DTBase©

Design & Technology
AQA A-Level

Performance characteristics of 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. Which thermoplastic is commonly used for plastic bags and packaging films due to its flexibility?

A HDPE

B LDPE

C PET

Q2. Which thermoplastic is known for its toughness and is used in LEGO bricks and automotive parts?

A ABS

B PMMA

C PVC

Q3. Which thermoset is used for electrical fittings and adhesives due to its excellent insulation properties?

A Polyester resin

B Urea formaldehyde (UF)

C Epoxy resin

Q4. Why are thermosets like epoxy resin unsuitable for recycling through melting?

A They dissolve in water

B They are too expensive

C They undergo permanent chemical bonding (cannot be remelted)

Q5. Compare and evaluate the suitability of Acrylonitrile Butadiene Styrene (ABS) and Polylactic Acid (PLA) for the manufacture of a 3D printed component **(6 marks)**

Q6. Explain why polypropylene (PP) is an appropriate material for the manufacture of an ice cream container **(6 marks)**

Q7. Explain why High Impact Polystyrene (HIPS) is an appropriate material for the manufacture of a protractor **(6 marks)**

Answers

Q1. B
Q2. A
Q3. B
Q4. C

Q5.
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.

Q6.

- PP has an excellent resistance to fatigue meaning that it will not break or tear with the constant removal and refitting of the lid
- PP is a food safe polymer making it suitable to contain the ice cream
- an ice cream container will potentially have a short lifespan so PP is suitable as it can be recycled
- PP can be injection moulded or vacuum formed which is necessary to achieve the close tolerances needed for the ice cream lid to securely click in place
- PP remains relatively flexible at low temperatures allowing the lid of the container to 'snap' over the rim of the ice cream container
- PP is a thermoplastic that is readily recycled, an essential property for a product with a short lifespan
- PP is a tough material that will withstand the likely impact that occurs in transit from supplier to store, store to consumer
- PP has a naturally milky appearance but can be easily pigmented allowing it to represent a variety of brands
- PP is available in a variety of grades; some are clear and would be appropriate for ice cream containers that wish to display the colour of the ice cream.

Q7.

- 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.