind speed decreases. There can be sheltered areas, for example behind a spit of land, where sediment is deposited in sufficient quantity to create features such as salt marshes. Onshore winds also allow the development of sand dunes if there is sufficient beach material of the right type.

Beaches are created by the deposition of material which has been eroded and transported from somewhere else. Depending on the direction and nature of the waves approaching the beach, sand and other beach material can be deposited as a variety of landforms. Spits (strips of beach material stretching out to sea), bars (a strip of beach material joining two headlands), mudflats and salt marshes are distinctive landforms resulting from deposition in the coastal zone.

Suggested Film
- Coastal Processes: Erosion, Deposition and Transportation

Suggested Films
- Coastal Processes: Erosion, Deposition and Transportation
- Coastal Landforms

Sandy beaches are formed by deposition
Section 3: Coastal Features and Their Protection

**Extension Questions**

Q2. What problems do people cause for beaches?
As well as the persistent problem of plastic pollution on many beaches, people can create other problems. One of the most obvious issues is the removal of beach material, which would otherwise absorb wave energy and reduce the rate of erosion. This can be done accidentally, on people’s feet, but can also be deliberate. The resort of Budleigh Salterton in Devon has seen its famous pebbles stolen in large quantities over the years, and signs warning of a fine of £1000 have been erected.

Q3. Which land processes shape our coastline?
In addition to the hydraulic action of waves on the shoreline, cliffs can also be affected by processes of erosion and physical and chemical weathering elsewhere on land. The action of plants and animals can cause cliffs to crumble. Many coastal features are also related to the deposition of sediment by rivers. Where cliffs are not vegetated they are more likely to be affected by erosion.

**Suggested Activities**

- Ask the students to research the formation of depositional features and draw labeled diagrams to describe their formation.
- Ask the students to find photographs of depositional coastal features and pinpoint their location to a map of the world.
- Ask the students to create a miniature beach in a plastic tray, using sand and small gravel pieces. With the aid of some plastic figures and some water, investigate the way that material is moved and deposited by the water. Blow through a straw to create waves.

Sea cliffs occur partly through the erosive action of waves on rocks exposed at the coast. Where the foot of the cliff is attacked by waves, a wave-cut notch forms, which can eventually undercut the cliff. A cliff collapse moves the shoreline inland.

Where wave action is concentrated on a particular part of the shoreline, or where less resistant rocks are surrounded by stronger rocks, bays can form as the coastline retreats inwards. The peninsula extending from the edge of a bay is known as a headland, and is often composed of much harder rock than the area of the bay. Erosion can then be concentrated on the headland, often partially or fully detaching the headland from the bay to form caves, arches or stacks.

**Suggested Films**
- Coastal Landforms
- How Do Caves Form?

**Suggested Activities**

- Ask the students to research the formation of erosional features and draw labeled diagrams to describe their formation.
- Ask the students to create a collage of photos of the features formed by coastal erosion, labeling their location.
• What is meant by hard engineering at the coastline?

Coasts are managed in order to reduce the impact that wave energy has on them. Coastal settlements need protection, and this can take the form of hard engineering. Hard engineering solutions include the construction of concrete sea walls and wooden revetments, which both aim to prevent erosion. These are expensive to build and last a relatively short time before repairs or replacements are needed.

A common method used to absorb the energy of the waves is rip-rap: lines of large boulders which are placed along the shoreline. These are sometimes used in association with wooden groynes, which try to keep the sediment in a particular stretch of beach in front of coastal settlements. A problem with hard engineering is that it is impossible to provide protection to the whole coastline, and by protecting only certain areas, there can be increased erosion for those stretches of coastline that are unprotected.

• Suggested Film
  - Coastal Process Management: Hard Engineering

• Suggested Activity
  - Ask the students to research the potential effects of rising sea levels and then to write a newspaper article on the subject from the year 2100.

• What is meant by soft engineering at the coastline?

Soft engineering is a less expensive, and possibly more sustainable, solution to the problems caused by coastal processes. Instead of attempting to prevent them, they work in tandem with them. Beach nourishment involves replacing sand that has been removed, and stabilizing it by building fences or planting marram grass. Beach nourishment is also more in keeping with the natural landscape. A relatively new technique is managed realignment, where a stretch of coastline is left for the sea to reclaim, rather than spending money and resources on attempting to fight the inevitable. As a result, new wetlands and salt marshes are created as the sea gradually moves inland.

• Suggested Film
  - Coastal Process Management: Soft Engineering
Waves

**Basic**

- Coasts are where land meets
  - A – low to high pressure
  - B – a river valley
  - C – the sea
  - D – a canyon

- In the open sea, waves transfer
  - A – water
  - B – wood
  - C – energy
  - D – rocks

- Waves are made up of
  - A – upbeach and return
  - B – updrift and backdrift
  - C – shore drift and rewash
  - D – swash and backwash

- The wave flowing up the beach is called the
  - A – swash
  - B – swish
  - C – rip swash
  - D – upwash

**Advanced**

- Ocean waves are created by
  - A – wind blowing over the water’s surface
  - B – the Moon’s gravitational influence
  - C – the magnetic pull of the land
  - D – the Moon’s gravitational influence and the magnetic pull of the land

- When waves reach the shore and the water shallows, the bottom of the wave
  - A – speeds up
  - B – slows down
  - C – remains unaltered
  - D – halts

- If the effect of the wave is to deposit, it is commonly known as
  - A – neutral wave
  - B – constructive wave
  - C – destructive wave
  - D – positive wave
Coastal Land Formations

**Basic**

- **Cliffs can form through a combination of weathering and**
  - A – constructive waves
  - B – destructive waves
  - C – deposition
  - D – transport

- **Weak points in the cliff can be exploited to form a**
  - A – wave-cut notch
  - B – spit
  - C – beach
  - D – stack

- **A collapsed arch is known as a**
  - A – wave-cut notch
  - B – spit
  - C – beach
  - D – stack

- **Beaches are formed by**
  - A – deposition
  - B – attrition
  - C – the fetch
  - D – weathering

**Advanced**

- **Cliffs are formed through a combination of**
  - A – weathering and constructive waves
  - B – weathering and destructive waves
  - C – constructive waves and destructive waves
  - D – weathering and deposition

- **Cliff retreat forms a**
  - A – beach
  - B – wave-cut platform
  - C – spit
  - D – bar

- **The nature of beaches depends mainly upon**
  - A – wave energy and the local geology
  - B – the shape of the coastline
  - C – the topography of the seabed
  - D – the topography of the seabed and the shape of the coastline

- **A spit is formed by**
  - A – longshore drift and erosion
  - B – longshore drift and attrition
  - C – longshore drift and deposition
  - D – longshore drift and transportation
### Erosion, Deposition and Transportation

#### Basic

- **Wearing away and breaking up of land is known as**
  - A – erosion
  - B – deposition
  - C – transportation
  - D – glaciation

- **Which of these is not a form of erosion?**
  - A – traction
  - B – solution
  - C – attrition
  - D – abrasion

- **The zigzag movement of waves moving water and material along a coastline is**
  - A – longshore drift
  - B – traction
  - C – solution
  - D – hydraulic action

- **Acidic seawater causing erosion by dissolving limestone is an example of**
  - A – disembution
  - B – dissolution
  - C – solution
  - D – dilution

#### Advanced

- **Which of these is NOT thought to be one of the three key coastal processes?**
  - A – erosion
  - B – transportation
  - C – deposition
  - D – glaciation

- **Particles in seawater colliding is known as**
  - A – attrition
  - B – abrasion
  - C – collision
  - D – hydraulic action

- **Rock and sand hurled against the cliff is termed**
  - A – attrition
  - B – abrasion
  - C – collision
  - D – solution

- **Which of these is not a process of transport?**
  - A – traction
  - B – suspension
  - C – saltation
  - D – hydraulic action
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