Diploma Programme
Programme du diplôme
Programa del Diploma

Design technology
Higher level and standard level
Paper 2

8 May 2024

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

Candidate session number

1 hour 30 minutes

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

2224 – 6403

23 pages

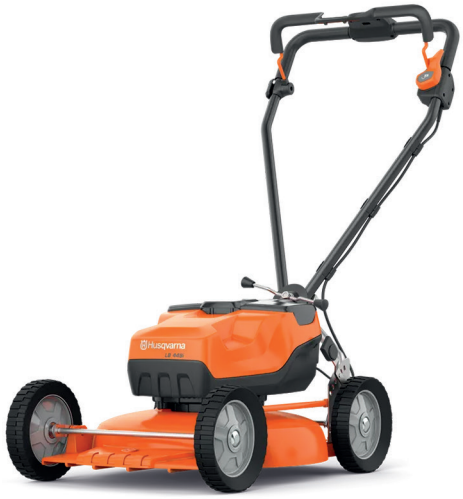
Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Outdoor gardening products have historically been powered by fossil fuels, but the market is quickly changing, and consumers are now adopting battery-powered products.

The Husqvarna 448i lawnmower, see **Figure 1**, is a robust, battery-powered machine with a 480 mm aluminium cutting deck. When in use, the spinning blades and grass cuttings are safely contained under the cutting deck.

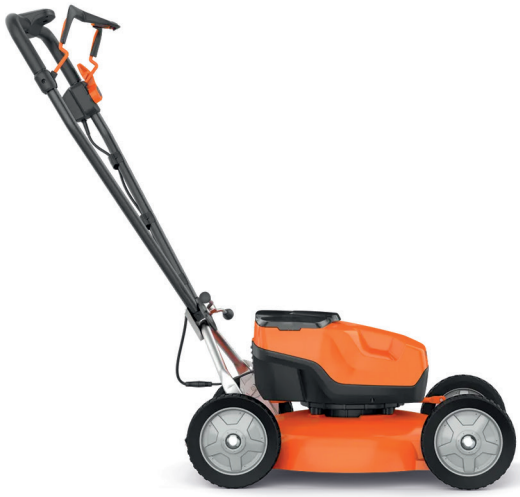
Figure 1: Husqvarna 448i lawnmower



The Husqvarna 448i is designed for users in need of a reliable and quiet lawnmower. It also has low running costs and easy maintenance.

The handle on the lawnmower has a fixed height when in use, see **Figure 2**.

Figure 2: Husqvarna 448i lawnmower handle



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(Question 1 continued)

(a) (i) State the percentile that would be used to determine the height of the handle of the Husqvarna 448i lawnmower. [1]

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(ii) Outline why practical function is influential in the design of the Husqvarna 448i lawnmower. [2]

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(b) (i) The aluminium cutting deck provides a robust base for the Husqvarna 448i lawnmower. Outline **one** property of aluminium that makes it suitable for the cutting deck. [2]

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(ii) Describe the type of computer-aided design (CAD) modelling used to test the forces acting on the aluminium cutting deck. [2]

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will not be marked.

(Question 1 continued)

(c) (i) Outline how modular innovation is used as the design innovation strategy for the Husqvarna 448i lawnmower. [2]

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(ii) Rogers' characteristics of innovation describe consumer adoption of products. Explain the **relative advantage** of the Husqvarna 448i lawnmower over fossil fuel powered lawnmowers. [3]

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(Question 1 continued)

Husqvarna have a standard battery, see **Figure 3** and **Figure 4**, that can also be used in other Husqvarna outdoor gardening products.

Figure 3: Standard Husqvarna battery

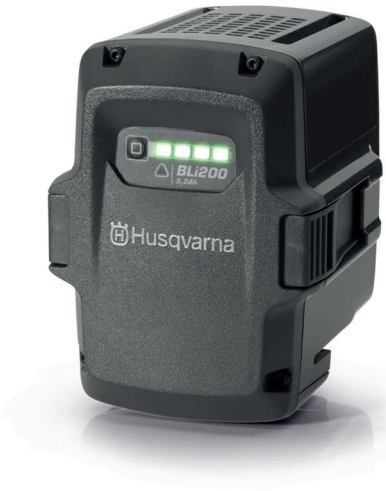
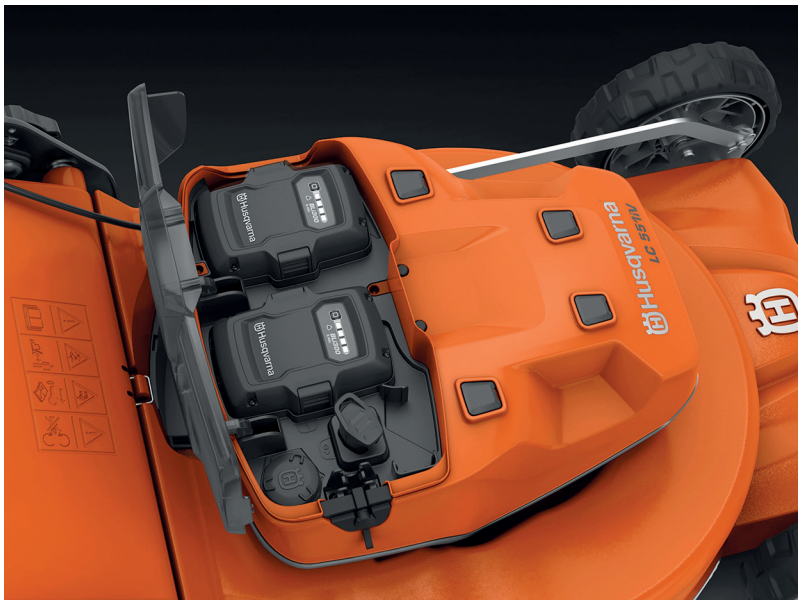


Figure 4: Husqvarna batteries in use



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(Question 1 continued)

(d) (i) The batteries for the Husqvarna 448i lawnmower can get hot during use. State the type of plastic that would be used for the battery cases. [1]

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(ii) The plastic wheels for the Husqvarna 448i lawnmower are injection moulded. Outline how plastic is injection moulded. [2]

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(e) (i) The Husqvarna 448i lawnmower uses a lithium-ion battery. List **two** advantages of using lithium-ion batteries. [2]

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(ii) Explain how the Husqvarna 448i lawnmower minimizes pollution in utilization compared to lawnmowers that use fossil fuels. [3]

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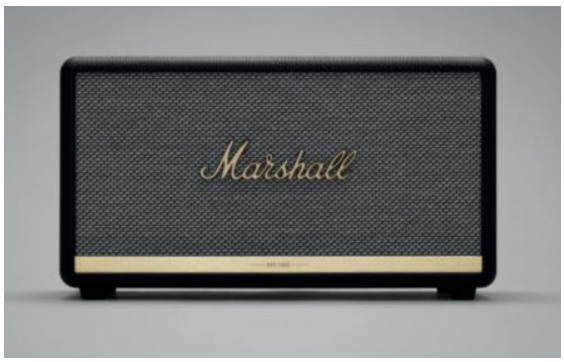
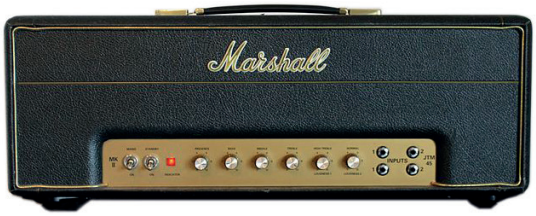
2. Marshall have been making audio equipment since 1960. The Marshall Speaker (2017) was inspired by the original Marshall Guitar Amplifier (1960), see **Figure 5**. The volume dial on the Marshall Speaker can be adjusted from 0 to 10 to achieve the desired volume, see **Figure 6**.

Figure 5: Marshall speakers

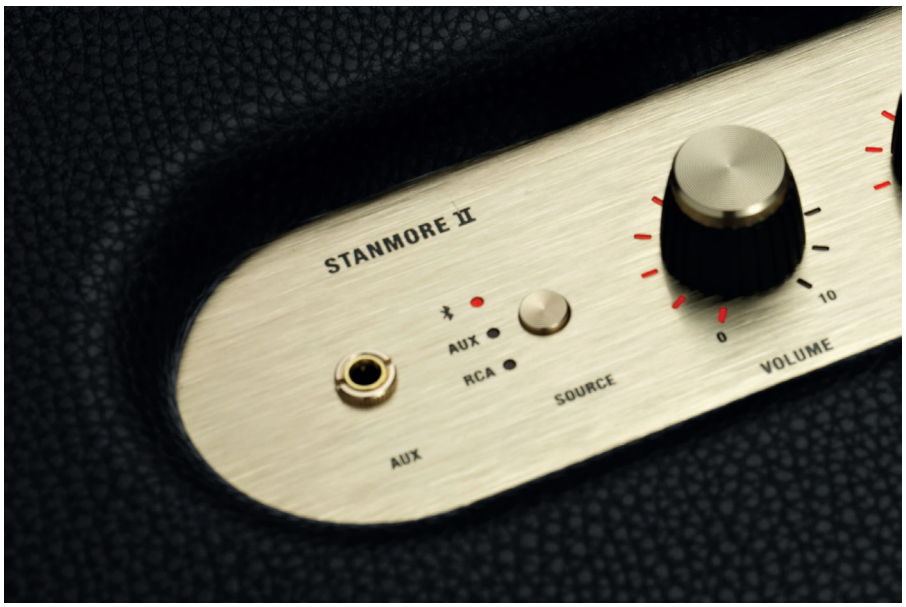


The Marshall Speaker (2017)



Marshall Guitar Amplifier (1960)

Figure 6: Marshall Speaker volume dial



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(Question 2 continued)

(a) Describe the type of scale used to adjust the volume on the Marshall Speaker, see **Figure 6**. [2]

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(b) Outline the classic design strategy used for the Marshall Speaker. [2]

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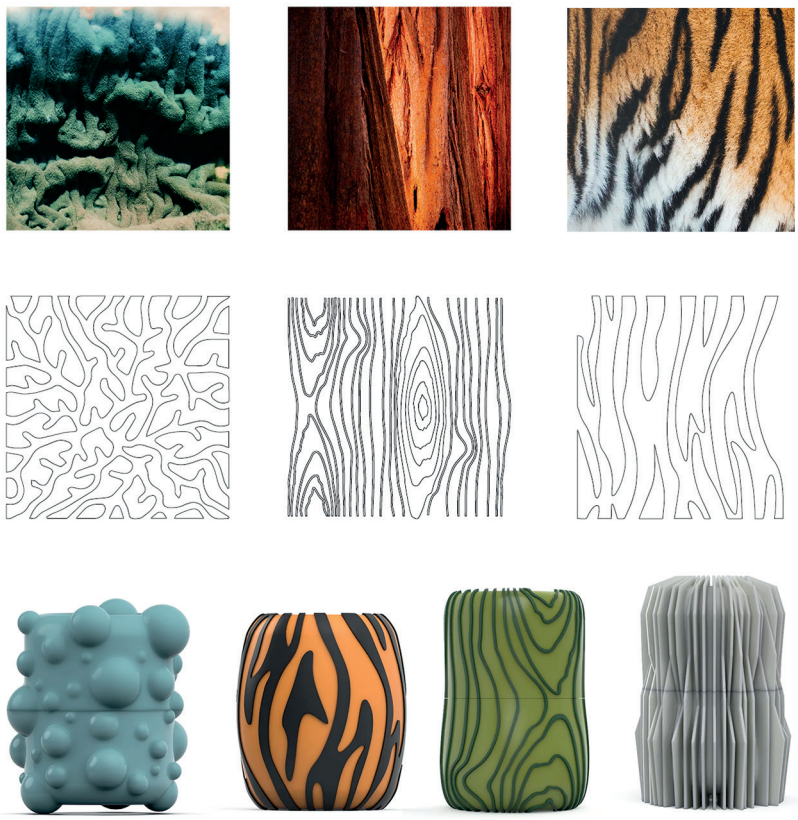
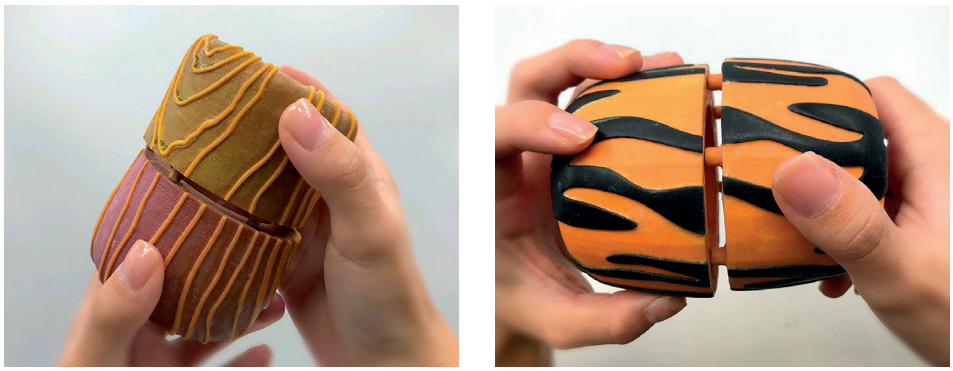
3. The Puzzler is a selection of sensory tools otherwise known as fidgets, designed to help relieve stress and improve focus for children in busy classroom environments. Their design is made up of two-pieces that fit together like a puzzle. Each one is decorated differently, including animal prints and nature-inspired textures, see **Figure 7**.

Figure 7: Puzzler design inspiration from nature



The Puzzler is a conceptual design that has not been taken to market. However, physical models of the Puzzler pieces have been made using rapid prototyping, see **Figure 8**.

Figure 8: Puzzler physical models in use



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(Question 3 continued)

Explain why analogy was used in the development of the Puzzler. [3]

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4. Fuse deposition modelling (FDM) is a type of rapid prototyping. Explain why designers would use FDM for prototyping. [3]

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Section B

Answer **one** question. Answers must be written within the answer boxes provided.

5. California-based Ecoline Brewery* uses by-products from the beer-making process to create biodegradable can rings that safely decompose, see **Figure 9**. The team initially experimented with seaweed but soon realised it became too rigid outside of water – which meant it might cut or choke an animal. Instead, they compression moulded a wheat and barley composite with the waste left over from the brewing process, see **Figure 10**.

Figure 9: Ecoline Brewery can rings

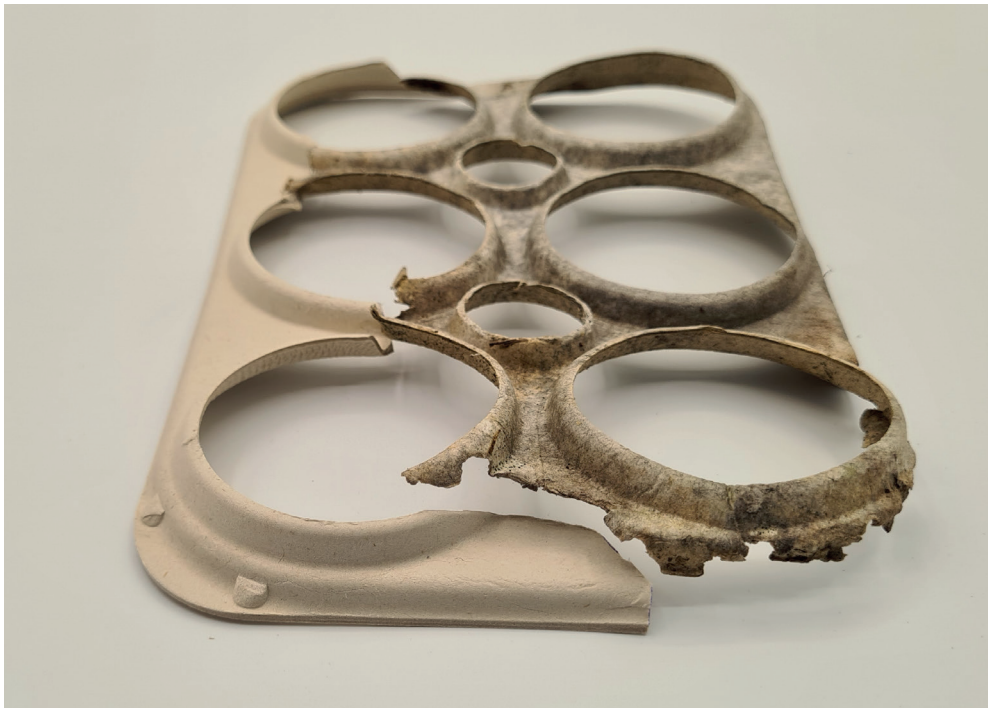
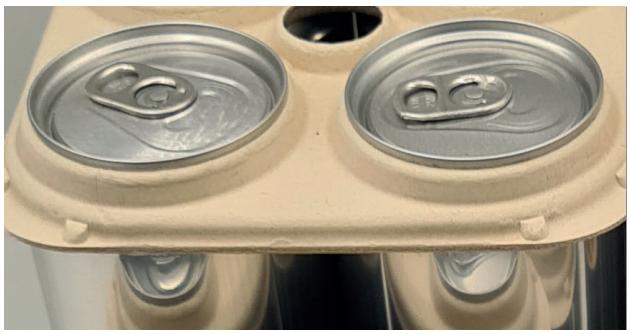
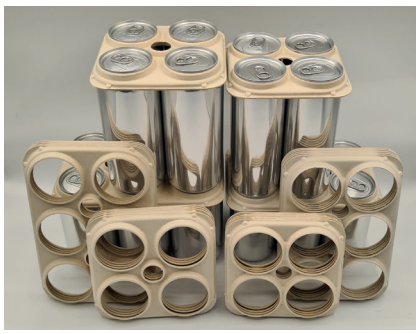


Figure 10: Ecoline Brewery can rings holding cans together





If the Ecoline Brewery can ring ends up in the ocean, in a matter of hours it starts breaking down, which addresses the issue of animals getting stuck in them.

* Note: Ecoline Brewery is a fictitious company, created for this case study.

(This question continues on the following page)

(Question 5 continued)

(a) Outline the waste mitigation strategy used by the can rings. [2]

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(b) Explain how the can rings would be compression moulded. [3]

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(Question 5 continued)

(c) The can rings are an incremental solution. Explain why manufacturers would consider incremental **and** radical solutions for green design. [6]

(This question continues on the following page)

(Question 5 continued)

(d) Explain how the barley and wheat composite addresses tensile strength, elasticity **and** plasticity. [9]

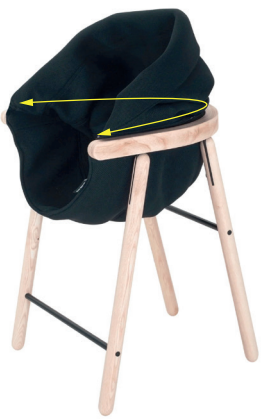
6. The Mia Hoodie Chair can support children with autism; it aids children's focus, learning and emotional intelligence. Its fabric seat hugs children, promoting calmness.

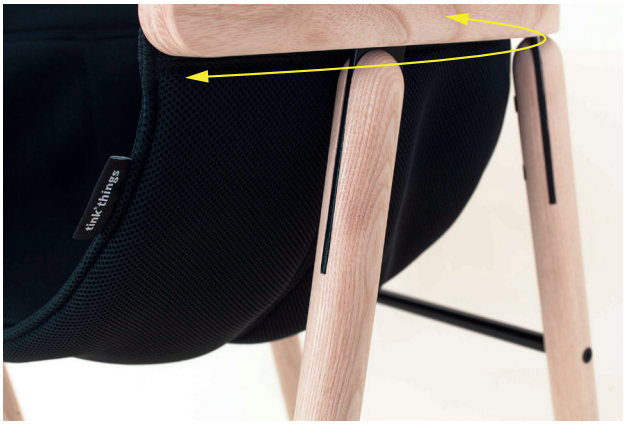
When overwhelmed, children can pull up the hoodie to create a comforting, enclosed space, see **Figure 11**.

Figure 11: A child in the Mia Hoodie Chair

The Mia Hoodie Chair is made of solid timber, aluminium joints, and 3D mesh fabric. The one-piece arm and back rest is made from laminated timber, see **Figure 12** and **13**.

Figure 12 and 13: Mia Hoodie Chair with yellow arrows showing laminated backrest





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(Question 6 continued)

(a) Outline the driver for invention for the Mia Hoodie Chair. [2]

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(b) Explain the process of lamination. [3]

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(Question 6 continued)

(c) Explain how the Mia Hoodie Chair satisfies the psychological factors of texture **and** light. [6]

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(Question 6 continued)

(d) Explain how sketches, mock ups **and** surface modelling would have been used in the development of the Mia Hoodie Chair. [9]

7. The Klhip ergonomically correct nail clipper gives increased control and leverage for trimming fingernails. Users find the nail clipper uses less force to cut and achieves a cleaner cut, see **Figure 14**.

Figure 14: Klhip nail clipper in use

Removed for copyright reasons

The Klhip nail clipper is precision engineered from surgical grade stainless steel, see **Figure 15**.

Figure 15: Stainless steel Klhip nail clipper

Removed for copyright reasons

Klhip have used a combination of patents, copyright **and** trademarks to protect its intellectual property (IP), see **Figure 16**.

Figure 16: Klhip logo

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(Question 7 continued)

(a) Outline why stainless steel was used for the Klhip nail clipper. [2]

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(b) The stainless steel parts of the Klhip nail clipper are manufactured by casting. Explain the process of casting. [3]

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(Question 7 continued)

(c) Explain how static **and** dynamic ergonomic data would have been used in the development of the Klhip nail clipper. [6]

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(Question 7 continued)

(d) Explain how Klhip would use patents, copyright **and** trademarks to protect its intellectual property (IP). [9]

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Figure 7 [Top left image] Coral – Photo by Bruno Figueiredo on Unsplash.

[Top middle image] Wood bark – Photo by Explore with Joshua on Unsplash.

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