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EDU4Plastic

D2.2.6 Definition of Exam Questions and Answers (for Online Quizzes)

WP2 – EDU4PlastiCircular Training methodology design

EDU4PlastiCircular Consortium members

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1 Module 1 - Introduction into the Plastic World

1.1 Exam questions for Lesson 1.1.

1. What is plastic?

A. A natural metal alloy
B. A natural fiber from plants
C. A synthetic or semi-synthetic material made from polymers
D. Compressed glass

☑ **Correct answer: C. A synthetic or semi-synthetic material made from polymers**

2. What is a monomer?

A. A molecule that dissolves polymers
B. A repeating unit in a metal compound
C. A small molecule that joins with others to form a polymer
D. A type of plastic additive

☑ **Correct answer: C. A small molecule that joins with others to form a polymer**

3. How are the terms polymer and plastic related?

A. Polymers are made from plastics
B. Plastics are materials based on polymers
C. They are unrelated terms
D. Plastic is a type of metal made from polymers

☑ **Correct answer: B. Plastics are materials based on polymers**

4. Which animal is historically linked to the beginning of plastic development?

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A. Whale
B. Elephant
C. Tiger
D. Lion

☑ **Correct answer: B. Elephant**
(*Due to the use of ivory for billiard balls, which led to the search for alternatives.*)

5. Which of the following was the first fully synthetic plastic?

A. Celluloid
B. Parkesine
C. Nylon
D. Bakelite

☑ **Correct answer: D. Bakelite**

6. What are the main characteristics of plastic materials?

A. Heavy, fragile, and water-absorbent
B. Light, strong, moisture- and chemical-resistant
C. Electrically conductive and rust-prone
D. Naturally degradable and flammable

☑ **Correct answer: B. Light, strong, moisture- and chemical-resistant**

7. Approximately how much plastic is produced globally each year?

A. less than 2 million tons
B. approx. 40 million tons
C. more than 400 million tons
D. 1 billion tons

☑ **Correct answer: C. more than 400 million tons**

8. What is the largest use of plastics worldwide?

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A. Medical devices
B. Textile production
C. Packaging
D. Automobiles

☑ **Correct answer: C. Packaging**

9. Why are some plastic additives regulated or banned?

A. They reduce the product's shelf life
B. They increase the recyclability of plastics
C. They pose health or environmental risks
D. They make plastics more expensive

☑ **Correct answer: C. They pose health or environmental risks**

1.2 Exam questions for Lesson 1.2

1. Which of the following is a characteristic of thermoplastics that makes them generally more suitable for mechanical recycling compared to thermosets?

a) High cross-linking density

b) Irreversible chemical change upon heating

c) Ability to be repeatedly softened and solidified by heating and cooling

d) High dimensional stability at elevated temperatures

2. Which of the following plastic types is most commonly used in beverage bottles and is a prime target for closed-loop recycling systems?

a) Polypropylene (PP)

b) Polyvinyl Chloride (PVC)

c) Polyethylene Terephthalate (PET)

d) High-Density Polyethylene (HDPE)

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3. Which manufacturing process is commonly used to create hollow plastic parts like bottles and containers?

a) Injection Molding

b) Extrusion

c) Blow Molding

d) Thermoforming

4. Plastics derived wholly or partly from renewable biological resources are known as: a) Biodegradable plastics

b) Compostable plastics

c) Bio-based plastics

d) Engineering plastics

5. A key challenge in mechanically recycling mixed plastic waste streams is the:

a) High energy consumption of the process

b) Difficulty in separating different polymer types due to incompatibility

c) Inability to remove additives from the plastic

d) Limited availability of collection infrastructure

6. Which manufacturing process involves forcing molten plastic through a die to create continuous profiles like pipes and films?

a) Injection Molding

b) Extrusion

c) Rotational Molding

d) Compression Molding

7. Plastics designed to break down into natural substances under specific composting conditions are called:

a) Biodegradable plastics

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b) Bio-based plastics

c) Compostable plastics

d) Recycled plastics

8. Which of the following is a characteristic of thermoset polymers that makes them challenging to recycle mechanically?

a) Low impact resistance

b) High flexibility

c) Formation of irreversible cross-links

d) Low thermal stability

9. Additive Manufacturing (3D printing) offers potential benefits for the circular economy of plastics by:

a) Primarily using virgin plastics for high precision

b) Enabling the creation of complex geometries with minimal waste and potentially using recycled materials

c) Requiring large-scale production runs for cost-effectiveness

d) Solely focusing on prototyping rather than end-product manufacturing

10. The process of heating a plastic sheet and shaping it over a mold using vacuum or pressure is known as:

a) Blow Molding

b) Injection Molding

c) Thermoforming

d) Rotational Molding

Answer Key

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1. c) Ability to be repeatedly softened and solidified by heating and cooling
2. c) Polyethylene Terephthalate (PET)
3. c) Blow Molding
4. c) Bio-based plastics
5. b) Difficulty in separating different polymer types due to incompatibility
6. b) Extrusion
7. c) Compostable plastics
8. c) Formation of irreversible cross-links
9. b) Enabling the creation of complex geometries with minimal waste and potentially using recycled materials
10. c) Thermoforming

1.3 Exam questions for Lesson 1.3

Instructions: Choose the best answer for each question.

1. What is the purpose of ISO 59004?

A. Define microplastic toxicity

B. Provide vocabulary and guidance for circular economy implementation

C. Regulate plastic packaging

D. Certify compostable plastics

2. Which ISO standard focuses on measuring circularity performance?

A. ISO 14001

B. ISO 59020

C. ISO 9001

D. ISO 15270

3. What does ISO 15270 address?

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A. Composting standards

B. Plastic recycling guidelines

C. Microplastic detection

D. Carbon footprinting

4. What is EN 13432 used for?

A. Identifying microplastics

B. Certifying industrial compostability of plastics

C. Measuring circularity

D. Sorting plastic waste

5. Which EU regulation restricts intentionally added microplastics?

A. REACH

B. RoHS

C. WEEE

D. CLP

6. What is the main goal of the EU Circular Economy Action Plan?

A. Promote fossil fuel use

B. Increase landfill capacity

C. Transition to a regenerative growth model

D. Ban all plastic products

7. What is the role of CEN in the EU?

A. Enforce environmental laws

B. Develop harmonized European standards

C. Monitor recycling plants

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D. Certify composting facilities

8. What is the Spanish standard UNE 53930 related to?

A. Biodegradable plastics

B. Microplastic detection

C. Plastic waste incineration

D. Recycled content in packaging

9. Which Spanish organization oversees standardization?

A. AENOR

B. ISO

C. CEN

D. ECHA

10. What is the Romanian national standardization body?

A. INMETRO

B. ASRO

C. UNI

D. SIST

11. What does ASRO stand for?

A. Romanian Association for Recycling

B. Association for Sustainable Resource Optimization

C. Romanian Standards Association

D. Agency for Solid Resource Oversight

12. Which Italian body is responsible for standardization?

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A. UNI

B. ISO

C. ENEA

D. ISPRA

13. What is UNI 10667 related to?

A. Composting food waste

B. Use of recycled plastics in products

C. Plastic incineration

D. Microplastic filtration

14. What is the Slovenian national standardization body?

A. SIST

B. SLOST

C. SENV

D. SLOISO

15. What is SIST EN 15343 about?

A. Biodegradable plastic certification

B. Traceability of recycled plastics

C. Microplastic detection in water

D. Plastic incineration standards

16. What is the purpose of ISO 59010?

A. Define plastic toxicity

B. Guide business model transition to circular economy

C. Certify compostable packaging

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D. Measure microplastic emissions

17. What is the focus of the DIN Standardization Roadmap for Circular Economy?

A. Fossil fuel alternatives

B. Technical rules for circular economy in key sectors

C. Plastic incineration

D. Water purification

18. What does ASTM D6400 certify?

A. Plastic recyclability

B. Industrial compostability of plastics

C. Microplastic content

D. Recycled content in textiles

19. What is the role of ECHA in microplastic regulation?

A. Promote plastic use

B. Certify compostable plastics

C. Regulate chemicals including microplastics under REACH

D. Develop recycling technologies

20. What is the main benefit of harmonized standards in the EU?

A. Increase product prices

B. Facilitate cross-border trade and compliance

C. Promote single-use plastics

D. Reduce recycling rates

Answer Key

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1. B
2. B
3. B
4. B
5. A
6. C
7. B
8. A
9. A
10. B
11. C
12. A
13. B
14. A
15. B
16. B
17. B
18. B
19. C
20. B

1.4 Exam questions for Lesson 1.4

Instructions: Choose the best answer for each question.

1. What is the main goal of the circular economy?

A. Increase product sales

B. Maximize landfill use

C. Keep materials at their highest utility and value

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D. Promote single-use plastics

2. What does LCA stand for?

A. Life Cycle Analysis

B. Linear Circular Assessment

C. Life Cycle Assessment

D. Low Carbon Application

3. Which model is described as "take-make-dispose"?

A. Circular Economy

B. Linear Economy

C. Closed-loop Economy

D. Green Economy

4. What is Extended Producer Responsibility (EPR)?

A. A recycling method

B. A tax on plastic

C. A policy assigning responsibility to producers for post-consumer waste

D. A consumer awareness campaign

5. What does Product-as-a-Service (PaaS) encourage?

A. Single-use packaging

B. Product ownership

C. Durability and recyclability

D. Fast product turnover

6. What is the top priority in the EU Waste Hierarchy?

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A. Recycling

B. Disposal

C. Prevention

D. Energy Recovery

7. What are Secondary Raw Materials?

A. Virgin materials

B. Waste sent to landfill

C. Recovered materials used in production

D. Materials used only once

8. What is Industrial Symbiosis?

A. A type of plastic

B. A recycling method

C. Waste from one industry used as input for another

D. A composting process

9. What is Greenwashing?

A. A type of eco-friendly detergent

B. A recycling process

C. Misleading environmental claims

D. A water purification method

10. What is a polymer?

A. A type of metal

B. A small molecule

C. A large molecule made of repeating units

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D. A natural fiber

11. Which plastic can be remelted and reshaped?

A. Thermoset

B. Elastomer

C. Thermoplastic

D. Bioplastic

12. What is a monomer?

A. A type of recycled plastic

B. A molecule that forms polymers

C. A plastic additive

D. A biodegradable material

13. What is Post-Consumer Recycled (PCR) Resin?

A. Virgin plastic

B. Industrial waste

C. Recycled material from consumer use

D. Plastic from compost

14. What is a major challenge with additives in plastics?

A. They improve recyclability

B. They reduce cost

C. They complicate recycling

D. They make plastics biodegradable

15. What is Design for Recycling (DfR)?

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A. Designing products for incineration

B. Designing products to be easily recycled

C. Designing products for single use

D. Designing products with multiple materials

16. What is multi-layer packaging known for?

A. Easy recyclability

B. Compostability

C. Difficulty in recycling

D. Being made of one material

17. What is extrusion used for?

A. Making hollow parts

B. Creating continuous plastic profiles

C. Sorting plastic

D. Composting

18. What is a nurdle?

A. A type of plastic bottle

B. A plastic additive

C. A small plastic pellet

D. A recycling machine

19. What is mechanical recycling?

A. Burning plastic for energy

B. Chemically breaking down plastic

C. Physically processing plastic waste

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D. Composting plastic

20. What does Near-Infrared (NIR) Spectroscopy do in recycling?

A. Melts plastic

B. Identifies polymer types

C. Adds color to plastic

D. Compresses plastic waste

Answer Key

1. C
2. C
3. B
4. C
5. C
6. C
7. C
8. C
9. C
10. C
11. C
12. B
13. C
14. C
15. B
16. C
17. B
18. C

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19. C

20. B

2 How did you do?

- 8-10 correct: Excellent! You have a strong understanding of plastic materials and manufacturing technologies in the context of the circular economy.
- 5-7 correct: Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions.
- Less than 5 correct: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

2. Module 2 - Plastic Waste Management

2.1 Exam questions for Lesson 2.1.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson *"Sources of Plastic Waste"*. You'll explore various origins, classifications, and environmental impacts of plastic materials, as well as challenges in plastic waste management. The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).
- **Part II** features true or false statements (11–20).

Take your time, think critically, and see how much you've learned. Good luck!

Instructions: Choose the best answer for each question.

Questionnaire Proposal (I)

1. **Multiple Choice (1–10)**

1. What is a primary reason why food packaging is difficult to recycle?
   A. It's always made from biodegradable plastics
   B. It often contains mixed materials and food residue
   C. It's collected in separate recycling streams
   D. It is made from natural polymers

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2.

2. Which plastic is most commonly used in beverage bottles?
A. PVC
B. HDPE
C. PET
D. ABS

3. Which of the following plastics is commonly used in the automotive sector for dashboards and bumpers?
A. PVC
B. PP
C. PET
D. PLA

4. What percentage of global fiber production is composed of synthetic textiles?
A. 25%
B. 60%
C. 75%
D. 90%

5. What term is used to describe plastic waste from fishing gear that continues to trap marine life?
A. Silent net
B. Plastic snare
C. Ghost gear
D. Lost loop

6. Which classification includes items like plastic bags, straws, and snack wrappers?
A. Durable plastics
B. Single-use plastics
C. Macroplastics
D. Composite plastics

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7. What is the main environmental concern with nanoplastics?
A. They biodegrade too quickly
B. They cannot be seen with a microscope
C. They can penetrate biological tissues and organs
D. They make up most visible litter

8. What plastic is typically used for blister packs in cosmetic products?
A. LDPE
B. PVC and aluminum
C. PLA
D. HDPE

10. Which sector is second only to packaging in terms of plastic use in the EU?
    A. Healthcare
    B. Automotive
    C. Construction
    D. Agriculture
11.

10. What type of microplastic is released when synthetic clothing is washed?
A. Nurdles
B. Microbeads
C. Microfibers
D. PLA strands

3. True or False (11–20)

11. Polyester and nylon are examples of synthetic textile fibers.
12. All 3D printing waste is biodegradable.
13. Microplastics are only found in marine environments.
14. Land-based sources contribute the least to global plastic pollution.
15. ALDFG stands for Abandoned, Lost, or Discarded Fishing Gear.
16. Plastic mulch films in agriculture break down rapidly and pose no environmental

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risk.
17. Nanoplastics can cross the blood-brain barrier in humans.
18. Most toys are made from easily recyclable plastics.
19. Take-out containers are an example of commercial and institutional plastic waste.
20. Air-based microplastics have been found in remote locations like the Arctic.

Questionnaire Proposal (II)

i. **Multiple Choice (1–10)**

1. Which sector is a significant contributor to microplastic pollution due to synthetic fiber shedding?
A. Automotive
B. Healthcare
C. Textile and clothing
D. Construction

2. What plastic is commonly used for insulation panels in construction?
A. PET
B. EPS
C. PVC
D. ABS

3. What challenge is commonly faced when recycling EEE (Electronic and Electrical Equipment) plastics?
A. Low production volume
B. Excessive moisture content
C. Presence of hazardous additives
D. Easily biodegradable polymers

4. What is a major reason composite shipping envelopes are hard to recycle?
A. They are too small
B. They are made of biodegradable plastic

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C. They combine plastic with other materials
D. They are always incinerated

5. Which size category includes plastic particles smaller than 1 micrometer?
A. Microplastics
B. Macroplastics
C. Mesoplastics
D. Nanoplastics

6. Which of the following is a land-based source of plastic pollution?
A. Ghost fishing gear
B. Ocean dumping
C. Urban littering
D. Offshore oil rigs

7. Why are multilayer plastic laminates problematic in recycling systems?
A. They are biodegradable
B. They are usually made of natural fibers
C. They contain metal or paper layers
D. They are easy to separate

8. What plastic material is most often found in marine fishing nets and monofilament lines?
A. PVC
B. Nylon
C. PET
D. ABS

9. What contributes to increased plastic waste from online shopping?
A. Increased consumer awareness
B. Reuse of materials

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C. Use of protective plastic packaging
D. Reduced packaging needs

10. Which of the following is *not* typically found in 3D printing waste?
A. PLA
B. ABS
C. Nylon
D. PE foam

ii. **True or False (11–20)**

11. Household plastic packaging often contains multiple polymer types, making recycling easier.

12. Plastic waste from agriculture includes mulch films and greenhouse covers.

13. Fishing gear made of plastic degrades within a few weeks in the ocean.

14. Urban runoff can transport plastics from cities to rivers and eventually oceans.

15. Durable plastics are generally used once and discarded quickly.

16. Polypropylene is a common material used in both packaging and automotive components.

17. Textiles made from natural fibers contribute most to microplastic pollution.

18. PVC is used in both construction and medical applications.

19. Plastic particles can be carried by atmospheric currents to remote regions.

20. Incinerating plastic waste generates zero air-based microplastics.

Answer Key

Answer Key of Questionnaire Proposal (I)

Multiple Choice:

1. **B**
2. **C**
3. **B**
4. **B**

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5. **C**
6. **B**
7. **C**
8. **B**
9. **C**
10. **C**

True or False:

11. **True**
12. **False**
13. **False**
14. **False**
15. **True**
16. **False**
17. **True**
18. **False**
19. **True**
20. **True**

Answer Key of Questionnaire Proposal (II)

Multiple Choice:

1. **C**
2. **B**
3. **C**
4. **C**
5. **D**
6. **C**

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7. **C**
8. **B**
9. **C**
10. **D**

True or False:

11. **False**
12. **True**
13. **False**
14. **True**
15. **False**
16. **True**
17. **False**
18. **True**
19. **True**
20. **False**

How did you do?

- **18–20 correct:** Plastic Prodigy! You have a solid grasp on the complexity of plastic waste and its global impact.
- **15–17 correct:** Sustainability Star! Great work, and just a few areas to polish up.
- **10–14 correct:** Eco-Aware Learner. You're on the right track — keep exploring the challenges of plastic pollution.
- **<10 correct:** Green Beginner. No worries — review the materials and try again. The environment needs informed advocates like you!

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2.2 Exam questions for Lesson 2.2.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson *Waste Plastic and Leakages to Landfill.* You'll revisit how plastics behave in landfills, how microplastics and leachate form and spread, and the role of landfill design, policy, and mitigation strategies in reducing environmental risk. The quiz is divided into two parts:

Part I includes multiple-choice questions (1–10).

Part II features true or false statements (11–20).

Take your time, think critically, and test how much you've learned. Good luck!

Instructions: Choose the best answer for each question.

Questionnaire Proposal (I)

a. **Multiple Choice (1–10)**

1. What is the main reason plastics degrade slowly in landfills?

a) Exposure to rainwater
b) High oxygen availability
c) Anaerobic conditions and lack of sunlight
d) Microbial enrichment

2. What is "leachate"?

a) Gas emitted from plastic decomposition
b) Water that flows off the surface of landfills
c) Liquid that drains through waste, containing dissolved and suspended contaminants
d) Airborne particles from landfill plastics

3. Which of the following is a common plastic additive found in landfill leachate?

a) Polyethylene glycol
b) Cellulose
c) Bisphenol A (BPA)
d) Sulfur dioxide

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4. Microplastics can migrate through landfill layers and reach:

a) Solar panels
b) Groundwater and nearby soils
c) Electricity grids
d) Surface ozone

5. Which condition does NOT favor plastic degradation?

a) High UV exposure
b) Anaerobic environment
c) High temperatures
d) Active microbial community

6. How can runoff transport microplastics?

a) By neutralizing their charge
b) By photodegrading them in place
c) By washing exposed plastics during rainstorms
d) By trapping them in landfill liners

7. Which landfill feature helps prevent leachate leakage?

a) Ventilation system
b) Gas flares
c) HDPE liners and compacted clay
d) Microbial inoculation

8. What is a health risk associated with leachate entering groundwater?

a) Muscle fatigue
b) Reduced pH in household paint
c) Hormonal disruption and carcinogenic effects
d) None; leachate is sterile

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9. What is one method to capture microplastics in landfill leachate treatment?

a) Magnetic separation
b) Reverse osmosis membranes
c) Lead piping
d) Ozone bleaching

10. Landfills are considered slow-release sources of plastic pollution because:

a) Plastic burns instantly
b) Decomposition halts waste migration
c) Plastics persist and release particles and chemicals over decades
d) Liners biodegrade quickly

b. **True or False (11–20)**

11. Leachate is formed when rainwater interacts with waste in landfills.
12. Microplastics have been found in both leachate and surrounding soil.
13. Proper landfill liners increase leachate pollution.
14. Runoff only occurs inside engineered pipes and poses no environmental threat.
15. Phthalates and brominated flame retardants are common in plastic leachate.
16. High rainfall volumes reduce microplastic mobility in landfills.
17. Landfill mining can help recover and recycle buried plastics.
18. Anaerobic degradation enhances rapid breakdown of most plastic polymers.
19. Microplastics can be ingested by plants and soil organisms.
20. Leachate treatment is not needed if liners are installed.

Questionnaire Proposal (II)

i. **Multiple Choice (1–10)**

1. Which factor is least likely to influence the migration of microplastics from landfills?
   a) Soil permeability

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b) Age of the landfill
c) Presence of solar panels
d) Volume of leachate generated

2. Which of the following materials is often used as a landfill liner?
   a) Asphalt
   b) Polyurethane foam
   c) High-density polyethylene (HDPE)
   d) Recycled PET bottles

3. Why are plastic additives problematic in landfill environments?
   a) They are biodegradable
   b) They can leach into surrounding environments and act as endocrine disruptors
   c) They neutralize harmful bacteria
   d) They strengthen the landfill cover

4. Which plastic type is most commonly associated with lightweight packaging and tends to float in leachate?
   a) HDPE
   b) LDPE
   c) PET
   d) PS

5. One environmental benefit of properly managed landfills is:
   a) Accelerated plastic biodegradation
   b) Complete elimination of plastic waste
   c) Prevention of groundwater contamination
   d) Reduction in UV exposure

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6. The long-term presence of plastics in landfills contributes to:
   a) Soil fertilization
   b) Microbial diversity enhancement
   c) Extended release of pollutants
   d) Reduction of waste volume

7. What is a typical sign that landfill leachate has leaked into surrounding areas?
   a) Increased oxygen levels
   b) Appearance of invasive plant species
   c) Detection of plasticizers in soil or water
   d) Dry and sandy soil

8. Which of the following actions can help reduce microplastic leakage from landfills?
   a) Installing solar-powered lights
   b) Improving stormwater runoff control systems
   c) Planting native grasses
   d) Increasing landfill temperatures

9. How does rainfall impact leachate production?
   a) It dries out the waste, stopping leachate formation
   b) It has no measurable effect
   c) It accelerates leachate production by increasing infiltration
   d) It sterilizes the waste

10. Which technology is currently used in advanced landfill leachate treatment systems?
    a) Wind turbines
    b) Reverse osmosis and filtration units
    c) Compost tumblers
    d) Chlorinated plastic coatings

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ii. True or False (11–20)

11. Plastics in landfills can release chemicals even without visible degradation.
12. Microplastics can bioaccumulate in food chains originating near landfills.
13. Landfill caps are designed to enhance water infiltration.
14. Macroplastics always degrade before releasing microplastics.
15. Leachate toxicity depends on waste composition and environmental conditions.
16. Rainfall can carry plastic particles from uncovered waste piles into drainage systems.
17. Microplastics are chemically inert and pose no biological risk.
18. Engineered landfills aim to isolate waste from the environment using multiple barriers.
19. Proper waste segregation can reduce harmful leachate formation.
20. Plastic waste remains biologically active in deep landfill layers for only one year.

Answer Key

Answer Key of Questionnaire Proposal (I)

Multiple Choice (1–10):

21. c

22. c

23. c

24. b

25. b

26. c

27. c

28. c

29. b

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30. c

True or False (11–20):

31. True
32. True
33. False
34. False
35. True
36. False
37. True
38. False
39. True
40. False

Answer Key of Questionnaire Proposal (II)

Multiple Choice:

1. c
2. c
3. b
4. b
5. c
6. c
7. c
8. b
9. c
10. b

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True or False:

11. **True**
12. **True**
13. **False**
14. **False**
15. **True**
16. **True**
17. **False**
18. **True**
19. **True**
20. **False**

How did you do?

- 18–20 correct: *Landfill Leakage Expert* – Outstanding! You clearly understand landfill behavior and plastic leakage risks.
- 15–17 correct: *Well-Informed* – Great work! A bit of review could help solidify the more complex points.
- 12–14 correct: *Emerging Learner* – You're on the right path. Revisit the parts on leachate formation and mitigation strategies.
- 0–11 correct: *Plastic Novice* – Don't worry! Review the reading again and try a retake. You'll improve quickly with practice.

2.3 Exam questions for Lesson 2.3.

This activity is designed to help you review and reflect on key concepts from the lesson *Waste plastic and leakages to water*. You'll explore the journey of plastic waste as it enters and moves through aquatic systems, emphasizing the urgent need to understand and manage plastic pollution in water environments.

The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).

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- **Part II** features true or false statements (11–20).

Take your time, think critically, and see how much you've learned. Good luck!

Instructions: Choose the best answer for each question.

Questionnaire Proposal (I)

a. Multiple Choice (1–10)

1. Which of the following is a primary source of microplastic pollution from industry?
   A) Agricultural runoff
   B) Resin pellet loss during transport
   C) Atmospheric fallout
   D) Domestic composting
2. What is a major concern about combined sewer overflows during heavy rainfall?
   A) They generate electricity
   B) They filter out all plastics
   C) They discharge untreated waste into rivers
   D) They clean stormwater before it enters lakes
3. Which river transport characteristic contributes most to the global spread of plastics?
   A) River length
   B) River speed
   C) Sediment composition
   D) Concentration of plastic in runoff
4. What is “ghost gear” in the context of plastic waste?
   A) Plastic from abandoned amusement parks
   B) Packaging that disappears in water
   C) Lost or discarded fishing gear that continues to trap marine life
   D) Microplastic particles from ghost nets
5. Which of the following pollutants is often added to plastic products and can act as an endocrine disruptor?
   A) Mercury
   B) Bisphenol A (BPA)

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C) Lead
D) Sodium chloride

6. Which project targets rivers to intercept plastic waste before it reaches the ocean?
   A) Save the Seas Act
   B) Operation Clean Sweep
   C) The Ocean Cleanup Project
   D) Marine Watchdog Network

7. Primary microplastics are defined as:
   A) Plastics made from recycled materials
   B) Fragments of larger plastic items
   C) Intentionally manufactured small plastic particles
   D) Natural polymers from plant-based sources

8. What proportion of ocean plastic discharge is estimated to come from just 1,000 rivers?
   A) 10%
   B) 25%
   C) 50%
   D) Nearly 80%

9. What is one documented environmental effect of tire wear particles?
   A) They increase soil fertility
   B) They release nitrogen into groundwater
   C) They enter water bodies through atmospheric fallout
   D) They are biodegradable

10. Which regulation introduced systematic microplastic monitoring in urban wastewater?
    A) EU Green Deal
    B) Directive on Water Resources Management
    C) EU Urban Wastewater Treatment Directive (2024)
    D) Basel Convention

b. True or False (11–20)

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11. Plasticulture refers to plastic use in agriculture, such as mulch films and irrigation lines.
12. Advanced wastewater treatment can remove 100% of microplastics.
13. The MSC Zoe incident caused millions of nurdles to spill into the Wadden Sea.
14. Microplastics have been found only in marine environments, not freshwater systems.
15. Phthalates are added to plastics to make them more rigid and brittle.
16. Atmospheric deposition is now recognized as a source of plastic pollution in remote areas like the Arctic.
17. Only synthetic microfibers from laundry can pass through wastewater treatment plants.
18. Microplastics pose no risk to human health because they are inert.
19. Plastic particles can act as carriers for heavy metals and pathogens in aquatic systems.
20. "Plastisphere" refers to a microbial community that forms on plastic surfaces in water.

c. Questionnaire Proposal (II)

- **Multiple Choice (1–10)**

1. Which of the following polymers is commonly found as nurdles in industrial plastic spills?
   A) Polyvinyl chloride (PVC)

B) Polyethylene (PE)

C) Polyurethane (PU)

D) Polycarbonate (PC)

2. What natural forces can transport plastics from open dumps to aquatic systems?
   A) Earthquakes
   B) Volcanic activity
   C) Flood events and wind
   D) Solar flares

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3. Which source of plastic waste is specifically linked to road and vehicle use?
   A) Ghost gear
   B) Atmospheric fallout
   C) Urban sewage
   D) Tire wear particles

4. Why are wastewater treatment plants (WWTPs) considered a secondary pathway for microplastics?
   A) They always incinerate waste
   B) They leak plastics during energy production
   C) They discharge both treated effluent and sludge
   D) They trap 100% of plastics effectively

5. What is the primary environmental risk of abandoned fishing nets?
   A) They pollute the air
   B) They increase crop yield
   C) They entangle and kill marine organisms
   D) They improve coral reef health

6. According to Lebreton et al. (2017), what global region contains most of the rivers contributing to plastic ocean discharge?
   A) Europe
   B) South America
   C) Asia and Africa
   D) North America

7. Which type of microplastic originates from the breakdown of larger plastic items?
   A) Primary
   B) Cosmetic microbeads
   C) Industrial powders
   D) Secondary

8. Which event is cited as an example of a massive accidental plastic release into the marine environment?
   A) Fukushima accident
   B) Deepwater Horizon spill
   C) MSC Zoe container spill
   D) Exxon Valdez incident

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9. Which pollutant group is absorbed by microplastics and can cause hormonal disruption?
   A) Polycyclic aromatic hydrocarbons (PAHs)
   B) Persistent organic pollutants (POPs)
   C) Sulfates
   D) Nitrates
10. Which of the following is a proposed regulatory improvement mentioned in the reading?
    A) Plastic incineration in open fields
    B) Use of more rigid plastic packaging
    C) Systematic monitoring and redesign of plastic products
    D) Reducing water usage in households

True or False (11–20)

11. Microplastics are defined as plastic particles smaller than 5 millimeters.
12. All plastics are chemically stable and do not release any compounds into water.
13. Sludge from WWTPs, when applied to agricultural land, can lead to microplastic contamination of rivers.
14. Only plastic visible to the naked eye poses ecological harm in aquatic systems.
15. UV radiation contributes to the fragmentation of plastics into microplastics.
16. Paint flakes from urban infrastructure are a known contributor to microplastic pollution.
17. The Ocean Cleanup Project mainly targets landfills and agricultural fields.
18. Microplastics can serve as habitats for bacteria and other microorganisms.
19. Fishing and tourism are categorized as ocean-based secondary sources of plastic pollution.
20. There is currently complete and unified international regulation on all plastic additives and leachates.

Answer Key

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Answer Key of Questionnaire Proposal (I)

Multiple Choice:

11. **B**
12. **C**
13. **D**
14. **C**
15. **B**
16. **C**
17. **C**
18. **D**
19. **C**
20. **C**

True or False:

21. **True**
22. **False**
23. **True**
24. **False**
25. **False**
26. **True**
27. **False**
28. **False**
29. **True**
30. **True**

Answer Key of Questionnaire Proposal (II)

Multiple Choice:

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1. **B**
2. **C**
3. **D**
4. **C**
5. **C**
6. **C**
7. **D**
8. **C**
9. **B**
10. **C**

True or False:

11. **True**
12. **False**
13. **True**
14. **False**
15. **True**
16. **True**
17. **False**
18. **True**
19. **True**
20. **False**

How did you do?

- **18–20 correct:** Plastic Pollution Expert – Outstanding work! You have a deep understanding of microplastics, pollution sources, and global impact. You're ready to lead informed discussions and develop effective solutions.
- **15–17 correct:** *Well-Informed Learner* – Great job! You have strong knowledge of key concepts. A quick review of the missed topics will sharpen your insight even

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further. **10–14 correct:** *Developing Learner* – Good effort! You grasp the core ideas but would benefit from reviewing parts of the readings and key terminology.

- **<10 correct:** *Emerging Learner* – Don't worry! Go back through the lesson materials and key terms. Take your time with the readings and try again. Progress comes with practice!

2.4 Exam questions for Lesson 2.4.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson *Waste Micro(nano)plastic in the Air*. You'll explore the emerging challenge of airborne microplastics and nanoplastics—an often-overlooked dimension of plastic pollution. The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).
- **Part II** features true or false statements (11–20).

Take your time, think critically, and see how much you've learned. Good luck!

Instructions: Choose the best answer for each question.

a. Questionnaire Proposal (I)

Multiple Choice (1–10)

1. What is the primary human exposure pathway to airborne microplastics?
   A) Dermal absorption
   B) Injection
   C) Inhalation
   D) Visual contact
2. Which of the following is a key source of airborne microplastics in cities?
   A) Sea spray
   B) Tire and road wear
   C) Agricultural waste
   D) Water filtration
3. What analytical method is commonly used to identify plastic polymers in environmental air samples?

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A) X-ray diffraction
B) Liquid chromatography
C) Fourier-transform infrared spectroscopy (FTIR)
D) PCR testing

4. What is one major limitation in detecting atmospheric nanoplastics?
   A) Lack of field samplers
   B) Too many reference libraries
   C) Their optical transparency and aggregation behavior
   D) Overabundance of large particles

5. How can microplastics re-enter aquatic systems from the air?
   A) Via solar radiation
   B) Through atmospheric deposition
   C) By lightning
   D) Through UV degradation

6. What type of feedback loop involves plastic particles being cycled between indoor and outdoor environments?
   A) Cryosphere loop
   B) Albedo loop
   C) Urban feedback loop
   D) Biogeochemical loop

7. Which of the following is NOT a known deposition method for atmospheric microplastics?
   A) Dry deposition
   B) Magnetic deposition
   C) Wet deposition
   D) Gravitational settling

8. Which of the following health risks is associated with inhalation of plastic nanoparticles?
   A) Osteoporosis
   B) Neuroinflammation
   C) Broken bones
   D) Increased red blood cells

9. What is one emerging technology to detect atmospheric nanoplastics?
   A) Gasoline testing kits

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B) DNA sequencers
C) Nanoparticle Tracking Analysis (NTA)
D) UV pen scanners

10. Why are microplastics not currently regulated under most air quality frameworks?
A) They don't exist in the air
B) They are naturally occurring
C) There's a lack of standard definitions and measurement protocols
D) They are visible and easy to remove

True or False (11–20)

11. Microplastics have been detected in remote regions like the Arctic and high mountains.
12. Indoor environments contribute very little to airborne microplastic exposure.
13. Vertical and horizontal atmospheric movement can carry microplastics across continents.
14. All airborne microplastics are easily visible to the naked eye.
15. Microplastic particles can serve as carriers for toxic pollutants like heavy metals.
16. There is currently a global legal framework that specifically regulates atmospheric microplastics.
17. AI and machine learning are being used to help identify and classify microplastic particles.
18. Dry deposition refers to particles settling via rain or snow.
19. Nanoplastics have been found to cross biological barriers, such as the placenta.
20. Textile fibers from clothes are a source of microplastics in both indoor and outdoor air.

b. Questionnaire Proposal (II)

Multiple Choice (1–10)

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1. Which of the following activities is a significant indoor source of airborne microplastics?
   A) Brushing teeth
   B) Using tumble dryers
   C) Drinking bottled water
   D) Watering plants
2. What atmospheric phenomenon may be affected by microplastic deposition?
   A) The ozone hole
   B) Magnetic storms
   C) Cloud formation and albedo
   D) Moon cycles
3. What is the main concern regarding the accumulation of microplastics in the human lungs?
   A) They block air conditioning
   B) They may cause respiratory inflammation and oxidative stress
   C) They strengthen immunity
   D) They release oxygen
4. Which type of microplastic exposure involves consuming food contaminated through air deposition?
   A) Inhalation
   B) Injection
   C) Ingestion
   D) Dermal exposure
5. What kind of plastic particles can remain suspended in the air for long periods and travel great distances?
   A) Macroplastics
   B) Microfibers only
   C) Nanoplastics
   D) Biodegradable bags
6. Which process returns airborne microplastics to the Earth's surface during rain or snow?
   A) Solar radiation
   B) Evaporation

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C) Wet deposition
D) Photochemical breakdown

7. Which of the following is a major challenge in detecting nanoplastics in the atmosphere?
   A) Their color
   B) Their weight
   C) Their size and low contrast
   D) Their taste
8. Why are microplastics considered vectors for toxic pollutants?
   A) They clean pollutants
   B) They repel chemicals
   C) They adsorb and carry harmful substances like PCBs and heavy metals
   D) They are sterile particles
9. Which occupational group is especially vulnerable to airborne microplastic exposure?
   A) Doctors
   B) Textile workers
   C) Gardeners
   D) Journalists
10. What policy action is recommended to reduce indoor exposure to airborne plastics?
    A) Increasing carpet use
    B) Installing microplastic detectors on TVs
    C) Using natural fiber textiles and better ventilation
    D) Burning all plastics

True or False (11–20)

11. Wind erosion can lift microplastics into the atmosphere from landfills and roadsides.
12. All national air quality standards include microplastic monitoring requirements.
13. Atmospheric microplastics have been detected in rain, snow, and even hailstones.

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14. Dermal contact is the primary route of human exposure to airborne microplastics.
15. Microplastic particles can contribute to soil and water pollution after atmospheric deposition.
16. Microplastics are classified as hazardous air pollutants under most national laws.
17. Advanced sensors and lab-on-a-chip tools are being developed for microplastic monitoring.
18. Plastic particles in the atmosphere have no effect on ecosystems.
19. The urban feedback loop includes the indoor-outdoor cycling of microplastic fibers.
20. Fragmented global governance is a barrier to effective regulation of airborne plastics. millimeters.

Answer Key of Questionnaire Proposal (I)

Multiple Choice:

31. C

32. B

33. C

34. C

35. B

36. C

37. B

38. B

39. C

40. **C**

True or False:

41. True

42. False

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43. True
44. False
45. True
46. False
47. True
48. False
49. True
50. True

Answer Key of Questionnaire Proposal (II)

Multiple Choice:

a. B
b. C
c. B
d. C
e. C
f. C
g. C
h. C
i. B
j. C

True or False:

k. True
l. False
m. True
n. False
o. True

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p. **False**

q. **True**

r. **False**

s. **True**

t. **True**

How did you do?

- **18–20 correct:** *Airborne Plastics Specialist* - Excellent work! You've demonstrated a comprehensive understanding of micro- and nanoplastic pollution in the atmosphere, including sources, pathways, health risks, and detection challenges. You're well-equipped to contribute to discussions and actions on air quality and emerging pollutants.
- **15–17 correct:** *Well-Informed Learner* - Great job! You have a strong grasp of key topics and critical concepts. A brief review of the more advanced areas—such as detection technologies and global policy gaps—will help deepen your expertise.
- **10–14 correct:** *Developing Learner* - You're making solid progress. You understand the fundamentals but may need to revisit parts of the lesson dealing with particle behavior, indoor sources, or scientific monitoring. Keep going—your awareness is growing!
- **<10 correct:** *Emerging Awareness* - Don't worry—this topic is complex and still evolving! Review the reading materials and key terms, and try the quiz again. Each attempt strengthens your understanding of this critical environmental issue.

2.5 Exam questions for Lesson 2.5.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson *Zero Plastic Initiative*. You'll explore the urgency of moving beyond recycling toward prevention, redesign, reuse, and innovative recovery strategies. The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).
- **Part II** features true or false statements (11–20).

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Take your time, think critically, and see how much you've learned. Good luck!

Instructions: Choose the best answer for each question.

Questionnaire Proposal (I)

Multiple Choice (1–10)

1. What is the core goal of the Zero Plastic Initiative (ZPI)?

A. To ban all forms of plastic globally

B. To promote plastic incineration

C. To eliminate plastic waste through prevention, redesign, reuse, and recovery

D. To shift from fossil fuels to nuclear energy

2. Which of the following sectors is highlighted for its potential to reuse and redesign packaging systems?

A. Military

B. Food & Beverage Industry

C. Space Exploration

D. Mining

3. What type of plastics does the EU's Single-Use Plastics Directive target?

A. Plastics used in construction

B. Durable household plastics

C. The top 10 most common beach litter items

D. Recyclable multi-layer packaging

4. Which policy tool directly places financial responsibility on producers for plastic waste?

A. Tax incentives

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B. Extended Producer Responsibility (EPR)

C. GPP guidelines

D. Retail subsidies

5. Which of the following is considered a form of upcycling?

A. Turning PET into textile fibers

B. Mixing plastic waste into asphalt

C. Converting HDPE into modular construction components

D. Disposing plastics in landfills

6. What is the main difference between bio-based plastics and compostable plastics?

A. Bio-based plastics always degrade naturally

B. Compostable plastics must degrade under specific conditions

C. Compostable plastics are made only from fossil fuels

D. Bio-based plastics are edible

7. What is one limitation of using compostable plastics?

A. They emit radioactive gases

B. They require industrial composting facilities

C. They cause cancer

D. They are banned in all EU countries

8. Which technology converts plastic waste into hydrogen fuel?

A. Mechanical shredding

B. Photovoltaic breakdown

C. Catalytic depolymerization

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D. Hydrofracking

9. What is the primary benefit of plastic bans?

A. Increases landfill space

B. Raises consumer prices

C. Catalyzes innovation and market shifts

D. Promotes fossil fuel dependency

10. What is a key enabler of cultural change in reducing plastic use?

A. Space policy reform

B. Community surveillance

C. Education and behavioral engagement

D. Corporate tax reductions

True or False (11–20)

11. The Zero Plastic Initiative supports only downstream recycling strategies.
12. Cities can act as innovation labs for zero plastic solutions.
13. Upcycling always results in a product of lesser value than the original plastic.
14. The European Green Deal includes targets related to plastic pollution reduction.
15. Microplastics have been detected in human lungs and blood.
16. Plastic pollution is mainly an ocean-based problem caused by ships.
17. Deposit-return systems are an example of a reuse business model.
18. The construction sector offers potential for incorporating plastic waste into durable materials.
19. Plastic-to-hydrogen conversion technologies are unregulated and unsafe in all contexts.

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20. International agreements like the UNEP treaty seek a legally binding framework to combat plastic pollution.

Questionnaire Proposal (II)

Multiple Choice (1–10)

21. According to OECD projections, what is likely to happen without systemic change in plastic use?
    A. Plastic waste will be fully recycled by 2060
    B. Plastic waste will triple by 2060
    C. Plastic will become biodegradable globally
    D. All microplastics will be eliminated

22. Which of the following is NOT one of the five pillars in the Blueprint to Zero Plastic Waste?
    A. Redesign
    B. Reuse
    C. Disposal in landfills
    D. Governance & Monitoring

23. Which global framework does the Zero Plastic Initiative align with?
    A. NATO Environmental Charter
    B. UN Sustainable Development Goals (SDGs)
    C. WTO Trade Facilitation Agreement
    D. Paris Agreement on Biodiversity

24. Which is a key indicator for monitoring plastic reduction progress?
    A. National GDP growth
    B. Number of incinerators
    C. Material flow analysis (MFA)
    D. Total tax collected on plastic bags

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25. What is a critical risk of relying solely on energy recovery technologies like pyrolysis?
    A. Too much compost is produced
    B. Overproduction of glass waste
    C. Excuse for continued plastic overproduction
    D. Reduced job opportunities

26. What type of event or location is ideal for applying plastic-free models in public engagement?
    A. High-security data centers
    B. Open-pit mines
    C. Community festivals and schools
    D. Offshore drilling platforms

27. Which approach best defines systems thinking in the context of plastic redesign?
    A. Focusing only on material cost
    B. Analyzing single products individually
    C. Considering the full lifecycle and leverage points
    D. Prioritizing aesthetics over utility

28. Which business model involves consumers returning packaging for reuse?
    A. Single-use retail
    B. Refill-at-home
    C. Deposit-return system
    D. Downcycling framework

29. What does Green Public Procurement (GPP) promote?
    A. Plastic-free military exercises
    B. Government purchasing of low-plastic goods/services
    C. The ban of all plastic packaging in schools
    D. Creation of new landfill zones

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30. What makes Ljubljana a leading example of zero waste success?
    A. It recycles only PET bottles
    B. It achieved over 68% separate waste collection and under 5% landfill
    C. It banned all electronic waste
    D. It built Europe's largest incineration plant

True or False (11–20)

11. The majority of plastic waste is currently incinerated.
12. Microplastics are only a problem in marine ecosystems.
13. The Zero Plastic Initiative encourages upstream innovation.
14. Bioplastics are always compostable.
15. The food and beverage sector is a major contributor to single-use plastic pollution.
16. Pyrolysis is a low-temperature plastic recovery process.
17. Circular retail involves both reusable packaging and return logistics.
18. Public procurement policies can help scale plastic-free practices.
19. The SUP Directive applies only to food containers.
20. Education campaigns can help shift social norms around plastic use.

Answer Key

Answer Key of Questionnaire Proposal (I)

Multiple Choice:

51. C

52. B

53. C

54. B

55. C

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56. **B**

57. **B**

58. **C**

59. **C**

60. **C**

True or False:

31. **False**

32. **True**

33. **False**

34. **True**

35. **True**

36. **False**

37. **True**

38. **True**

39. **False**

40. **True**

Answer Key of Questionnaire Proposal (II)

Multiple Choice:

1. **B**
2. **C**
3. **B**
4. **C**
5. **C**
6. **C**
7. **C**
8. **C**

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9. **B**
10. **B**

True or False:

11. **False**
12. **False**
13. **True**
14. **False**
15. **True**
16. **False**
17. **True**
18. **True**
19. **False**
20. **True**

How did you do?

- **18–20 correct:** *Circular Economy Champion* - Outstanding! You've shown an excellent grasp of zero plastic strategies, technologies, and policy tools. You're ready to drive real-world change and contribute meaningfully to sustainable innovation and advocacy.
- **15–17 correct:** *Well-Informed Advocate* - Great work! You understand the major components of the Zero Plastic Initiative and circular approaches. With a bit more focus on emerging technologies or global frameworks, you'll be ready to lead informed discussions and initiatives.
- **10–14 correct:** *Developing Change Agent* - You're building a strong foundation. Keep reviewing the key concepts—like EPR, upcycling, and policy tools—and you'll soon be able to confidently apply circular solutions in real contexts.
- **<10 correct:** *Emerging Awareness* - No worries—this is a complex and evolving topic. Revisit the reading materials, focus on the principles of circular economy and plastic policy, and take the quiz again. Every step is progress toward impactful learning!

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2. Module 3 - Plastic in Circular Economy & Climate Neutral

3.1 Exam questions for Lesson 3.1.

Quiz Activity

This activity is designed to help you review and reflect on key concepts from the lesson "*Circular Economy and lifecycle thinking*". Take your time, think critically, and see how much you've learned. The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).
- **Part II** features true or false statements (11–20).

Instructions: Choose the best answer for each question.

Questionnaire Proposal

1. What is the main objective of Life Cycle Thinking (LCT) within the circular economy framework?

A. To reduce environmental impact of disposal and recycling process

B. To maximize the material composition efficiency

C. To analyze environmental impact during the production phase

D. To assess environmental, social, and economic impacts of a product

2. In the context of Social Life Cycle Assessment (S-LCA), what is a key challenge in evaluating packaging systems?

A. The lack of standardized environmental metrics

B. The inability to apply it to consumer products

C. The need for quantitative data and stakeholder-specific social indicators

D. The excessive reliance on greenhouse gas emissions

3. What distinguishes Social Life Cycle Assessment (S-LCA) from traditional LCA?

A. S-LCA is still under development, a standard method doesn't exist yet

B. S-LCA include also economic assessment

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C. There is no regulation yet to apply the SLCA

D. It assesses social and socio-economic impacts on stakeholders across the life cycle

4. What is the primary function of Extended Producer Responsibility (EPR)?

A. Assigning responsibility to producers for the product's end of life

B. Delegating disposal responsibilities to municipalities

C. Assesses LCA on their product's life cycle

D. Increase the product's cost to sustain the end of life management

5. How do LCA and LCC complement each other in sustainability assessment?

A. LCA analyses costs only through the production phase

B. LCC evaluates costs across the life cycle

C. LCC is only suitable for services, not products

D. LCA evaluates environmental impacts

6. Which of the following statements is inconsistent with circular economy principles in packaging?

A. Using easily separable materials

B. Designing re-usable multilayer packaging for guarantee durability and reuse

C. Implementing reuse systems

D. Minimizing the number of different materials used

7. According to the document, why is the packaging sector central to applying CE and LCT?

A. Because it is a very environmentally persistent material

B. Because packaging is short-lived, high-volume, and highly impactful

C. Because it is relatively easy to recycle plastic packaging

D. Because we have to prevent the exhaustion of raw materials

8. Which EU tool institutionalizes the use of LCA to evaluate product sustainability?

A. Product Environmental Footprint (PEF)

B. European Green Deal

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C. Agenda 2030 and SDGs

D. UNI EN ISO 14044

9. What is the main advantage of using mono-material plastic over multilayer solutions?

A. It is more scratch-resistant

B. It increases recyclability in sorting plants

C. It is easier for consumer for a correct disposal

D. It removes the need for labeling

10. According to the document, which strategy offers the greatest GHG emission reduction in the plastics sector, based on LCT modeling?

A. Adoption of bioplastics

B. Use of exclusively compostable materials

C. Reduction and elimination of plastics through reuse

D. Diversify some parts of the product in non-plastic material

Answer Key of Questionnaire Proposal

61. **D**

62. **C**

63. **D**

64. **A**

65. **B**

66. **B**

67. **B**

68. **A**

69. **B**

70. **C**

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How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the collection and recovery of plastic materials in the context of the circular economy.
- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

True & False activity

Instructions: Determine whether each statement (1-10) is true or false.

Statements proposal

1. Plastic in packaging is a top priority for circular economy strategies due to its high quality performance.
2. LCT is the foundation for evaluating alternatives in packaging ecodesign projects.
3. According to LCT, reducing and reusing plastic has a lower climate impact than recycling.
4. The LCT approach highlights that packaging design affects the entire collection, sorting, and recycling system.
5. Adopting post-consumer recycled (PCR) content can significantly reduce the carbon footprint of plastic packaging.
6. Extended Producer Responsibility (EPR) extends up to the sales and distribution stage of the product.
7. LCT allows for evaluating the environmental implications of using multi-layer packaging materials.
8. According to LCT, using mono-material plastic in packaging facilitates recycling and improves environmental performance.
9. LCT allows comparison of alternative packaging solutions only in terms of climate impact, not in terms of overall environmental impact.

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10. According to LCT, packaging eco-design must also consider compatibility with existing collection and recycling infrastructures.

Answer Key of True & False activity

1. False
2. True
3. True
4. True
5. True
6. False
7. True
8. True
9. False
10. True

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the collection and recovery of plastic materials in the context of the circular economy.
- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

3.2 Exam questions for Lesson 3.2.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson "*Collect and recovery of plastic packaging materials*". Take your time, think critically, and see how much you've learned. The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).

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- **Part II** features true or false statements (11–20).

Instructions: Choose the best answer for each question.

Questionnaire Proposal

1. What specific fiscal advantage does the door-to-door collection system offer to local authorities?

A. Elimination of non-recyclable materials
B. Easier implementation of pay-as-you-throw systems
C. Reduction in the number of waste collection staff
D. Reduction in waste production

2. What is a key limitation of conventional street container systems regarding waste separation?

A. High reliance on RFID technology
B. Inflexibility during tourist seasons
C. Limited control over waste sorting accuracy
D. Tendency to not reduce the waste production

3. In the plastic sorting plants, what type of sequence is most found?

A. Bag tearing, bulky objects removal, optical detectors, sieving, manual control, ballistic separation
B. Ballistic separation, manual control, sieving, bag tearing, bulky objects removal, optical detectors
C. Optical detectors, sieving, bulky objects removal, manual control, bag tearing, ballistic separation
D. Bulky objects removal, bag tearing, sieving, ballistic separation, optical detectors, manual control

4. What is the main factor affecting the sustainability of pneumatic waste collection systems?

A. The system requires high amount of electric energy
B. The type of fraction of waste that are collected
C. The source of energy powering the system
D. The number of collection vehicles used

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5. What characterizes "plasmix" in plastic sorting plants?

A. High recyclability due to pure polymer content
B. Residual fraction unsuitable for separation into pure polymers
C. Transparent HDPE used in food packaging
D. High level of impurity

6. Which legislative tool has proven effective in increasing recycling rates for beverage containers?

A. Deposit refund programs (DRPs)
B. Pay-as-you-throw regulations
C. Color-coded labelling
D. Door-to-door education

7. What is a disadvantage of static pneumatic waste systems in older urban areas?

A. Overproduction of waste
B. Need for extensive underground infrastructure
C. High initial economic investments
D. Traffic generation from waste collection vehicles

8. Why is it recommended to avoid multilayer packaging unless necessary?

A. It decreases product visibility
B. It limits the density of polymers
C. It complicates separation and recycling
D. It encourages spontaneous separation of components

9. In sorting plants how the main separation between the main types of polymers is carried out?

A. Using near-infrared (NIR) scanning and air jets
B. By visual inspection from operators
C. By measuring weight and density
D. Through the application of manual tags

10. What communication strategy proved most effective in encouraging waste separation among households?

A. Distribution of printed leaflets
B. Public meetings involving local authorities

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C. Mass media advertisements
D. Home advisor programs with door-to-door engagement

Answer Key of Questionnaire Proposal

71. **A**
72. **C**
73. **D**
74. **C**
75. **B**
76. **A**
77. **B**
78. **C**
79. **A**
80. **D**

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the collection and recovery of plastic materials in the context of the circular economy.
- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

True & False activity

Instructions: Determine whether each statement (1-10) is true or false.

Questionnaire Proposal

1. Plastic waste sorting is always done manually to ensure material purity.

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2. Ballistic separation is used to distinguish between heavy and light objects.
3. Clear, coloured, and opaque PET are separated thanks to scanners' ability to read the visible spectrum.
4. LDPE is usually found in the coarse fraction during the screening process.
5. Plasmix is a mixture of plastics that cannot be economically separated into pure polymers.
6. The sorted product outputs also include impurities like glass and paper.
7. Colour sorting of PET is not possible with NIR technology.
8. Polymer sorting via optical reading can be integrated with compressed air jets to divert identified materials.
9. Manual sorting is eliminated in modern plants thanks to automation.
10. Airflow separation uses material density to distinguish plastics from metals.

Answer Key of True & False activity

1. False
2. False
3. True
4. True
5. True
6. True
7. False
8. True
9. False
10. False

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the collection and recovery of plastic materials in the context of the circular economy.

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- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

3.3 Exam questions for Lesson 3.3.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson "*From waste to recycling plant – Turning plastic waste into resources*". Take your time, think critically, and see how much you've learned.

Instructions: Choose the best answer for each question.

Questionnaire Proposal

1. What is the global percentage of plastic that was recycled in 2023?

A. 25%
B. 9%
C. 15%
D. 41.7%

2. What does "downcycling" mean in the context of plastic recycling?

A. Chemical recycling that produces new monomers
B. Incinerating plastic waste to generate energy
C. Recycling that results in lower-quality materials than the original
D. Production of "PLASMIX"

3. What is one of the major barriers to the widespread use of high-quality recycled plastic?

A. Competitive price of virgin plastic
B. Lack of demand in the production sector
C. Lack of adequate technologies
D. Strict food industry regulations

4. Which of the following is a feature of chemical recycling compared to mechanical recycling?

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A. Requires high-quality input materials
B. Produces low-quality materials
C. Easily decentralized
D. Can generate food-grade plastics

5. What is achieved through flotation separation in mechanical recycling?

A. Cleaning the material from residues
B. Separation of metals from polymers
C. Sorting polymers based on their density
D. Material identification via spectroscopy

6. Which sector in Europe has the highest content of recycled plastic in its products?

A. Automotive
B. Agriculture and gardening
C. Food packaging
D. Textiles

7. What is a major disadvantage of mechanical recycling compared to other methods?

A. It is more expensive than chemical recycling
B. It cannot be used for mono-material plastic
C. It produces more CO_2 than chemical recycling
D. It causes a progressive loss in material quality

8. Which recycling process is based on dissolving plastics in solvents without altering their chemical structure?

A. Physical recycling
B. Mechanical recycling
C. Chemical recycling
D. Waste-to-energy

9. Which of the following technologies is used in chemical recycling to obtain monomers from plastic polymers?

A. Depolymerisation
B. Gasification

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C. Pyrolysis
D. Microfiltration

10. What distinguishes plastic bio-upcycling from traditional recycling?

A. It uses only thermal processes to break down plastics
B. It regenerates plastics with the same structure and quality
C. It converts plastic waste into entirely new high-value molecules
D. It involves shredding and melting plastic waste

Answer Key of Questionnaire Proposal

81. **B**
82. **C**
83. **A**
84. **D**
85. **C**
86. **B**
87. **D**
88. **A**
89. **A**
90. **C**

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the concepts regarding the steps “from waste to recycling plant – turning plastic waste into resources" in the context of the circular economy.
- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

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3.4 Exam questions for Lesson 3.4.

Quiz Activity

This activity is designed to help you review and reflect on key concepts from the lesson "*Plastic and energy recovery at high temperature*". Take your time, think critically, and see how much you've learned. The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).
- **Part II** features true or false statements (11–20).

Instructions: Choose the best answer for each question.

Questionnaire Proposal

1. What is the main advantage of pyrolysis over gasification in plastic waste management?

A. It produces higher amounts of electricity per ton of waste

B. It requires no pre-treatment of input waste

C. It preserves more of the chemical energy and enables recovery of monomers

D. It emits significantly less CO_2 because the syngas output is limited

2. Why is polyethylene (PE) preferred over PVC in pyrolysis processes?

A. PE has a lower melting point

B. It is only the combination of PE and PVC that produces contaminated products

C. PE leads to higher-quality pyrolysis products and less toxic residue

D. PVC enhances chlorine content in syngas

3. Which product is not typically derived from gasification of plastic waste?

A. TACOIL® for use in virgin-grade packaging

B. Syngas for methanol synthesis

C. Hydrogen after purification

D. Liquid fuels via Fischer–Tropsch

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4. What is a key regulatory challenge in the use of SRF (Solid Recovered Fuel) in Europe?

A. Its calorific value is too low for industrial applications

B. Lack of harmonized End-of-Waste criteria across EU countries

C. It cannot be used in high-temperature furnaces

D. Establish criteria on impurity levels

5. Which of the following is a major environmental concern related to incineration of mixed plastic waste?

A. It is not possible to guarantee environmental balance in terms of CO_2 emissions

B. Emissions of dioxins, furans, and heavy metals

C. Slow processing speed

D. The combustion of mixed plastic waste needs a higher amount of external energy

6. What is a major technical challenge in converting pyrolysis oil into new plastics?

A. The need for extensive purification due to contaminants like chlorine and heavy metals

B. Its low calorific value prevents use as feedstock

C. It is not ready for direct use in steam cracking units

D. The inability to blend it with fossil-derived monomers

7. Which of the following statements about pyrolysis is false?

A. It is carried out in the absence of oxygen

B. It can produce syngas, oil, and char

C. Its output depends heavily on input material and process conditions

D. It produces pyrolysis oil that is ready to be converted in new feedstock

8. According to LCA-based comparisons, what is the CO_2-equivalent emission difference between pyrolysis and incineration per ton of mixed plastic waste?

A. They are roughly equal

B. Pyrolysis emits about 50% less CO_2eq than incineration

C. Incineration emits 90% less due to full oxidation

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D. Pyrolysis emissions are higher due to oil upgrading

9. Which is the main difference between the gasification and pyrolysis processes?

A. The operating temperature

B. The requirement specification of input material

C. The composition of the output products

D. The quality of the output products

10. What is a key economic advantage of producing SRF from plastic waste?

A. SRF can be exported in all EU countries

B. SRF requires no quality control or certification because it is not classified as EoW

C. SRF from plastic waste has higher LHV than SRF from other residual waste

D. SRF has a market value if it is classified as EoW

Answer Key of Questionnaire Proposal

91. **C**
92. **C**
93. **A**
94. **B**
95. **B**
96. **A**
97. **D**
98. **B**
99. **C**
100. **D**

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the collection and recovery of plastic materials in the context of the circular economy.

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- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

True & False activity

Instructions: Determine whether each statement (1-10) is true or false

Statements proposal

1. Solid Recovered Fuel (SRF) can also be produced from hazardous waste, provided it undergoes advanced treatment.
2. The Lower Heating Value (LHV) is commonly used to assess the energy efficiency of SRF-based facilities.
2. Polymers like PE (polyethylene) and PP (polypropylene) are discouraged for SRF production due to their low calorific value.
4. Directive 2008/98/EC considers energy recovery via SRF as a form of disposal rather than recovery.
5. There is currently no harmonized European regulation defining End-of-Waste (EoW) status for SRF.
6. Including plastic in SRF may pose environmental risks, but it does not enhance the fuel's energy value.
7. Using SRF in cement production has shown a reduction in fossil fuel consumption.
8. The presence of PVC in SRF does not affect fuel quality or emissions.
9. The production cost of plastic-based SRF ranges under €100 per ton.
10. The demand for plastic SRF in Europe is influenced by fossil fuel prices and decarbonization policies.

Answer Key of True & False activity

1. False

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2. True
3. False
4. False
5. True
6. False
7. True
8. False
9. True
10. True

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the collection and recovery of plastic materials in the context of the circular economy.
- **5–7 correct:** Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions
- **Less than 5 correct**: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

4. Module 4 - Innovation in the Plastic World

4.1 Exam questions for Lesson 4.1.

Quiz Activity - Plastics have revolutionized modern life—but their environmental impact has sparked a global search for smarter, more sustainable alternatives. In this quiz, you'll explore the exciting world of innovative materials that are reshaping industries, reducing waste, and driving the transition toward a circular economy.

From bioplastics and compostable polymers to natural fiber composites and recycled innovations, test your knowledge on the latest breakthroughs and discover how science and design are working together to replace traditional plastics.

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Instructions: Choose the best answer for each question.

Questionnaire proposal

First proposal

Multiple Choice (1–10)

Choose the correct answer.

1. **Which of the following is a biodegradable alternative to traditional plastic?**
    - A. Polyethylene
    - B. Polystyrene
    - C. Polylactic Acid (PLA)
    - D. PVC
2. **What is the primary raw material used to produce PLA?**
    - A. Crude oil
    - B. Corn starch
    - C. Natural gas
    - D. Limestone
3. **Which of these materials is derived from fungi and used as a packaging substitute?**
    - A. Mycelium
    - B. Cellulose
    - C. Chitosan
    - D. Alginate
4. **What does the term "circular economy" emphasize?**
    - A. Linear production and disposal
    - B. Recycling and reuse
    - C. Increased fossil fuel use
    - D. Exporting waste

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5. **Which of the following is not a plant-based plastic alternative?**
    - A. PLA
    - B. PHA
    - C. PET
    - D. Starch-based polymers
6. **Which innovation uses seaweed to create edible packaging?**
    - A. Notpla
    - B. Ecovative
    - C. Biopak
    - D. Terracycle
7. **What is the main environmental benefit of bioplastics?**
    - A. They are cheaper to produce
    - B. They are stronger than plastic
    - C. They reduce reliance on fossil fuels
    - D. They are waterproof
8. **Which of the following is a key challenge of bioplastics?**
    - A. They are non-renewable
    - B. They are not compostable
    - C. They may require industrial composting
    - D. They are made from petroleum
9. **Which company is known for developing mushroom-based packaging?**
    - A. Notpla
    - B. Ecovative
    - C. Loop
    - D. Biome
10. **What is the goal of extended producer responsibility (EPR)?**
    - A. To reduce consumer waste

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- B. To make producers responsible for the entire lifecycle of their products
- C. To ban plastic bags
- D. To increase landfill capacity

True or False (11–20)

11. PLA can decompose in a home compost bin.
12. Biodegradable plastics always break down in the ocean.
13. Mycelium packaging is water-resistant and flame-retardant.
14. The circular economy promotes single-use products.
15. PHA is produced by bacterial fermentation.
16. Seaweed-based packaging is edible.
17. All bioplastics are compostable in natural environments.
18. Recycling is a key principle of the circular economy.
19. Bioplastics are always more sustainable than traditional plastics.
20. Industrial composting facilities are required for some bioplastics to degrade properly.

Questionnaire proposal (II)

What is the primary advantage of using bioplastics derived from corn starch?

A.They are transparent and suitable for all food packaging.

B.They are cheaper to produce than petroleum-based plastics.

C.They are stronger than traditional plastics.

D.They are biodegradable and come from a renewable source.

Which of the following is a key challenge in the widespread adoption of mushroom-based materials (mycelium)?

A.Their production is very fast.

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B.Controlling the growth and ensuring consistency of the material.

C.They are not water-resistant.

D.They are not biodegradable.

What is Polyhydroxyalkanoate (PHA)?

A.A bioplastic produced by microorganisms.

B.A composite material made of wood and plastic.

C.A type of recycled plastic.

D.A synthetic plastic made from petroleum.

What is the main component of liquid wood?

A.Hemp fibers

B.Starch

C.Lignin

D.Cellulose

Which of these is a benefit of using bamboo as a substitute for plastic?

A.It is a slow-growing plant, which ensures high quality.

B.It requires a lot of pesticides and fertilizers.

C.It is a highly renewable resource due to its fast growth.

D.It is not very strong or durable.

What does 'compostable' mean in the context of bioplastics?

A.It will break down in any environment.

B.It is the same as biodegradable.

C.It can be recycled with traditional plastics.

D.It will break down in an industrial composting facility.

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What is a significant drawback of seaweed-based plastics?

A.They are often soluble in water.

B.They can be very brittle.

C.They are not edible.

D.Their production harms marine ecosystems.

What are 'drop-in' bioplastics?

A.Bioplastics that can be used with existing machinery for producing conventional plastics.

B.Bioplastics that are designed to be dropped into the ocean to biodegrade.

C.A type of bioplastic that is soft and flexible.

D.Bioplastics that are still in the experimental phase.

Which statement is true about the circular economy for plastics?

A.It only focuses on recycling plastics at the end of their life.

B.It aims to keep materials in use for as long as possible, at their highest value.

C.It promotes the use of single-use plastics.

D.It is a system that has been fully achieved globally.

10/10

What is a potential issue with PLA (Polylactic Acid) disposal?

A.It releases methane when it biodegrades.

B.It is toxic to the soil once it breaks down.

C.It cannot be distinguished from PET plastic, complicating recycling.

D.It requires industrial composting facilities to break down and will not biodegrade in a typical home compost or in nature.

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Answer Key

Answer key of first questionnaire proposal

Multiple Choice:

1. C
2. B
3. A
4. B
5. C
6. A
7. C
8. C
9. B
10. B

True or False:

41. ✗ False
42. ✗ False
43. ☑ True
44. ✗ False
45. ☑ True
46. ☑ True
47. ✗ False
48. ☑ True
49. ✗ False
50. ☑ True

Answer key of second questionnaire proposal

1d,

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2b,

3a,

4c,

5c,

6d,

7a,

8a,

9b,

10d

How did you do?

- 8-10 correct: Excellent! You have a strong understanding of plastic materials and manufacturing technologies in the context of the circular economy.
- 5-7 correct: Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions.
- Less than 5 correct: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

4.2 Exam questions for Lesson 4.2.

Quiz Activity - As global industries confront the dual pressures of environmental degradation and resource scarcity, clean technologies and eco-solutions have emerged as critical enablers of sustainable transformation. In sectors such as plastics manufacturing and recycling—where material waste, energy intensity, and pollution have long been central concerns—innovative process redesigns are essential to achieving a circular economy.

Clean technologies refer to processes, products, and services that reduce negative environmental impacts through significant improvements in energy efficiency, resource conservation, and emission reduction. Eco-solutions go a step further by integrating

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holistic design thinking that aligns economic performance with ecological integrity, often leveraging renewable inputs, closed-loop systems, and green chemistry.

In the context of plastics, these technologies span bio-based polymer synthesis, advanced mechanical and chemical recycling, zero-waste manufacturing, and digitally optimized supply chains. Each represents a shift from linear, extractive systems to regenerative, circular models where materials are continually cycled at their highest value.

Instructions: Choose the best answer for each question.

Frist questionnaire proposal

First proposal

Multiple Choice – Choose the Correct Answer

1 What is the primary goal of clean technologies in plastic production?

a) Reduce product cost

b) Improve aesthetics

c) Minimize environmental impact

d) Increase production speed

2 Which of the following is a clean technology for recycling plastics?

a) Incineration

b) Mechanical recycling

c) Landfilling

d) Pyrolysis without emission control

3 Which process converts plastic waste into fuels or chemicals using heat in the absence of oxygen?

a) Composting

b) Mechanical shredding

c) Pyrolysis

d) Oxidation

4 Eco-design in plastic manufacturing emphasizes:

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a) Short product lifespans

b) Use of complex multi-layered materials

c) Recyclability and material efficiency

d) Maximizing raw material usage

5 Which of the following is NOT an eco-solution in plastics?

a) Bio-based polymers

b) Closed-loop recycling

c) Single-use plastics

d) Renewable energy usage in production

6 What does LCA (Life Cycle Assessment) measure?

a) Product shelf life

b) Energy cost

c) Environmental impacts throughout a product's life

d) Material strength

7 Which clean technology reduces water usage in plastic processing?

a) Injection molding

b) Closed-loop water systems

c) Extrusion blow molding

d) High-pressure washing

8 Chemical recycling differs from mechanical recycling by:

a) Shredding plastics

b) Using heat and chemicals to break down polymers

c) Reducing carbon emissions

d) Cleaning plastic surfaces only

9 Which of the following polymers is considered compostable under industrial conditions?

a) PVC

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b) PET

c) PLA

d) PS

10 What is the primary benefit of using renewable energy in plastic production?

a) Faster production

b) Reduced labor cost

c) Lower carbon footprint

d) Improved transparency

11 Biodegradable plastics break down under:

a) UV light only

b) Specific environmental conditions

c) Any condition

d) Vacuum-sealed environments

12 Circular economy in plastics aims to:

a) Eliminate recycling

b) Keep materials in use for as long as possible

c) Promote linear resource extraction

d) Encourage waste incineration

13 An example of eco-solution in plastic packaging is:

a) Multilayer foil

b) Non-recyclable composite materials

c) Monomaterial film

d) Laminated plastic with aluminum

14 What role do additives play in clean technology solutions?

a) Increase shelf life only

b) Improve color vibrancy

c) Enhance recyclability or biodegradability

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d) Make plastic denser

15 Which strategy helps reduce plastic waste during the manufacturing process?

a) Overproduction

b) Lean manufacturing

c) Maximizing resin variety

d) Cross-contamination

16 Which of the following is a barrier to implementing clean technologies in plastics?

a) Increased consumer awareness

b) Lack of investment and regulation

c) Market demand for sustainable products

d) Technological innovation

17 Which term refers to a product's ability to be repaired, reused, or recycled?

a) Modularity

b) End-of-life responsibility

c) Circularity

d) Linear design

18 Design for Disassembly is an eco-design approach that:

a) Avoids using adhesives or mixed materials

b) Encourages long-lasting bonding

c) Increases product rigidity

d) Uses complex joining techniques

19 Which technology helps trace plastics for better recycling?

a) Incineration sensors

b) Smart labeling (e.g., digital watermarks, QR codes)

c) Color blending

d) X-ray curing

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20 In clean production processes, VOC emissions can be reduced by:

a) Increasing processing temperatures

b) Using water-based adhesives and solvents

c) Using more plasticizers

d) Adding fillers

Second questionnaire proposal (II)

1. What is the main objective of clean technologies?

A) Increase production speed

B) Reduce environmental impact

C) Maximize profit

D) Use more raw materials

2. Which of the following is a clean technology in plastic waste management?

A) Open burning

B) Landfilling

C) Mechanical recycling

D) Exporting waste

3. What does the term "eco-solution" refer to in industrial processes?

A) A marketing strategy

B) A cost-cutting measure

C) A solution that reduces environmental harm

D) A type of plastic

4. Which of the following is a key principle of the circular economy?

A) Linear production

B) Single-use design

C) Waste elimination

D) Planned obsolescence

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5. What is the purpose of Life Cycle Assessment (LCA)?

A) To measure product popularity

B) To assess environmental impacts across a product's life

C) To calculate production costs

D) To determine shelf life

6. Which plastic recycling method breaks down polymers into monomers?

A) Mechanical recycling

B) Incineration

C) Chemical recycling

D) Composting

7. What is a major benefit of using biodegradable plastics?

A) Lower cost

B) Higher strength

C) Reduced environmental persistence

D) Easier coloring

8. What is a digital product passport used for?

A) International shipping

B) Tracking plastic origin and recycling

C) Marketing campaigns

D) Customs clearance

9. Which of the following is an example of an eco-design strategy?

A) Designing for single use

B) Using mixed materials

C) Designing for disassembly

D) Adding decorative coatings

10. What is Extended Producer Responsibility (EPR)?

A) A tax on plastic

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B) A recycling method

C) A policy that holds producers accountable for post-consumer waste

D) A packaging label

11. Which of the following is a renewable feedstock for plastic production?

A) Crude oil

B) Natural gas

C) Corn starch

D) Coal

12. What is the main environmental concern with traditional plastic production?

A) High labor cost

B) Water usage

C) Greenhouse gas emissions

D) Noise pollution

13. What is meant by "closed-loop recycling"?

A) Recycling into a different product

B) Recycling into energy

C) Recycling back into the same product

D) Recycling with no sorting

14. Which clean technology reduces water usage in plastic processing?

A) Waterless dyeing

B) Water recirculation systems

C) Steam injection

D) High-pressure washing

15. What is the role of enzymes in eco-friendly plastic degradation?

A) Strengthen plastic

B) Color plastic

C) Break down polymers

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D) Prevent recycling

16. Which of the following is a clean energy source for plastic manufacturing?

A) Diesel

B) Coal

C) Solar power

D) Natural gas

17. What is the main advantage of using bio-based plastics?

A) Lower melting point

B) Derived from renewable resources

C) Higher density

D) Easier molding

18. What is the function of a material recovery facility (MRF)?

A) Incinerate waste

B) Sort and prepare recyclables

C) Manufacture new plastics

D) Store hazardous waste

19. Which of the following is a barrier to plastic recycling?

A) High demand

B) Color uniformity

C) Material contamination

D) Lightweight design

20. What is the goal of zero-waste manufacturing?

A) Reduce labor

B) Eliminate all emissions

C) Eliminate landfill waste

D) Increase production speed

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Third questionnaire proposal (III)

Multiple Choice – Select the Correct Answer

1. What defines a clean technology in plastic production?

a) Higher production speed

b) Minimal workforce involvement

c) Reduced environmental impact

d) Enhanced plastic flexibility

2. Which of the following is considered a clean technology recycling method?

a) Landfilling

b) Pyrolysis with emission control

c) Open-air burning

d) Incineration without energy recovery

3. What is the key principle behind eco-design?

a) Maximize complexity

b) Optimize recyclability and environmental performance

c) Use rare additives

d) Design for single-use

4. Which process breaks plastics down into monomers?

a) Injection molding

b) Mechanical recycling

c) Chemical recycling

d) Sintering

5. Which of the following is a circular economy strategy for plastics?

a) Planned obsolescence

b) Virgin resin dependence

c) Design for reuse and recycling

d) Mixed material packaging

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6. What type of plastic is often industrially compostable?

a) PET

b) HDPE

c) PLA

d) PVC

7. Eco-solutions in plastic packaging include:

a) Complex multi-layer film

b) Aluminum-plastic laminates

c) Monomaterial flexible packaging

d) Glitter-infused plastics

8. What does "Design for Disassembly" promote?

a) High adhesive bonding

b) Mixed material joints

c) Simplified material separation

d) Fast assembly lines

9. Which of the following reduces carbon footprint in plastic production?

a) Fossil-based feedstock

b) Use of renewable energy sources

c) Extended curing times

d) Overheating polymers

10. Why is closed-loop recycling preferred?

a) It downgrades plastic quality

b) It sends plastics to incineration

c) It keeps materials in a continuous cycle

d) It mixes different resin types

11. What makes bio-based plastics "clean"?

a) Low cost

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b) Derived from renewable resources

c) High opacity

d) Derived from petrochemicals

12. VOC emissions in plastics production can be reduced by using:

a) Solvent-based adhesives

b) Additives with phthalates

c) Water-based processing agents

d) Long curing ovens

13. What is a common clean innovation in injection molding?

a) Overmolding PVC

b) Using recycled polymer blends

c) Adding lead-based pigments

d) Maximizing energy load

14. What is a key enabler of traceability in eco-design?

a) Deep embossing

b) RFID and digital watermarks

c) Opaque coloring

d) Metallic labels

15. Which technology is used to recover plastics without combustion?

a) Plasma burning

b) Solvolysis

c) Flash pyrolysis

d) Autoclaving

16. What is a benefit of modular product design in plastics?

a) Harder to repair

b) Easy disassembly for recycling

c) Promotes use of mixed polymers

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d) Encourages incineration

17. Lean manufacturing contributes to clean technologies by:

a) Eliminating energy-efficient equipment

b) Reducing waste and improving efficiency

c) Increasing raw material use

d) Encouraging overproduction

18. In the context of eco-solutions, what does "upcycling" refer to?

a) Using trash as fuel

b) Creating products of higher value from waste

c) Melting plastic for energy

d) Mixing polymers for easier molding

19. What is a drawback of multilayer plastic films in eco-design?

a) Improved durability

b) Limited printing space

c) Difficult to recycle

d) Too flexible

20. The term "zero discharge" in clean technologies refers to:

a) Complete disposal of wastewater

b) Elimination of solid waste

c) No release of pollutants to the environment

d) Non-stop production lines

Answer Key

Answer key of first questionnaire proposal

Multiple Choice:

1. C
2. B

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3. C
4. C
5. C
6. C
7. B
8. B
9. C
10. B
11. B
12. C
13. C
14. B
15. B
16. C
17. A
18. B
19. B
20. C

Answer key of second questionnaire proposal

1b,

2c,

3c,

4c,

5b,

6c,

7c,

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8b,

9c,

10c

11c

12c

13c

14b

15c

16c

17b

18b

19c

20c

Answer key of third questionnaire proposal

1c

2b

3b

4c

5c

6c

7c

8c

9b

10c

11b

12c

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13b

14b

15b

16b

17b

18b

19c

20c

How did you do?

- 8-10 correct: Excellent! You have a strong understanding of plastic materials and manufacturing technologies in the context of the circular economy.
- 5-7 correct: Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions.
- Less than 5 correct: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

4.3 Exam questions for Lesson 4.3.

Quiz Activity - In response to growing environmental challenges and the urgent need to transition toward sustainable development, eco-solutions and clean technologies have emerged as key enablers of a low-impact, circular economy. These solutions aim to reduce the environmental footprint of industrial and manufacturing activities while promoting resource efficiency, waste reduction, and innovation.

In the field of plastics, the shift from a linear "take-make-dispose" model to a circular model—where materials are reused, recycled, or safely biodegraded—has become a critical priority. The implementation of clean technologies within plastic production, processing, and recovery systems supports this transformation by minimizing energy consumption, emissions, and virgin resource extraction. Best practices in clean technological processes encompass:

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- Eco-design: Creating products and packaging with their entire life cycle in mind, enabling easier reuse, repair, and recycling.
- Energy efficiency: Integrating low-energy technologies such as variable-speed drives, efficient motors, and renewable energy sources.
- Material innovation: Using bio-based, recycled, or mono-materials to improve sustainability and recyclability.
- Advanced recycling techniques: Leveraging mechanical, chemical, and biological recycling to recover plastics in high quality, reducing landfill use and fossil fuel dependency.
- Waste minimization: Implementing closed-loop systems and process optimization to reduce production waste and water usage.
- Lifecycle thinking and LCA: Assessing and improving the environmental impact of technologies across the product life cycle.

These practices not only contribute to regulatory compliance and brand reputation but also deliver economic value through cost savings, innovation opportunities, and enhanced market competitiveness. In essence, clean technologies and eco-solutions represent the bridge between industrial productivity and ecological responsibility—a cornerstone for a truly sustainable future.

Instructions: Choose the best answer for each question.

First questionnaire proposal

Multiple Choice – Choose the Correct Answer

1. What is the primary goal of the circular economy?

A) Increase single-use plastics

B) Eliminate waste and keep materials in use

C) Maximize landfilling

D) Encourage resource extraction

2. Which of the following is a mechanical recycling process?

A) Shredding and remolding of plastics

B) Pyrolysis

C) Depolymerization

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D) Gasification

3. What is the main limitation of mechanical recycling?

A) High energy demand

B) Material downcycling and contamination

C) Requires complex catalysts

D) Produces hazardous waste

4. What does pyrolysis do in the context of plastic recycling?

A) Converts plastics into compost

B) Physically remolds plastics

C) Thermally breaks down plastics into oils and gases

D) Combines plastics into biopolymers

5. Which of the following is an advantage of chemical recycling?

A) Requires less sorting

B) Can process contaminated or mixed plastic waste

C) Only works with PET

D) Produces direct food-grade products

6. PLA is a type of bioplastic derived from:

A) Petroleum

B) Algae

C) Fermented plant starch (e.g., corn)

D) CO_2 gas

7. Which term refers to designing products to be easily reused or recycled?

A) Smart packaging

B) Eco-design

C) Modular marketing

D) Extended aging

8. What is a Digital Product Passport?

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A) A certification for biodegradable plastics

B) A system that tracks product lifecycle information

C) A trade license for plastic producers

D) A carbon offset policy

9. Which standard supports environmental management in eco-design?

A) ISO 14006

B) ISO 9001

C) ASTM D6400

D) EN 13432

10. What role does AI play in plastic recycling facilities?

A) Increasing landfill capacity

B) Banning certain polymers

C) Enhancing sorting accuracy and speed

D) Packaging inspection only

11. Which of the following is a biodegradable plastic?

A) PVC

B) PHA

C) PS

D) HDPE

12. What type of recycling process returns plastics to monomers?

A) Depolymerization

B) Thermal extrusion

C) Blending

D) Photodegradation

13. What does "design for disassembly" support?

A) Easier repair and recycling of products

B) Lower production speed

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C) High material toxicity

D) Automatic incineration

14. Which policy tool incentivizes producers to manage end-of-life of products?

A) Extended Producer Responsibility (EPR)

B) Plastic tax

C) Eco-labeling

D) Carbon trading

15. Which additive manufacturing technique promotes local circular economies?

A) Thermoforming

B) Injection molding

C) 3D printing with recycled filaments

D) Blow molding

16. A key challenge in scaling chemical recycling is:

A) Market demand

B) Color of plastics

C) High cost and energy intensity

D) Excess bioplastics

17. Cradle to Cradle certification evaluates:

A) Financial sustainability

B) Product circularity and material health

C) Tax compliance

D) Labor conditions only

18. What is the main advantage of biodegradable plastics in agriculture?

A) Higher durability

B) Reduce soil pollution from plastic mulch

C) Lower labor needs

D) Unlimited reuse

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19. What is "closed-loop recycling"?

A) Recycling where material returns to same product type

B) Recycling across unrelated industries

C) Linear production process

D) Energy-from-waste system

20. What principle does green chemistry promote?

A) Use of expensive catalysts

B) Creation of persistent materials

C) Design of products to reduce or eliminate hazardous substances

D) Delayed biodegradation

Second questionnaire proposal (II)

1. What is the main objective of clean technologies in plastic production?

A. Increase plastic durability

B. Reduce environmental impact

C. Lower production costs

D. Improve color quality

2. Which of the following is a key feature of a circular economy?

A. Linear production and disposal

B. Planned obsolescence

C. Waste elimination and resource reuse

D. Exporting waste

3. What does "design for disassembly" mean in product development?

A. Making products harder to recycle

B. Designing products to be easily taken apart for reuse or recycling

C. Using more adhesives

D. Increasing product complexity

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4. What is mechanical recycling?

A. Burning plastic for energy

B. Chemically breaking down plastics

C. Shredding and remolding plastic waste

D. Composting plastic

5. Which plastic type is most commonly recycled globally?

A. PVC

B. PET

C. PS

D. LDPE

6. What is the role of eco-labeling in clean technologies?

A. Marketing strategy only

B. Increases product price

C. Informs consumers about environmental impact

D. Reduces product quality

7. What is the main advantage of biodegradable plastics?

A. They are cheaper

B. They decompose under specific conditions

C. They are stronger

D. They are non-recyclable

8. What is pyrolysis used for in plastic waste management?

A. Composting

B. Converting plastic into fuel

C. Sorting plastic

D. Coloring plastic

9. Which technology is used to sort plastics by polymer type?

A. X-ray

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B. Near-infrared (NIR) spectroscopy

C. UV light

D. Manual sorting

10. What is the purpose of Extended Producer Responsibility (EPR)?

A. Increase plastic imports

B. Shift waste management responsibility to producers

C. Reduce consumer rights

D. Promote incineration

11. What is a major challenge in recycling multi-layer plastic packaging?

A. High cost

B. Color variation

C. Difficulty in separating layers

D. Lack of demand

12. What is a closed-loop recycling system?

A. Recycling within a single country

B. Recycling waste into the same product

C. Exporting waste for recycling

D. Incineration with energy recovery

13. Which clean technology reduces water usage in plastic manufacturing?

A. Dry cooling systems

B. Water jet cutting

C. Closed-loop water systems

D. Steam injection

14. What is the environmental benefit of using bio-based plastics?

A. They are non-degradable

B. They reduce reliance on fossil fuels

C. They are cheaper

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D. They are stronger

15. What is the function of a material recovery facility (MRF)?

A. Landfilling

B. Sorting and preparing recyclables

C. Burning waste

D. Composting

16. Which of the following is a clean technology for reducing emissions in plastic production?

A. Open burning

B. Carbon capture and storage (CCS)

C. Diesel generators

D. Chlorination

17. What is the main goal of life cycle assessment (LCA)?

A. Increase product sales

B. Evaluate environmental impacts of a product

C. Improve aesthetics

D. Reduce labor costs

18. What is the benefit of modular product design in circular economy?

A. Increases complexity

B. Reduces recyclability

C. Facilitates repair and reuse

D. Increases waste

19. What is the role of enzymes in plastic degradation?

A. Strengthen plastic

B. Accelerate decomposition

C. Color plastic

D. Prevent recycling

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20. What is the best practice for reducing plastic pellet loss in manufacturing?

A. Use of open drains

B. Manual sweeping

C. Implementing Operation Clean Sweep protocols

D. Increasing production speed

Third questionnaire proposal (III)

Multiple Choice – Select the Correct Answer

1. What is the main goal of clean technology in manufacturing?

A. Increase production speed

B. Reduce environmental impact

C. Maximize resource extraction

D. Minimize labor costs

2. Which of the following is a principle of circular economy?

A. Linear throughput

B. Planned obsolescence

C. Keep products and materials in use

D. Maximize single-use plastics

3. What does "design for disassembly" aim to achieve?

A. Increase product size

B. Enable easier repair and recycling

C. Improve energy consumption

D. Make products disposable

4. In plastics recycling, what is mechanical recycling?

A. Burning plastic for energy

B. Shredding and melting plastics for reuse

C. Using bacteria to break down plastics

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D. Converting plastic into fuel

5. What is one key benefit of closed-loop recycling?

A. It reduces product lifespan

B. It minimizes virgin material use

C. It increases landfill waste

D. It requires more water

6. Which clean technology is most relevant in treating industrial plastic waste?

A. Reverse osmosis

B. Wind turbines

C. Pyrolysis for plastic-to-fuel conversion

D. Carbon capture

7. What is Life Cycle Assessment (LCA) used for?

A. Determining prices of products

B. Assessing environmental impact across a product's life

C. Predicting consumer behavior

D. Managing supply chains

8. What does "biodegradable plastic" require to break down properly?

A. Dry storage

B. UV light only

C. Specific conditions like heat and microbes

D. Room temperature only

9. What process converts plastic waste back into raw monomers?

A. Fermentation

B. Mechanical shredding

C. Chemical recycling

D. Landfilling

10. What is one major limitation of mechanical recycling?

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A. High carbon emissions

B. Plastic quality degrades after multiple cycles

C. Energy generation is low

D. Too expensive for developing countries

11. What is an example of an eco-design strategy?

A. Over-packaging

B. Modular components

C. Permanent adhesives

D. Mixed-material packaging

12. What role does Extended Producer Responsibility (EPR) play in eco-solutions?

A. Encourages illegal dumping

B. Makes producers responsible for end-of-life products

C. Reduces consumer responsibility

D. Supports fossil fuel usage

13. What material is often used in bio-based plastics?

A. Petroleum

B. Corn starch or sugarcane

C. Coal

D. Glass

14. What is the best practice for plastic packaging sustainability?

A. Use multiple materials

B. Add decorative coatings

C. Use mono-material packaging

D. Make packaging heavier

15. What is one way clean technology reduces energy use in production?

A. Using coal-fired boilers

B. Implementing energy-efficient motors and drives

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C. Using non-recyclable materials

D. Outsourcing waste disposal

16. What is the main environmental benefit of using recycled plastics?

A. Higher product weight

B. Reduction in greenhouse gas emissions

C. Increased landfill waste

D. More expensive logistics

17. In water treatment, which process is a clean technology?

A. Chlorine bleaching

B. Membrane filtration

C. Coal sedimentation

D. Thermal burning

18. What type of clean energy can power eco-friendly manufacturing plants?

A. Diesel generators

B. Solar photovoltaics

C. Lead-acid batteries

D. Kerosene

19. What is one goal of the EU Green Deal regarding plastics?

A. Increase incineration

B. Make all plastic packaging recyclable or reusable by 2030

C. Eliminate bioplastics

D. Ban recycling

20. What is "upcycling" in the context of plastic reuse?

A. Burning for energy

B. Converting plastic to monomers

C. Creating higher-value products from waste

D. Degrading plastic into soil

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Answer Key

Answer key of first questionnaire proposal

Multiple Choice:

11. b
12. a
13. b
14. c
15. b
16. c
17. b
18. b
19. a
20. c
51. b
52. a
53. a
54. a
55. c
56. c
57. b
58. b
59. a
60. c

Answer key of second questionnaire proposal

1b,

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2c,

3b,

4b,

5b,

6c,

7b,

8c,

9c,

10b,

11b,

12b,

13b,

14c,

15b,

16b,

17b,

18b,

19b,

20c.

Answer key of third questionnaire proposal

1b

2c

3b

4c

5b

6c

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7b

8b

9b

10b

11c

12b

13c

14b

15b

16b

17b

18c

19b

20c

How did you do?

- 8-10 correct: Excellent! You have a strong understanding of plastic materials and manufacturing technologies in the context of the circular economy.
- 5-7 correct: Good job! You have a solid grasp of the fundamental concepts. Consider reviewing the areas where you might have missed questions.
- Less than 5 correct: Keep exploring! There's a lot to learn about this fascinating and crucial area. Revisit the reading materials and continue to build your knowledge.

4.4 Exam questions for Lesson 4.4.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson *Mixed Waste Sorting*. You'll explore how conventional mechanical and manual sorting methods are being enhanced—or replaced—by smart systems using

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artificial intelligence, robotics, and sensor fusion to improve sorting speed, accuracy, and purity. The quiz is divided into two parts:

Part I includes multiple-choice questions (1–10).

Part II features true or false statements (11–20).

Take your time, think critically, and test how much you've learned. Good luck!

Instructions: Choose the best answer for each question.

Questionnaire Proposal (I)

Multiple Choice (1–10)

1. Which factor primarily limits the effectiveness of density-based sorting for plastic waste?
   A) Excess moisture
   B) Similar polymer densities
   C) Lack of automation
   D) Energy consumption
2. What is the main advantage of Near-Infrared (NIR) spectroscopy in plastic sorting?
   A) Low energy use
   B) Detection of all black plastics
   C) Fast, non-contact polymer identification
   D) Cost-effective for small plants
3. YOLO v8 is best suited for which type of plastic sorting context?
   A) Offline batch processing
   B) High-precision research labs
   C) Real-time conveyor belt sorting
   D) Manual sorting stations
4. What does a digital twin enable in a plastic sorting plant?
   A) Manual recalibration of robotic arms
   B) Delayed sorting for higher purity
   C) Real-time simulation and optimization
   D) Blockchain-based transactions

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5. Which model provides pixel-level segmentation for accurate plastic identification?
   A) YOLO v8
   B) MobileNet
   C) Mask R-CNN
   D) Inception-v3
6. What sorting challenge is caused by carbon-black pigments in packaging?
   A) Chemical degradation
   B) Misclassification due to invisibility to NIR
   C) Mechanical jamming
   D) Loss of elasticity
7. Which design principle supports successful sorting and recycling?
   A) Multilayer construction with different polymers
   B) Opaque and black packaging
   C) Use of mono-materials and NIR-detectable materials
   D) Application of strong adhesives
8. Which system component is NOT typically found in a “smart” sorting prototype?
   A) RGB or NIR sensors
   B) Servo motors or pneumatic arms
   C) Chemical dissolvers
   D) Edge computing platforms
9. In a digital twin feedback loop, what happens after optimization suggestions are made?
   A) The plant shuts down for recalibration
   B) Material input stops
   C) Process settings are automatically updated
   D) Manual sorting begins
10. Which case study featured a low-cost AI-powered prototype using Jetson Nano and servo bins?
    A) Multi-Sensor System
    B) Smart Bin System
    C) AutoRecycler
    D) Digital Twin Lab

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True or False (11–20)

21. Froth flotation is effective for separating plastics based on surface energy differences.
22. Selective dissolution and precipitation yield low-purity outputs but are fast and cheap.
23. Multilayer and contaminated plastics pose major challenges to all conventional sorting systems.
24. Mask R-CNN is faster but less accurate than YOLO v8.
25. Digital twins allow simulation of sorting performance before changing physical equipment settings.
26. The AutoRecycler prototype was designed for industrial-scale deployment only.
27. Machine learning models in waste sorting require large labeled datasets for training.
28. Packaging with incompatible materials may appear recyclable but fail sorting processes.
29. Life Cycle Assessment (LCA) can help guide better design decisions for recyclability.
30. AI-based sorting systems can adapt over time through feedback loops and retraining.

Questionnaire Proposal (II)

Multiple Choice (1–10)

1. Which sorting method relies on the different buoyancies of plastic types in liquid media?
   A) Eddy current separation
   B) Froth flotation
   C) Manual sorting
   D) Thermal imaging
2. What is a key drawback of conventional NIR systems when identifying plastics?
   A) Too expensive for large-scale use
   B) Inability to detect transparent materials

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C) Poor performance with dark or black plastics
D) Slow scanning speed

3. What feature makes YOLO v8 effective for use in dynamic waste sorting environments?
   A) Thermal stability
   B) High memory consumption
   C) Real-time object detection with high accuracy
   D) Predictive maintenance

4. What is the goal of “design for recyclability” in product manufacturing?
   A) Reduce packaging size
   B) Lower production cost
   C) Ensure packaging can be effectively sorted and recycled
   D) Make packaging water-resistant

5. What is a common function of edge computing devices in AI-powered sorting systems?
   A) Printing labels for sorted items
   B) Sending data to landfill operators
   C) Processing sensor data directly on-site
   D) Storing waste securely

6. Which polymer property can cause sorting systems to confuse PET with PVC?
   A) Their similar melting points
   B) Their nearly identical density
   C) Their high transparency
   D) Their biodegradable nature

7. What does the "feedback loop" in AI-enabled digital twins allow?
   A) Automatic plastic disposal
   B) Simulation of product designs
   C) Continuous adjustment of operations based on sensor data
   D) Physical alteration of packaging

8. What kind of image data does Mask R-CNN process for plastic waste identification?
   A) Audio frequencies
   B) Temperature gradients

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C) Pixel-wise segmented images
D) Holographic projections

9. Why is material compatibility important in packaging design?
   A) It improves shelf life
   B) It reduces consumer confusion
   C) It ensures effective sorting and recycling
   D) It enables better color contrast

10. What was the main objective of the AutoRecycler case study?
    A) To build a mobile recycling app
    B) To demonstrate the use of deep learning in real-time sorting
    C) To create a biodegradable plastic prototype
    D) To test landfill gas emissions

True or False (11–20)

11. Gravity separation is often used to distinguish plastics with different densities.
12. YOLO v8 is a type of real-time object detection algorithm.
13. Smart sorting systems only function in industrial-scale facilities.
14. Digital twins replace the need for physical sensors in sorting systems.
15. Improperly labeled or incompatible packaging can undermine the effectiveness of automated sorting.
16. NIR systems cannot identify multilayer packaging with hidden polymer layers.
17. Deep learning models can become more accurate over time with new training data.
18. Polypropylene and PET are always easily separated using density-based methods.
19. Edge computing helps reduce latency in data processing during real-time waste sorting.
20. The AutoRecycler model showed that cost-effective sorting solutions can be implemented even with small devices like Jetson Nano.

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Answer Key

Answer Key of Questionnaire Proposal (I)

Multiple Choice (1–10):

1. **B**
2. **C**
3. **C**
4. **C**
5. **C**
6. **B**
7. **C**
8. **C**
9. **C**
10. **C**

True or False (11–20):

1. **True**
2. **False**
3. **True**
4. **False**
5. **True**
6. **False**
7. **True**
8. **True**
9. **True**
10. **True**

Answer Key of Questionnaire Proposal (II)

Multiple Choice:

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11. B
12. C
13. C
14. C
15. C
16. B
17. C
18. C
19. C
20. B

True or False:

1. True
2. True
3. False
4. False
5. True
6. True
7. True
8. False
9. True
10. True

How did you do?

- **18–20 correct:** *Mixed Waste Sorting Master* - Outstanding! You have a deep understanding of sorting technologies, waste stream complexities, and the challenges of optimizing recovery in real-world systems. You're well prepared to support innovation and decision-making in the field.

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- **15–17 correct:** *Advanced Learner* - Great job! You clearly grasp key concepts such as sensor-based sorting, contamination issues, and material recovery strategies. A quick review of the missed points will sharpen your technical insights even more**.**
- **12–14 correct:** *Developing Competence* - Good effort! You understand the basics and can identify key sorting challenges, though more practice and review—especially on design-for-recycling and system integration—will help reinforce your knowledge.
- **0–11 correct:** *Beginner Awareness* - No worries—mixed waste sorting is a complex and evolving topic! Revisit the lesson materials, key terms, and case studies. With continued study, you'll build confidence and clarity in navigating the waste management landscape.

5. Module 5 - Awareness of Plastic Waste Impact & Responsible Behavior

5.1 Exam questions for Lesson 5.1.

1. Why is the "take–make–dispose" model incompatible with the objectives of the European Green Deal?

a. It relies on digital technologies and smart production
b. It increases employment in the recycling sector
c. It promotes sustainable material cycles and ecosystem restoration
d. It externalizes environmental costs and relies on fossil fuels

Correct answer: d

2. What does the mindset shift from extraction to regeneration emphasize in the context of engineering education?

a. Maximizing short-term production efficiency
b. Promoting fossil fuel extraction technologies
c. Restoring ecosystems and designing regenerative systems

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d. Encouraging market competition through innovation

Correct Answer: C

3. Which set of GreenComp competencies aligns with anticipatory thinking for long-term sustainability transitions?

a. Valuing sustainability, promoting nature, and supporting fairness
b. Futures literacy, adaptability, and exploratory thinking
c. Systems thinking, critical thinking, and problem framing
d. Political agency, collective action, and individual initiative

Correct Answer: B

4. According to the GreenComp framework, responsibility in engineering implies:

a. Compliance with industry rules without questioning
b. Avoiding collaboration to reduce delays
c. Designing for short-term functionality
d. Proactive and accountable action for social and environmental outcomes

Correct Answer: D

5. Which of the following engineering design choices most directly contributes to a circular system?

a. Designing products for single use to reduce material costs
b. Selecting non-recyclable composite materials for aesthetic purposes
c. Designing for disassembly to enable component reuse
d. Ignoring end-of-life considerations during product development

Correct Answer: C

6. When engineers evaluate material choices based on their recyclability, renewability, and environmental impact, they are demonstrating:

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a. Exploratory thinking unrelated to sustainability
b. A compliance-based design mindset
c. Responsibility and systems thinking in circular design
d. A preference for aesthetics over function

Correct Answer: C

7. Which characteristic best defines systems thinking?

a. Focusing on isolated events
b. Understanding feedback loops and interconnections
c. Optimizing a single process without considering outcomes
d. Applying a strict cause-effect model in a narrow context

Correct Answer: B

8. Which of the following practices reflects a systems thinking approach in engineering?

a. Designing for minimum upfront cost
b. Evaluating environmental impact at the disposal stage only
c. Conducting life cycle assessment of product design
d. Ignoring downstream impacts

Correct Answer: C

9. Which action reflects short-term efficiency thinking?

a. Using recyclable materials
b. Designing for rapid cost recovery without environmental assessment
c. Scenario-based life cycle analysis
d. Planning for material reuse

Correct Answer: B

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10. An engineer who integrates long-term climate impacts into design is applying:
    a. Tactical thinking
    b. Financial forecasting
    c. Anticipatory thinking
    d. Process optimization only

Correct Answer: C

11. Which behavior exemplifies sustainability responsibility?
    a. Choosing single-use plastic for convenience
    b. Ignoring product end-of-life impacts
    c. Designing with ethical and ecological consequences in mind
    d. Delegating all accountability to producers

Correct Answer: C

12. Passive consumption is best described as:
    a. Engaged decision-making on material choices
    b. Awareness of product lifecycle impacts
    c. Accepting environmental externalities without question
    d. Participating in extended producer responsibility schemes

Correct Answer: C

13. Which practice aligns with the mindset of collaboration over competition?
    a. Prioritizing proprietary innovation to dominate the market
    b. Designing products without stakeholder consultation
    c. Co-creating circular solutions with industry and community actors
    d. Withholding sustainability data for competitive advantage

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Correct Answer: C

14. How can Life Cycle Assessment (LCA) support regenerative engineering decisions?

a. By focusing solely on the cost-efficiency of manufacturing
b. By promoting the use of linear supply chains
c. By identifying environmental impacts across all product life stages
d. By accelerating time-to-market for new products

Correct Answer: C

15. Why is the "take–make–dispose" model considered incompatible with climate neutrality objectives?

a. It relies on bio-based raw materials
b. It limits energy use in production
c. It is highly dependent on fossil fuels and generates significant GHG emissions
d. It encourages long product life cycles and reuse

Correct Answer: C

5.2 Exam questions for Lesson 5.2.

1. **In which of the following ways can humans be exposed to microplastics?**
   A) Inhalation, ingestion, dermal contact, and prenatal transfer
   B) Only through drinking bottled water and eating processed foods
   C) Only by wearing synthetic clothing
   D) Mainly through dermal contact with cosmetics and their packaging

Correct answer: A

2. **Which exposure route allows microplastics to deposit in bronchi and alveoli?**
   A) Ingestion
   B) Dermal absorption

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C) Inhalation

D) Prenatal transfer

Correct answer: C

3. **Which plastic, when heated, can release dioxins—a known toxic inhalant?**

A) Polypropylene (PP)

B) Polyvinyl Chloride (PVC)

C) Polyethylene (PE)

D) Polymethyl Methacrylate (PMMA)

Correct answer: B

4. **What is the primary source of microplastics in seafood?**

A) Airborne fiber accumulation

B) Plastic ingestion by marine organisms

C) Textile dyes in ocean runoff

D) Personal care product residues

Correct answer: B

5. **Which chemical is commonly found in polycarbonate and is an endocrine disruptor?**

A) Styrene

B) Acrylonitrile

C) Bisphenol A (BPA)

D) Formaldehyde

Correct answer: C

6. **How can plastic particles reach a developing fetus?**

A) Through the baby's clothing

B) Via placental transfer from the mother

C) By inhaling ambient air

D) Through diaper absorption**Correct answer: B**

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7. **What percentage of primary microplastics in oceans is attributed to textiles?**
   A) 25%
   B) 35%
   C) 50%
   D) 80%

Correct answer: B

8. **Why is fast fashion considered environmentally unsustainable?**
   A) It reduces clothing prices permanently
   B) It supports biodegradable textile use
   C) It promotes long-term garment use
   D) It increases production and waste due to shorter clothing lifespans

Correct answer: D

9. **Which of the following ingredients is most likely a microplastic commonly found in cosmetic products?**

A. Sodium laureth sulfate
B. Polyethylene
C. Tocopheryl acetate
D. Panthenol

Correct answer: B.

10. **What is the main difference between rinse-off and leave-on cosmetic products in terms of microplastic environmental risks?**

A. Leave-on products do not contain any microplastics.
B. Microplastics in rinse-off products enter wastewater and aquatic environments more directly.
C. Microplastics from leave-on products are immediately washed off and captured by wastewater treatment.
D. Rinse-off products are designed to remain on the skin, preventing microplastic release.

Correct answer: B.

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5.3 Exam questions for Lesson 5.3.

1. Which of the following polymers is biodegradable under composting conditions?
    a. Polyethylene (PE)
    b. Polyvinyl chloride (PVC)
    c. Polylactic acid (PLA)
    d. Polystyrene (PS)

Correct answer: c

2. How do microplastics contribute to atmospheric pollution?
    a. By generating greenhouse gases directly
    b. By forming ozone in the stratosphere
    c. Through their presence in airborne particles inhaled by humans
    d. By reducing wind circulation

Correct answer: c

3. What is the ecological effect of microplastics in soils?
    a. Improved microbial diversity
    b. Increased nutrient cycling and water retention
    c. Disruption of soil structure and plant-soil interactions
    d. Accelerated decomposition of organic matter

Correct answer: c

4. What is the common environmental fate of buoyant plastics like PE and PP in aquatic systems?

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a. They dissolve instantly
b. They float and can travel long distances
c. They decompose in sunlight within days
d. They sink immediately to the bottom

Correct answer: b

5. Why is it important to address plastic pollution from a planetary boundaries perspective?
   a. It helps to improve economic growth directly
   b. It supports the stability of Earth's safe operating space
   c. It allows the expansion of industrial activities
   a. It reduces the need for environmental regulations

Correct answer: b

6. Which of the following best describes the trophic transfer of plastic in ecosystems?
   a. Plastics remain only in primary producers and do not move up the food chain
   b. Plastics are fully degraded by digestive enzymes and do not affect predators
   c. Plastic particles and their additives accumulate and biomagnify through food webs
   d. Trophic transfer only occurs in aquatic ecosystems and not in terrestrial ones

Correct answer: c

7. Which strategy promotes the transformation of plastic waste into higher-value products?
   a. Upcycling
   b. Landfilling
   c. Composting
   d. Incineration

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Correct answer: a

8. Which of the following, represent a technological strategy for managing plastic waste in landfills?
    a. Use of open pits without liners
    b. Landfill mining to recover materials
    c. Allowing informal dumping
    d. Avoiding waste segregation

Correct answer: b

9. Which technology uses light-activated catalysts to degrade plastics?
    a. Chemical recycling
    b. Magnetic separation
    c. Waste to energy technologies
    d. Photocatalysis

Correct answer: d

10. What is the primary source of monomers used to produce plastics?
    a. Renewable energy sources
    b. Fossil hydrocarbons
    c. Recycled plastics
    d. Natural fibers

Correct answer: b.

11. Which of the following is NOT a source of plastic pollution?
    a. Agricultural practices
    b. Fishing and maritime activities

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c. Natural biodegradation of plastics

d. Municipal solid waste improper management

Correct answer: c

12. Which polymer is known for being flexible, hydrophobic, and chemically inert?

a. Polyethylene (PE)

b. Polypropylene (PP)

c. Polyvinyl chloride (PVC)

d. Polystyrene (PS)

Correct answer: a

13. How do microplastics typically enter the atmosphere?

a. Through UV radiation breakdown

b. Via abrasion from textiles and tires

c. By chemical reactions in soil

d. Through direct emissions from oceans

Correct answer: b

14. What is a key factor influencing the transport of plastic particles in aquatic systems?

a. The color of the plastic

b. The density of the plastic

c. The temperature of the water

d. The salinity of the water

Correct answer: b

15. Which degradation process involves UV radiation breaking polymer chains?

a. Thermal degradation

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b. Photochemical degradation
c. Hydrolytic degradation
d. Biodegradation

Correct answer: b

16. What is the primary environmental impact of plastic mulch films in agriculture?
    a. They increase soil fertility
    b. They reduce soil porosity and water retention
    c. They enhance microbial biodiversity
    d. They prevent soil erosion

Correct answer: b

17. Which process involves rain or snow capturing airborne plastics and depositing them on the surface?
    a. Dry deposition
    b. Wet deposition
    c. Bioturbation
    d. Hydrolytic degradation

Correct answer: b

18. What is the main mechanism for vertical transport of microplastics in soil?
    a. Wind erosion
    b. Surface runoff
    c. Infiltration with water
    d. Urban morphology

Correct answer: c

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19. What is the primary environmental impact of microplastics in aquatic sediments?
    a. They increase oxygen levels.
    b. They obstruct feeding and reproduction in benthic fauna.
    c. They enhance microbial colonization.
    d. They degrade rapidly under UV radiation.

Correct answer: b

20. What is the primary concern regarding the "plastisphere" formed on plastic surfaces?
    a. It enhances plastic biodegradation.
    b. It facilitates colonization by invasive species and pathogens.
    c. It reduces the mobility of plastics in the environment.
    d. It prevents chemical leaching from plastics.

Correct answer: b

21. What is a key factor influencing the resuspension of deposited plastic particles in urban areas?
    a. Soil permeability
    b. Wind speed and human activities
    c. UV radiation intensity
    d. Rainfall frequency

Correct answer: b

22. What is the primary focus of depollution strategies during the production phase of plastics?
    a. Increasing the use of fossil-based materials
    b. Reducing the volume of generated plastics
    c. Promoting single-use plastics

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d. Encouraging open dumping of waste

Correct answer: b

23. Which of the following is a key strategy to minimize plastic consumption?
    a. Promoting single-use plastics
    b. Encouraging excessive packaging
    c. Banning or taxing single-use plastics
    d. Using fossil-based feedstocks

Correct answer: c

24. What is the main environmental concern associated with inadequate waste handling at the post-use stage?
    a. Increased recyclability of plastics
    b. Leakage of plastics into the environment
    c. Reduction in landfill burden
    d. Enhanced biodegradability of plastics

Correct answer: b

25. Which technology is used to remove floating plastic debris directly from water bodies?
    a. Landfill mining
    b. Floating barriers and booms
    c. Chemical recycling
    d. Waste-to-energy systems

Correct answer: b

26. What is the primary benefit of using renewable energy sources during plastic production?

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a. Increased greenhouse gas emissions
b. Reduced energy consumption and emissions
c. Enhanced fossil-based material usage
d. Improved recyclability of plastics

Correct answer: b

27. What is the purpose of landfill mining in plastic depollution strategies?
    a. To increase plastic production
    b. To recover valuable materials and reclaim space
    c. To promote single-use plastics
    d. To enhance microplastic formation

Correct answer: b

28. What is a key challenge associated with waste-to-energy technologies for non-recyclable plastics?
    a. High recyclability of plastics
    b. Emission control and environmental safety
    c. Reduced energy efficiency
    d. Increased landfill burden

Correct answer: b

29. What is the primary goal of promoting reusable and upcycled plastics?
    a. To increase the demand for new plastic production
    b. To extend the plastic lifespan and reduce environmental impact
    c. To enhance microplastic formation
    d. discourage circular product design

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Correct answer: b.

5.4 Exam questions for Lesson 5.4.

1. What is the main goal of Extended Producer Responsibility (EPR)?

A. To increase product sales

B. To shift the cost of waste management to consumers

C. To make producers responsible for the post-consumer stage of their products

Correct answer: C

2. Which principle underlies EPR?

A. The Polluter Pays Principle

B. The Free Market Principle

C. The Principle of Least Effort

Correct answer: A

3. What is a Producer Responsibility Organization (PRO)?

A. A government agency that collects taxes

B. A group that manages EPR compliance for producers

C. A consumer advocacy group

Correct answer: B

4. Which of the following is an economic instrument in EPR schemes?

A. Mandatory take-back

B. Deposit-refund system

C. Eco-labeling

Correct answer: B

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5. What is the purpose of plastic traceability in EPR?

A. To increase plastic production

B. To track plastic flows and ensure compliance

C. To advertise plastic products

Correct answer: B

6. Which technology is used for invisible sorting of plastic packaging?

A. QR codes

B. Digital watermarks

C. Barcodes

Correct answer: B

7. What is greenwashing?

A. A method of recycling plastic

B. A marketing strategy to promote eco-design

C. Misleading claims about environmental friendliness

Correct answer: C

8. Which of the following is a sign of greenwashing?

A. Verified eco-labels

B. Vague claims like “100% natural” without proof

C. Transparent lifecycle reporting

Correct answer: B

9. What is a Digital Product Passport (DPP)?

A. A travel document for eco-tourism

B. A digital record of a product’s lifecycle and environmental data

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C. A recycling bin tracking system

Correct answer: B

10. Which ethical principle supports the idea that nature has value beyond human use?

A. Anthropocentrism

B. Biocentrism

C. Capitalism

Correct answer: B

11. What is the main ethical concern with "free-riding" in EPR?

A. It increases recycling rates

B. It creates unfair competition and undermines shared responsibility

C. It encourages innovation

Correct answer: B

12. Which of the following is a regulatory instrument in EPR?

A. Public awareness campaigns

B. Mandatory take-back requirements

C. Deposit-refund systems

Correct answer: B

13. What is the role of blockchain in plastic traceability?

A. To reduce plastic production

B. To create secure, tamper-proof records of material flows

C. To advertise recycled products

Correct answer: B

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14. What does the precautionary principle advocate?

A. Acting only when there is full scientific certainty
B. Avoiding actions that may cause serious environmental harm
C. Prioritizing economic growth

Correct answer: B

15. What is the ethical responsibility of companies under EPR?

A. To maximize profits
B. To ensure products are cheap and disposable
C. To take responsibility for environmental impacts throughout the product lifecycle

Correct answer: C

5.5 Exam questions for Lesson 5.5.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson " *Citizens' Responsibility. Ethical Behavior in Consumption and Use*". The quiz is divided into two parts:

- **Part I** includes multiple-choice questions (1–10).
- **Part II** features true or false statements (11–20).

Instructions: Choose the best answer for each question.

Questionnaire Proposal

Instructions: Choose the best answer for each question.

1. How does plastic waste most directly affect the built environment?

E. It clogs drainage and sewage systems, increasing the risk of urban flooding
F. It accelerates corrosion of metal infrastructure through chemical reactions
G. It contributes to the structural weakening of buildings via UV degradation

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H. It lowers the thermal insulation efficiency of concrete in urban areas

2. Which of the following consumption decisions best illustrates ethical responsibility according to the environmental ethics framework?

A. Purchasing the most affordable available product regardless of origin

B. Choosing locally made goods even if they are packaged in non-recyclable materials

C. Selecting products certified for sustainable sourcing and fair labor practices

D. Preferring imported organic food over unpackaged conventional produce

3. In the Theory of Planned Behavior, which component primarily reflects the influence of peer expectations on individual consumption?

A. Perceived behavioral control

B. Subjective norms

C. Value-action gap

D. Behavioral intention

4. Which of the following constitutes a perceptual barrier to engaging in plastic circularity?

E. Lack of access to municipal sorting infrastructure

F. Availability of biodegradable plastic alternatives

G. Distrust in the actual outcomes of recycling efforts

H. Confusion between glass and paper recycling codes

5. Which of the following most effectively incentivizes circular plastic behavior in an institutional setting?

E. Price reductions for single-use plastic alternatives

F. Increased penalties for non-compliance

G. Peer recognition and integration of social reward systems

H. Unrestricted consumer access to all material types

6. In the context of psychological drivers of behavior change, which factor most effectively sustains long-term reduction in plastic use?

E. Internalized values and emotional engagement

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F. Sporadic public awareness campaigns

G. Provision of financial penalties for wasteful behavior

H. Passive exposure to eco-labels on products

7. Which scenario most accurately reflects the ethical obligations of a citizen in sustainable transitions?

E. Delegating responsibility to regulatory agencies

F. Participating in symbolic environmental actions without follow-through

G. Choosing personal behaviors that align with planetary boundaries and encouraging peers

H. Avoiding unsustainable consumption only when convenient

8. Which characteristic best explains the success of behavioral interventions in young people?

E. Reliance on personal moral reasoning

F. Subtle default-based behavior engineering without consent

G. Strict monitoring and mandatory compliance

H. Visibility of behavior within peer groups and normative framing

9. Which of the following reflects a condition of high perceived behavioral control in sustainable consumption contexts?

E. Feeling overwhelmed by the complexity of environmental issues

F. Having clear access to infrastructure and decision-making autonomy

G. Believing that one's behavior is insignificant in systemic terms

H. Being aware of issues but lacking alternatives

10. Which strategy most closely reflects a systemic approach to plastic circularity?

E. Replacing plastics with single-use biodegradable alternatives

F. Promoting consumer responsibility without altering production systems

G. Redesigning products and infrastructures for material recirculation and reuse

H. Encouraging consumers to reduce demand through moral appeals alone

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Answer Key of Questionnaire Proposal

1. **A**
2. **C**
3. **B**
4. **C**
5. **C**
6. **A**
7. **C**
8. **D**
9. **B**
10. **C**

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the key concepts related to ethical consumption, citizen responsibility, behavioral change, plastic circularity, and sustainable systems.
- **5–7 correct:** Good job! You demonstrate a solid understanding of the material. Review the few areas where you may have chosen distractors.
- **Less than 5 correct**: It looks like the core ideas need some reinforcement. Re-read the sections on citizen responsibility, TPB, and plastic circularity. Focus on understanding how environmental behaviors are shaped not only by personal values but also by social norms and enabling infrastructures.

True & False activity

Instructions: Determine whether each statement (1-10) is true or false.

Statements proposal

11. Plastics labeled as "biodegradable" always break down completely in natural marine or soil environments within a short time frame.

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12. Ethical consumption includes not only what people buy but also what they choose not to consume.
13. According to the Theory of Planned Behavior, strong environmental concern guarantees consistent environmentally responsible behavior.
14. Persistent organic pollutants (POPs) such as PCBs and DDT can adsorb to plastic particles, increasing the toxic potential of ingested plastics.
15. Carbon neutrality can be achieved solely through citizens' choices.
16. Social norms are more influential in shaping sustainable behavior in individualistic societies than in collectivist ones.
17. Plastic circularity aims to redesign both products and systems so that plastic remains in use at its highest value for as long as possible.
18. One key reason behavior change interventions may fail is that they do not align with users' perceived behavioral control or lived infrastructure access.
19. The reuse of plastic waste in construction materials always guarantees reduced environmental impact.
20. Peer influence and visibility of sustainable actions enhance the likelihood of individual behavior change in campus environments

Answer Key of True & False activity

11. False (Many so-called "biodegradable plastics" require industrial composting conditions to decompose effectively. In natural environments, they may fragment rather than fully degrade, persisting as microplastics.)
12. True
13. False (Concern may influence attitudes, but actual behavior also depends on subjective norms, perceived behavioral control, and habitual or contextual constraints)
14. True
15. False (Individual behavior plays a role, but achieving true carbon neutrality requires systemic interventions, such as infrastructure, policy frameworks, and technological transitions)

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16. False (While norms operate differently across cultures, collectivist societies often exhibit stronger compliance with group-based norms, potentially making social influence even more powerful in shaping environmental behaviors.)
17. True
18. True
19. False (While reuse reduces landfill volumes, concerns remain about chemical leaching, material durability, and long-term health risks, especially in unregulated or informal contexts)
20. True

How did you do?

- **8–10 correct:** Excellent! You have a strong understanding of the key concepts related to ethical consumption, citizen responsibility, behavioral change, plastic circularity, and sustainable systems.
- **5–7 correct:** Good job! You demonstrate a solid understanding of the material. Review the few areas where you may have chosen distractors.
- **Less than 5 correct**: It looks like the core ideas need some reinforcement. Re-read the sections on citizen responsibility, TPB, and plastic circularity. Focus on understanding how environmental behaviors are shaped not only by personal values but also by social norms and enabling infrastructures.

5.6 Exam questions for Lesson 5.6.

Quiz Activity - This activity is designed to help you review and reflect on key concepts from the lesson *Rethinking Education and Awareness of Plastic Initiatives in Circular Economy*.

You'll explore how transformative education, sustainability competencies, and the EDU4PlastiCircular model contribute to developing plastic circularity and climate-neutral lifestyles. The lesson highlights how awareness, GreenComp, and nature-based learning approaches can empower learners to act as innovators and changemakers in the transition to a circular economy. The quiz is divided into two parts:

Part I includes multiple-choice questions (1–10).

Part II features true or false statements (11–20).

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Take your time, think critically, and test how much you've learned.

Instructions: Choose the best answer for each question.

Questionnaire Proposal

Multiple Choice (1–10)

1. Which of the following examples best reflects the GreenComp competence "Valuing Sustainability" in the context of plastics?
    a. Promoting low-cost plastic alternatives regardless of environmental impact
    b. Prioritizing convenience over sustainability in product packaging
    c. Choosing bio-based packaging materials to reduce long-term environmental harm
    d. Increasing production of plastic bottles for water distribution
2. How does "Systems Thinking" help students understand plastic pollution?
    a. It simplifies the issue to focus only on recycling processes
    b. It frames plastic as a disconnected problem from other sustainability topics
    c. It reveals how plastic production, use, and disposal are interconnected with environmental, economic, and social systems
    d. It encourages avoiding analysis and focusing on singular solutions
3. What activity best supports the GreenComp competence "Promoting Nature" in a lesson on plastic circularity?
    a. Memorizing facts about fossil fuels
    b. Participating in a community beach clean-up and reflecting on the impact of plastic on ecosystems
    c. Designing promotional materials for single-use plastics
    d. Calculating profit margins for plastic packaging companies
4. Which practice best exemplifies "Futures Literacy" in relation to plastic awareness?
    a. Designing scenarios for a zero-waste city with bioplastic infrastructure
    b. Predicting next year's oil price

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c. Studying historical uses of plastic in packaging

d. Encouraging students to memorize recycling codes

5. What is the role of a "disorienting dilemma" in transformative learning?

a. To teach facts about plastic waste

b. To reinforce previously held beliefs

c. To challenge students' assumptions and provoke critical reflection

d. To provide standardized testing on sustainability

6. Which learning activity best aligns with transformative learning principles?

a. Reading a textbook and completing multiple-choice quizzes

b. Organizing a student-led campaign to eliminate single-use plastics on campus

c. Memorizing chemical formulas of plastic compounds

d. Watching a documentary without discussion

7. How does "Perspective Transformation" relate to plastic awareness?

a. It leads to defensive thinking

b. It helps learners critically reassess their role in contributing to plastic waste and adopt more sustainable behaviors

c. It encourages resistance to change

d. It promotes isolated thinking

8. What defines a "sustainability mindset" cultivated through transformative learning?

a. A short-term focus on plastic profit

b. Passive acceptance of environmental problems

c. A systems-based, long-term, regenerative view of plastic-related decisions

d. A purely technical problem-solving perspective

9. Which of the following is not a feature of the EDU4PlastiCircular educational model?

a. Interactive learning modules based on GreenComp

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b. Digital tools for monitoring awareness campaigns
c. Training focused only on recycling plant operations
d. Competency-based learning paths for circularity and climate-neutrality

10. What is a key outcome expected from students who complete EDU4PlastiCircular activities?
    a. Ability to memorize plastic types
    b. Capability to design, assess, and advocate for circular solutions related to plastics
    c. Specialization in fossil-based plastic production
    d. Promotion of traditional linear business models

Answer Key

Answer Key of Questionnaire Proposal

Multiple Choice (1–10):

11. C

12. C

13. B

14. A

15. C

16. B

17. B

18. C

19. C

20. B

How did you do?

Maximum: 10 points

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- **9–10 correct: EDU4PlastiCircular Master -** Outstanding! You've demonstrated a deep understanding of sustainability competencies, transformative learning, and circular strategies in plastic education. You're well-equipped to design educational pathways, promote circularity, and lead real-world innovation for climate-neutral practices.
- **7–8 correct: Advanced Learner -** Great job! You clearly understand the key principles behind GreenComp, systems thinking, and the EDU4PlastiCircular framework. A quick review of missed areas will further strengthen your ability to apply these concepts in teaching or professional projects.
- **5–6 correct: Emerging Competence -** Good effort! You have a solid grasp of core ideas but may benefit from revisiting transformative learning concepts or sustainability values. With more reflection and practice, you're on track to build impactful sustainability education skills.
- **0–4 correct: Foundational Awareness -** No worries—this is a great starting point! Sustainability education is a broad and evolving field. Revisit the lesson materials, especially GreenComp, transformative learning stages, and plastic circularity solutions. With continued exploration, you'll gain confidence and clarity.

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