Total marks — 20

Attempt ALL questions

Settlement X lies at the estuary of a major Scottish river, and sits on one of the largest shingle complexes in Britain. The shingle complex comprises rock debris continuously transported by the river from the Cairngorm Mountains since the last ice age, deposited as rounded stones in the river mouth. Sea level rise at the end of the last ice age flooded the estuary, leaving behind extensive deposits of shingle on the land surface as sea level fell again.

The shingle complex is constantly shaped by river and coastal processes. Shingle transported by river down to the estuary is moved westwards by coastal currents. Currently, the shingle complex extends 1 km inland and 8 km along the coast. The shingle banks closest to the shore have long provided protection to coastal communities, including Settlement X, against high tides and storms.

The shingle complex, the river, and the estuary are exceptional sites in their own right, and also as an integrated system. Two SSSI designations are in place, on account of the geomorphological nature of the shingle plus the range of specialised species it supports. Geomorphology refers to the formation and structure of a landform, such as the shingle banks.

Tourism brings valuable revenue to the area. Large numbers of wildlife enthusiasts visit the estuary each year, while the river supports salmon fishing, distilleries, canoeing and rafting companies, and local communities along its length. Golf courses sit on either side of the river, and hotels and B&Bs offer food and accommodation.

Sea level change and an increase in storm events over the last few decades have significantly eroded the shingle banks closest to the shore. In storm events, waves ‘over-top’ the banks, and have broken through them on occasion. Such events are now occurring almost annually and are also increasing in intensity. At the same time, the shingle banks are under threat from behind, due to increased precipitation affecting the river’s flow rate and volume.

A team of coastal engineers has been commissioned to assess options for protection of the shingle complex and communities located behind them.

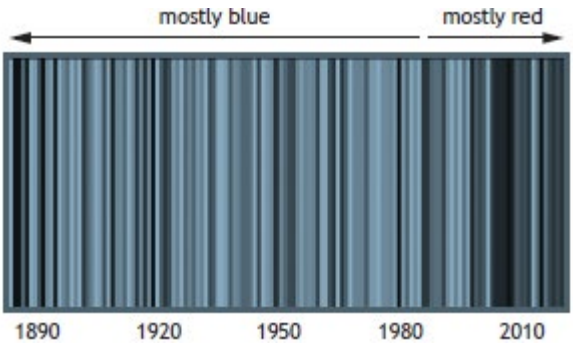
Using the information provided here and in the supplementary source booklet, as well as your knowledge of environmental science, attempt the following questions.

MARKS

DO NOT WRITE IN THIS MARGIN

1. The UK Climate Change Risk Assessment (2017) lists risks linked to changes in temperature that are likely to impact on Scotland (Source D).

The 'warming stripe' diagram is a visual representation of changes in temperature measured in Scotland between 1884 and 2019. Each stripe represents the temperature average in Scotland over a year. Blue lines represent cooler than average temperatures and red lines represent warmer than average. The darker the line, the more the temperature differs from the average.



(a) Describe the trend shown in the diagram. **2**

Example 1

from ~~1884~~ 1884 to 1980 the stripes are mostly blue meaning there were more cooler than average temperatures. from just after 1980 to 2019 the stripes are mostly red re showing that there were more warmer than average temperatures.

Example 2

by 2010 the temperatures are very different from the average

(b) Freshwater drawn from the river is used by local communities and industries.

Suggest why there is concern that climate change will impact water quality. **1**

Example 1

water may become unsafe drink

Example 2

the increased amount of precipitation due to climate change causes the rock debris to be taken into the river and due to the sea level change there is resulting in more erosion^ ~~and~~ run-off into the river impacting the quality, by soil and stones being swept into the river.

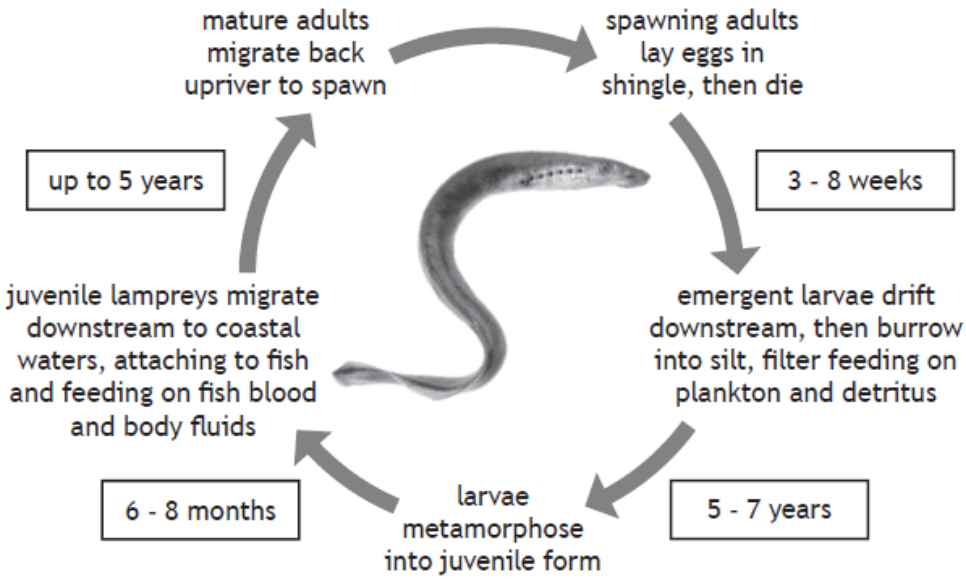
MARKS | DO NOT WRITE IN THIS MARGIN

2. The sea lamprey (Petromyzon marinus) is one of the species designated under the river's SSSI (Source C).

The sea lamprey is a jawless, eel-like vertebrate.

Sea lampreys are anadromous, which means they are able to survive in both freshwater and saltwater at different stages of their lifecycle.

The lifecycle stages are largely driven by water temperature.



Sea lamprey habitat requirements:
- minimal obstructions likely to inhibit migration up or down a river
- good quality water
- clean sand and gravel areas for spawning
- silt for larvae to burrow into
- supply of organic matter for filter feeding by larvae
- plentiful supply of host fish for juveniles.

(a) During metamorphosis, the sea lamprey develops a sucker-like mouth lined with rows of small teeth. It uses this to attach to fish, feeding on
their blood and body fluids.

The sea lamprey is a parasite.

Define *parasite*. **1**

Example 1

a parasite is an organisms that either latches onto it's host or is consumed by the host, then gets it's food, heat and energy from it's ~~host~~ host. It uses the teeth to move around.

Example 2

A parasite is a species that lives on or in another and depends on it to survive which can negatively effect the animal host the parasite lives on

(b) The sea lamprey is non-trophic both while it is metamorphosing from a larva into a juvenile, and when the adult migrates upriver from coastal water to spawn.

Suggest what is meant by *non-trophic*. **1**

Example

It does not consume a different trophic level to its own.

MARKS | DO NOT WRITE IN THIS MARGIN

3. A forestry plantation covering 818 hectares of the shingle complex was leased to a key forestry agency in the late 1930s. Since then, the plantation has been continuously restocked by planting or natural regeneration. This helps stabilise large areas of the shingle.

(a) (i) Name the key agency that looks after, manages, and promotes Scotland's national forests. **1**

Example 1

Scottish woodland trust

Example 2

SFA

Example 3

the Forestry Comission

(ii) Part of the plantation lies within the shingle complex's SSSI. The forestry agency is required to prepare a conservation management plan for this area.

The plan includes a requirement for the periodic removal of gorse (*Ulex europaeus*) from the shingle. Gorse is an extremely hardy, evergreen, prickly, native shrub.

Suggest why there is a need to remove gorse from the shingle complex. **1**

Example 1

to allow trees (trees plants) to be planted because the gorse is dominant so they would out-compete the trees (plants trees) for light & water so the trees (trees plants) wouldn't grow

Example 2

Gorse is very difficult to kill off and it can grow out of hand so by removing it the forestry agency can control it.

(b) Environmental monitoring takes place within the plantation SSSI area.

(i) Explain the purpose of environmental monitoring. **1**

Example 1

To make sure any laws or legislations are not being broken.

Example 2

to gather data on specific habitats, environments, or plants or organisms, to see wether they need protecting from harm.

(ii) During a monitoring exercise, groundwater samples are collected from the plantation SSSI area.

A range of tests are conducted on the samples, including measurements of salinity.

Describe how the salinity of groundwater could be measured. **2**

Example 1

Using a salinity refractometer and reading the result from the display.

Example 2

by using a salinity refractometer or by boiling a beaker of groundwater until all the water has evaporated, and all that is left is the salt.

Example 3

Two probes can be placed into the sample that run electric currents between them which pick up the salt levels in the sample

MARKS | DO NOT WRITE IN THIS MARGIN

4. A review of coastal engineering options was carried out in 1996.

(a) The estimated costs of coastal engineering options at the estuary in 1996 are shown in Source E.

The graph in Source F shows the change in value of £100 since 1996 once adjusted for inflation.

Calculate the estimated equivalent cost of emergency works (over 50 years) in 2020. **2**

Example 1

Space for working

1996 = 100
2020 = 1.98

776,554 × 1.98

= £1522045.84

Example 2

£776,554 - emergency work

776,554 / 296 = £2623.49

(b) Settlement X includes 103 properties.

The 1996 review concluded that 31 properties located on low ground would be at risk of frequent flooding if the shingle banks on the shore were regularly over-topped by large waves. It also concluded that all 103 properties would be at risk if no action was taken to protect and improve the shingle banks.

The current value of the 31 properties is estimated at £5·52 million, based on the mean value for properties in the area.

Calculate, to the nearest £, the total estimated value of all 103 properties. **2**

Example 1

£5520000

31 properties = £178064.5161

1 property = £178064.5161

103 properties = £18340645

Example 2

£5.52m ÷ 31 × 103 = £18.34 million

(c) Environmental assessment and monitoring are required before a decision can be made about which coastal engineering option to use.

Name the type of assessment that provides a local planning authority with details of possible significant environmental effects of a proposed development, and mitigation for these. **1**

Example 1

Environment Impact Assessment

Example 2

impalt assesment

MARKS | DO NOT WRITE IN THIS MARGIN

5. A do-nothing scenario will have severe detrimental consequences for the area. The local authority must therefore decide which coastal engineering approach to implement.

Using the evidence from the sources and your knowledge of environmental science, decide whether hard engineering or soft engineering would be most appropriate in this location.

Justify your answer. **5**

Example 1

[X] Hard engineering

[ ] Soft engineering

Peoples livelyhoods are at risk therefore something has to be done quickly and effectively. There is more than £18m worth of assets and none of the engineering options cost anywhere near that amount. If there was to be nothing done then hundreds of people would have to be rehomed, putting pressure on local authorities to find suitable places. There would be a loss in revenue in the local area as BnBs + shops would eventually become flooded and therefore have no income. The golf course would lose a significant amount of business due to lack of tourists and may have problems with flooding in the future if nothing is done

Example 2

- [x] Hard engineering
- [ ] Soft engineering

- hard engineering is a one-off construction meaning less air pollution as it only in place ~~once moved of~~
- it will break the waves and absorb their energy meaning ~~how~~ will will be less erosion and less building damage.
- it is easy to maintain so ~~its~~ it doesn't need work done to it that often so doesn't effect any ~~A~~ new habitats formed near it.
- it ~~co~~ can create new habitats for marine species meaning they ~~can~~ have a stable environment and they can ~~reproduce~~ mate with other organisms and reproduce. ~~Hence~~ it also increases biodiversity.
- It traps shingle ~~results~~ and helps prevent erosion meaning less soil and run-off into the water, which improves water quality.

Example 3

- [ ] Hard engineering
- [x] Soft engineering

Soft engineering, is less likely to effect the species living in this area as well as the SSSI status. It is also a much faster way of protecting the site than Hard engineering is. However soft engineeering requires lots of maintenance to keep running and may not be a long term solution to hard engineering. despite this it poses much less threat to the SSSI than hard engineering does.