

Design & Technology

Eduqas GCSE

Thermoforming and thermosetting polymers

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try answer all questions
- Use the space provided to answer questions
- Calculators can be used if necessary
- For the multiple choice questions, circle your answer

Advice

- Marks for each question are in brackets
- Read each question fully
- Try to answer every question
- Don't spend too much time on one question

Good luck!

Q1. What are most synthetic polymers made from?

- A** Crude oil
- B** Plants and trees
- C** Metal ores

Q2. Why can't thermosetting plastics be reshaped when reheated?

- A** They have no polymer chains
- B** Strong cross links form when they are first heated and set
- C** They melt into a liquid

Q3. Which polymer has good fatigue resistance and is used for living hinges on bottle caps?

- A** Polystyrene
- B** PVC
- C** Polypropylene

Q4. Which of the following is a thermosetting plastic?

- A** Urea formaldehyde
- B** HDPE
- C** Acrylic

Q5. Which thermosetting resin is used as an adhesive (e.g. Araldite)?

- A** Melamine formaldehyde
- B** Epoxy resin
- C** Polyester resin

Q6. Which of these is an example of a natural polymer?

- A** PVC
- B** Polythene
- C** Latex

Q7. A pair of safety glasses is made from a thermoforming plastic.

Q7a. Explain the term thermoforming. **(2 marks)**

Q7b. Name a thermoforming plastic that could be used to make the safety glasses and explain a characteristic or property that makes it suitable. **(3 marks)**

Q8. A mobile phone stand is made from a thermoforming polymer. Polymers can also be classed as thermosetting polymers.

Q8a. In the table below, state the name of a thermoforming and a thermosetting polymer. **(2 marks)**

	Polymer example
Thermoforming	
Thermosetting	

Q8b. Thermosetting polymer resins can be combined with fibres. Describe one advantage of adding fibres to a thermosetting polymer. **(2 marks)**

Q9. Disposable products such as cups and food trays are made from a thermoforming plastic.

Q9a. State a thermoforming plastic that could be used for these disposable products. **(1 mark)**

Q9b. Thermoforming plastics are sold in many different forms. Name one example. **(1 mark)**

Q9c. Acrylic is a plastic commonly used in design and make projects. Describe the benefits of using this plastic. **(2 marks)**

Q10. This question is about HDPE (High Density Polyethylene).

Q10a. The main body of a game controller is made from HDPE. State the group of plastics to which HDPE belongs. **(1 mark)**

Q10b. Describe a property of HDPE that makes it a suitable material to use in the manufacture of the game controller. **(2 marks)**

Q10c. A public bench is made from recycled HDPE. State the name of a product that could have been recycled to make the bench. **(1 mark)**

Q10d. Explain why HDPE is an appropriate plastic to use in the manufacture of the public bench. **(2 marks)**

Q11. Two drinking cups are made from different polymers: polypropylene (PP) and melamine formaldehyde (MF).

Q11a. Put one tick in the table below to identify whether each polymer is thermoforming or thermosetting. **(2 marks)**

Polymer	Thermoforming	Thermosetting
Polypropylene (PP)		
Melamine formaldehyde (MF)		

Q11b. Discuss the properties of polypropylene (PP) and melamine formaldehyde (MF) that make them suitable materials for the drinking cups. **(6 marks)**

Q12. Two sets of bowls are made from different polymers: one set from a thermosetting polymer and the other from a thermoforming polymer.

Q12a. State the name of a specific polymer used to make the thermosetting bowl set. **(1 mark)**

Q12b. Evaluate why the designer selected a thermosetting polymer for one type of bowl and a thermoforming polymer for the other type of bowl. **(6 marks)**

Answers

Q1. A

Q2. B

Q3. C

Q4. A

Q5. B

Q6. C

Q7a.

Up to 2 marks for a clear understanding. For example: thermoforming is where a plastic can be softened by heating and reformed into complex shapes, such as the safety glasses; this can be done multiple times.

Q7b.

One mark for naming a correct plastic/property and up to two marks for a clear explanation. Normally polycarbonate or polypropylene. Typical properties:

- Good resistance to scratching
- Good resistance to impact
- Light in weight
- Clear, so it can be seen through
- Easily cleaned/sterilised

Q8a.

Thermoforming: acrylic, polyethylene (HDPE/LDPE), PVC, PET, polypropylene (1). Thermosetting: urea formaldehyde, melamine formaldehyde, polyester resin (1).

Q8b.

Up to 2 marks for a described advantage; one mark for an advantage without description or example. For example:

- Fibres provide high strength (1), e.g. polyester resin in boats (1)
- High strength while being lightweight (1), e.g. glass fibre on yachts (1)
- Carbon fibre increases impact resistance (1), e.g. bike helmets where safety matters (1)

Q9a.

Polystyrene (PS) or expanded polystyrene (EPS) (1).

Q9b.

One of: sheet, film, bar, rod, tube (also accept powder or granules) (1).

Q9c.

1 mark for each benefit of acrylic. For example: acrylic can be moulded into almost any shape (1) and is available in many colours (1). Other benefits: can be recycled, good thermal insulation, good weather resistance, good dimensional stability, good plasticity for shaping.

Q10a.

Thermoplastics (thermoforming) (1). Only acceptable answer.

Q10b.

Must refer to strength and rigidity, impact resistance, low heat conductivity or being available in different colours. 2 marks with detail, e.g. "HDPE is a strong and rigid plastic that resists breaking and cracking when dropped due to its high impact resistance". 1 mark if lacking detail, e.g. "it doesn't break when dropped".

Q10c.

1 mark for any of: milk bottles, carrier bags, cleaning product/detergent bottles, toys, wheelie bins, plastic chairs or slides.

Q10d.

Up to 2 marks for a clear explanation. For example: HDPE is very hard-wearing and does not break down with exposure to sunlight or sudden temperature changes; or HDPE is recyclable and remouldable, and is durable and weather resistant.

Q11a.

Polypropylene: thermoforming (1). Melamine formaldehyde: thermosetting (1).

Q11b. (6 marks)

Must relate to both PP and MF. Up to 3 marks for discussing up to 3 properties, plus up to 3 marks for justifications or comparisons. A maximum of two marks if three properties are simply listed. No credit for simply "cheap" or "strong". If only one material is discussed, award up to 4 marks. For example: polypropylene has excellent thermal properties (1), so it suits hot and cold drinks (1). It is light in weight (1), so it is easy to hold even when full (1). Melamine formaldehyde resists staining (1), an advantage for tea and coffee (1).

- Polypropylene: good heat and chemical resistance; lightweight; excellent thermal insulator; good tensile strength and hard to break; waterproof; resists bacteria; recyclable
- Melamine formaldehyde: excellent tensile strength; excellent heat and flame resistance; resists scratching and staining; smooth surface; durable; cannot be recycled
- Credit discussion of manufacture: injection moulding (both) and compression moulding (MF)

Q12a.

Melamine (accept melamine formaldehyde) (1).

Q12b. (6 marks)

Answers must evaluate both thermosetting and thermoforming polymers for full marks.

Thermosetting polymers

- Advantages: good strength to weight ratio; more durable and harder than most thermoforming polymers, so better scratch resistance and longer life; melamine is generally considered food-safe and "shatterproof"; dishwasher safe; can withstand microwaves
- Disadvantages: more expensive; a more limited choice of polymers; does not biodegrade; made from oil, a non-renewable resource; cannot be

recycled (although durability means a longer life); melamine may release monomers when heated above 70°C

Thermoforming polymers

- Advantages: a greater range of materials to choose from (e.g. HDPE, LDPE, PP); can be recycled; cheaper, making products more affordable
- Disadvantages: less able to withstand microwave use due to lower melting points; made from oil, a non-renewable resource; recycling depends on consumer habits

Band	Marks	Descriptor
3	5 to 6	A coherent answer with detailed, relevant knowledge and understanding when evaluating the choice of polymers for both bowls. Relevant examples and well-developed, substantiated judgements in a logically structured response.
2	3 to 4	Some coherence, with partial knowledge and understanding. Mostly relevant examples and partly substantiated judgements in a generally well structured response.
1	1 to 2	Basic knowledge and understanding. Limited relevant examples or judgements, with little structure.
0	0	Incorrect or irrelevant answers.