

Design & Technology

Polymers

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try to 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
- Don't spend too much time on one question

Good luck!

Q1. What is an advantage of all thermoplastics?

- A** Resist UV degradation
- B** Can be reheated and reshaped
- C** Easy to finish

Q2. What might acrylic be used for?

- A** CD cases
- B** Piping
- C** fizzy drinks bottles

Q3. What is an advantage of using Polyvinyl Chloride?

- A** Scratch resistant
- B** Easy to recycle
- C** Available in a range of colours

Q4. ABS is used in motorcycle helmets for what reason?

- A** Its chemical resistant
- B** Its heat resistant
- C** It's tough

Q5. What is epoxy resin used for?

- A** Adhesives
- B** Domestic appliances
- C** Garden furniture

Q6. What is a disadvantage of using Urea formaldehyde?

- A** Emits toxic gases when manufactured
- B** Poor heat resistance
- C** Causes allergic reactions

Q7. What non-renewable resource are polymers made from?

- A** Natural gas
- B** Crude oil
- C** Petrol

Q8. What is a common disadvantage of most thermosets?

- A** Soft
- B** Brittle
- C** Poor corrosion resistance

Q9. Disposable forks can be manufactured from polystyrene. Polystyrene is chosen since it is lightweight and readily accessible in a variety of colours.

List **six** additional characteristics of polystyrene that make it a good choice for throwaway forks **(6 marks)**

Q10. PVC has many characteristics, including strength and the ability to be made in a variety of colours.

Explain **three** additional characteristics that this polymer has that make it a good choice for making drainpipes **(6 marks)**

Q11. Packaging frequently makes use of polymers.

Analyse and evaluate the use of plastics in packaging **(6 marks)**

[illegible]

Q12. A bathtub plug is made from rubber. Explain one reason why rubber is a suitable material for the bathtub plug. **(3 marks)**

Q13. Compare and evaluate the suitability of ABS and PLA for the manufacture of a 3D parts. **(6 marks)**

Q14. Explain why High Impact Polystyrene (HIPS) is an appropriate material for the manufacture of the protractor. **(6 marks)**

Answers

Q1. B

Q2. A

Q3. C

Q4. C

Q5. A

Q6. A

Q7. B

Q8. B

Q9.

- Tough (1)
- Easily mass produced (1)
- Inexpensive polymer (1)
- Chemical resistant (1)
- Non-toxic (1)
- Heat resistant to food temperatures (1)
- Recyclable (1)
- Thermal insulator (1)
- Smooth surface finish (1)

Q10.

- Corrosion resistant (1) so that it is not affected by outside conditions (1)
- UV resistant (1) so will not become brittle as quickly as other polymers (1)
- Tough (1) so can withstand knocks (1)
- Sufficiently hard (1) not worn away by flowing contents (1)
- Easily extruded (1) so it can be mass produced economically (1)
- Flexible (1) so can be fitted to uneven surfaces (1)
- Lightweight (1) does not require substantial mountings (1)
- Easily cut/joined (1) so fitting is simple (1)
- Relatively cheap (1) so it can be sold at a high margin (1)
- Self-finishing (1) reducing maintenance procedures (1)
- Recyclable (1) so does not contribute to land fill (1)
- Can be textured (1) to blend with existing architectural styles (1)
- Sufficiently high melting point (1) so is not softened by boiling water/ bright sunlight (1)

Q11.

Advantages (max 5)

- Lightweight so will not increase weight of product (1)
- Strong (1)
- Water resistant (1)
- Can be formed into intricate shapes (1)
- Easily printed on (1)
- Inexpensive in comparison to other materials (1)
- Greater speed of production than other materials (1)
- Impact resistant (1)
- Recyclable (1)
- Can be transparent so contents can be seen (1)
- Does not affect flavour of the contents as they are unreactive (1)
- Self-finishing (1)
- Comes in a wide range of colours (1)
- Chemically resistant (1)

Disadvantages (max 5)

- Consume large amounts of energy in production (1)
- Use up non-renewable resources (1)
- Pollute environment (1)
- Uneconomical (1)
- Add to land fill (1)
- Can be hazardous to health (1)
- Creates toxic fumes when burnt (1)
- Some plastics cannot be recycled (1)

Q12.

- Rubber is waterproof (1) and will expand into the plug hole (1) providing a watertight seal (1)
- Rubber is a renewable material (1) because it can be harvested continuously without damaging the tree (1) so does not deplete natural resources (1)
- Rubber is chemically resistant to soaps/shampoo (1) so it can be used in a domestic environment (1) without degrading (1)

Q13.

ABS

- ABS is a crude oil-based polymer which comes from a finite resource.
- ABS is a tough material that can be used to create a 3D printed component with good resistance to impact.
- ABS can be pigmented to produce a filament with a wide range of bright and bold colour options.
- 3D printing often creates waste material in the form of rafts and supports. Although ABS can be recycled, it would more than likely be disposed of and contribute to landfill.

PLA

- PLA is a bio polymer that is engineered from natural and renewable resources.
- PLA is a brittle material so may create a component with poor impact resistance.
- PLA is becoming increasingly available in a wider range of colour options in line with ABS.
- Rafts and support material in PLA will eventually biodegrade and have a reduced environmental impact when disposed of.

General

- ABS has a higher melting point than PLA which means it requires more energy to print in ABS than PLA.
- ABS can give off toxic fumes when heated and can often require extraction and filtration.
- ABS requires a 3D printer to have a heated bed to improve adhesion when printing whereas PLA is generally an easier material to work with.
- The lower melting point of PLA makes it unsuitable for the manufacture of a component that may be exposed to friction or higher working temperatures.

Q14.

- HIPS has excellent optical properties and can be translucent allowing for clear visibility through the product, essential for use.
- HIPS has a good level of hardness allowing it to resist scratching when stored in a pencil case, and preventing the surface from being obscured.

- HIPS is a rigid polymer that maintains the thin flat shape of the protractor so that it can be used to measure angles on drawings accurately.
- HIPS is a shatter resistant polymer that prevents the product from cracking if exposed to impact such as a bag getting dropped.
- HIPS has a low melting point which makes it particularly suitable for the injection moulding process used to manufacture the protractor.
- HIPS can be easily injection moulded which is appropriate for the scale of the market.
- HIPS can be easily printed on allowing for the application of the angle increments and text needed for the protractor.