SECTION 4

Questions 31-40: Complete the notes below.
Write **ONE WORD ONLY** for each answer.

Marine renewable energy (ocean energy)

Introduction
More energy required because of growth in population and 31.....
What's needed:

- renewable energy sources
- methods that won't create pollution

Wave energy

Advantage: waves provide a 32..... source of renewable energy
Electricity can be generated using offshore or onshore systems
Onshore systems may use a reservoir
Problems:

- waves can move in any 33.....
- movement of sand, etc. on the 34..... of the ocean may be affected

Tidal energy

Tides are more 35..... than waves
Planned tidal lagoon in Wales:

- will be created in a 36..... at Swansea
- breakwater (dam) containing 16 turbines
- rising tide forces water through turbines, generating electricity
- stored water is released through 37....., driving the turbines in the reverse direction

Advantages:

- not dependent on weather
- no 38..... is required to make it work
- likely to create a number of 39.....

Problem:

- may ham fish and birds, e.g. by affecting 40..... and building up silt

Ocean thermal energy conversion
Uses a difference in temperature between the surface and lower levels
Water brought to the surface in a pipe

Producing **enough energy** to **meet our needs** has become a serious problem. **Demand** is **rising rapidly**, because of the world's **increasing population** and **expanding industry**. Burning **fossil fuels**, like gas, coal, and oil, seriously **damages** the environment and they'll eventually **run out**. For a number of years now, scientists have been working out how we can **derive** energy from **renewable sources**, such as the **sun** and **wind**, without **causing pollution**. Today I'll outline **marine renewable** energy – also called **ocean** energy – which **harnesses** the **movement** of the oceans.

Marine renewable energy can be divided into three main categories: **wave** energy, **tidal** energy, and **ocean thermal** energy **conversion**, and I'll say a few words about each one.

First, wave energy. Numerous **devices** have been **invented** to **harvest** wave energy, with names such as Wave Dragon, the Penguin, and Mighty Whale, and research is going on to try and come up with a really **efficient method**. This **form** of energy has plenty of **potential**, as the source is **constant**, and there's **no danger of** waves coming to a **standstill**. Electricity can be **generated** using **onshore** systems, using a **reservoir**, or **offshore** systems. But the problem with ocean waves is that they're **erratic**, with the **wind** making them **travel** in every **direction**. This **adds to the difficulty** of creating efficient technology: **ideally** all the waves would travel **smoothly** and **regularly** along the same **straight line**. Another **drawback** is that **sand** and other **sediments** on the ocean floor might be **stopped from flowing** normally, which can lead to **environmental** problems.

The second category of marine energy that I'll mention is **tidal** energy. One major advantage of using the **tide**, rather than **waves**, as a source of energy is that it's **predictable**: we know the exact time of **high** and **low** tides for years to come.

For tidal energy to be effective, the **difference** between high and low tides needs to be **at least five meters**, and this occurs **naturally** in only about **forty places** on Earth. But the right **conditions** can be created by **constructing** a tidal **lagoon**, an area of **seawater separated** from the sea.

One current plan is to create a **tidal lagoon** on the coast of Wales. This will be an area of water **within a bay** at Swansea, **sheltered** by a **U-shaped breakwater**, or **dam**, built out from the coast. The **breakwater** will contain **sixteen hydro turbines**, and as the tide **rises**, water **rushes through** the breakwater, **activating** the turbines, which **turn a generator** to **produce electricity**. Then, for three hours as the tide **goes out**, the water is **held back within** the breakwater, **increasing** the **difference** in **water level**, until it's several meters **higher within** the lagoon **than** in the open sea. Then, in order to **release** the **stored water**, **gates** in the breakwater are **opened**. It **pours powerfully** out of the lagoon, **driving the turbines** in the breakwater in the **opposite direction** and again **generating thousands** of **megawatts** of electricity. As there are two high tides a day, this lagoon scheme would generate electricity **four times a day**, every day, for a total of around **14 hours** in every 24 – and enough electricity for over **150,000** homes.

This system has quite a lot **in its favor**: unlike solar and wind energy it **doesn't depend on** the weather; the turbines are **operated** without **the need for fuel**, so it doesn't create any greenhouse gas emissions, and **very little maintenance is needed**. It's **estimated** that electricity generated in this way will be **relatively cheap** and that **manufacturing** the components would create more than **2,000 jobs**, a big **boost** to the **local economy**.

On the other hand, there are fears that lagoons might **harm** both **fish** and **birds**, for example by **disturbing migration patterns**, and causing **a build-up of silt**, affecting local **ecosystems**.

There are other forms of tidal energy, but I'll go on to the third category of marine energy: ocean **thermal** energy conversion. This depends on there being a big difference in **temperature** between **surface water** and the water a couple of **kilometers below the surface**, and this occurs in **tropical coastal** areas. The idea is to bring **cold water** up to the surface using a **submerged pipe**. The concept dates back to 1881, when ...