DTBase©

Design & Technology
Eduqas GCSE

Polymers: specialist techniques and processes

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. Why is the protective film usually left on acrylic sheet while it is marked out and cut?

A To protect the surface from scratches

B To make it easier to bend

C To stop it melting in the laser cutter

Q2. Why should plastics be cut slowly?

A To give a matt edge

B To stop the plastic melting and re-fusing behind the blade

C To make the blade last longer

Q3. Which type of hole lets a countersunk screw sit flush with the surface?

A Pilot hole

B Clearance hole

C Countersunk hole

Q4. Which plastic must never be cut on a laser cutter?

A Acrylic

B PVC

C HIPS

Q5. What is Tensol used for?

A A solvent cement that joins acrylic

B Polishing the edges of acrylic

C Lubricating drill bits

Q6. Which machine turns acrylic or nylon rod into round parts such as knobs and wheels?

A Milling machine

B Lathe

C Laser cutter

Q7. An adjustable stand for a tablet is made from 4 mm thick acrylic in a school workshop. The base is marked out on a sheet of acrylic, cut out, drilled with two Ø10 mm holes, then bent to shape.

Q7a. Name two tools or items of equipment that could be used to mark out the lines on the surface of the acrylic sheet. **(2 marks)**

Q7b. Name two types of saw that could be used to remove the waste material. **(2 marks)**

Q7c. Use sketches and notes to show two precautions, other than Personal Protective Equipment (PPE), that need to be taken when using a drilling machine to drill the holes in the acrylic sheet. **(3 marks)**

Q7d. Name the item of equipment that heats a narrow strip of the acrylic so it can be bent along a straight line. **(1 mark)**

Q8. A phone stand is made by line bending sheet polymer. Using words and sketches, show how the sheet polymer phone stand can be bent precisely and accurately. **(4 marks)**

Q9. A storage unit with adjustable shelves will be used in a bathroom. It is made from acrylic in a school workshop using hand tools and CAD/CAM.

Q9a. Give two benefits of using acrylic to make products that will be used in a bathroom. **(2 marks)**

Q9b. The shelf slots will be cut out of the uprights. Describe how CAD/CAM could be used to produce the shelf slots quickly and accurately. **(4 marks)**

Q9c. Give two benefits, other than speed, of using a scroll saw to cut out the slots. **(2 marks)**

Q9d. A strip of acrylic will be heated and bent to match the curved front edge of a shelf. Explain why the acrylic would be heated in an oven rather than by a strip heater or line bender. **(2 marks)**

Q9e. The curved edging will be joined to the shelf using acrylic cement. State one safety precaution that must be taken when using acrylic cement. **(1 mark)**

Q10. Holes have been drilled in a piece of 10 mm thick acrylic. Use notes and sketches to show how to cut a screw thread through one of the holes in the acrylic. **(4 marks)**

Q11. Using notes and sketches, describe how two pieces of thermoforming polymer can be welded together. Identify the equipment used. **(6 marks)**

Q12. A vacuum formed prototype bowl is trimmed out using a gerbil. Describe one advantage of using a gerbil rather than other techniques. **(2 marks)**

Q13. In commercial manufacture, sheet polymer products can be laser cut. Analyse the advantages and disadvantages of laser cutting sheet polymers. **(5 marks)**

Answers

Q1. A
Q2. B
Q3. C
Q4. B
Q5. A
Q6. B

Q7a.

Any two (1 mark each): scriber, chinagraph pencil, marker pen. Also accept steel rule, try square.

Q7b.

Any two (1 mark each): tenon saw, coping saw, Hegner (scroll) saw, band saw, hacksaw.

Q7c.

Any two precautions (1 mark each), plus 1 mark for a sketch showing the acrylic correctly on the table of the drilling machine. Do not accept PPE or safety glasses. For example:

- Clamp the acrylic sheet securely, e.g. in a machine vice or with G clamps
- Put a sacrificial board (scrap wood) under the acrylic sheet
- Take care with the pressure applied so the acrylic does not crack

Q7d.

Strip heater (1). Accept line bender.

Q8.

Up to 4 marks for a clear understanding of the stages. A maximum of 2 marks for clear sketches if the written explanation is missing. For example:

- Mark out the bend lines with a try square so the line is heated accurately at 90° (1)
- Place the sheet on the strip heater/line bender, wearing heat resistant gloves (1)

- Wait until the sheet has softened (1)
- Hold the sheet accurately at the required angle, e.g. using a bending jig (1)
- Wait until it has cooled (1), then repeat for any other bend lines (1)

Q9a.

Any two (1 mark each): attractive appearance; colours available to match; resistant to moisture or water resistant; easy to clean. Do not accept lightweight.

Q9b.

0 to 4 marks depending on the technical accuracy of the points. For example: the slots are drawn in CAD (1); the CAD data is transferred to a laser cutter or other CNC machine (1); the machine settings are set for the acrylic (1); the acrylic is positioned on the bed of the machine and the job is run (1).

Q9c.

Any two (1 mark each): easy to control and handle; thin blade; the acrylic is held flat during the cut so it is less likely to snap. Do not accept "accurate".

Q9d.

A line bender or strip heater only heats a small, specific area (1), whereas an oven heats and softens the whole strip of acrylic so it can be bent into a curve (1).

Q9e.

Any one (1): barrier cream or gloves to protect the hands; a mask; good ventilation.

Q10.

Cap at 3 marks if there are no sketches, or sketches with no notes. One mark for each:

- Use a tap held in a tap wrench (1)
- Make sure the tap is at 90° to the work surface (1)

- Turn forwards to cut the thread, then turn back to clear the waste (swarf) (1)
- Wind through to cut the thread (1)
- Use a second (plug) tap to finish the thread (1)

Q11. (6 marks)

Marks	Descriptor
5 to 6	A detailed description using notes and sketches showing a full understanding of the welding process, with specific, correctly named tools and equipment.
3 to 4	A description showing some understanding of the process using notes and sketches, with basic reference to some tools and equipment.
1 to 2	Simple notes or a sketch showing limited understanding.
0	Nothing worthy of credit.

An excellent response with no sketches is limited to 5 marks.

Indicative content:

- Polymers can be fused using heat or chemicals
- Heat welding: clean the edges and hold the parts together; a hot air gun heats the joint and a filler rod of the same type of thermoforming plastic (e.g. HDPE); the surfaces melt and fuse, then cool into one piece
- Friction or ultrasonic welding can also be used to heat the joint
- Chemical welding: a solvent cement such as Tensol melts the surfaces of acrylic so they fuse together
- Only the same type of thermoplastic can be joined; the result is a strong, permanent, waterproof joint

Q12.

1 mark for an advantage and 1 mark for a description. For example: using a gerbil is more accurate (1) than other methods such as a bandsaw or cutting knife (1). Other advantages: it is more controllable; it is safer; it makes trimming curves easier. Credit any other appropriate response.

Q13. (5 marks)

Answers must include both advantages and disadvantages to access the full 5 marks.

Advantages

- Thermoforming sheet polymers are ideal for laser cutting, in a variety of thicknesses
- Gives a polished, self-finished edge
- Any shape can be cut, however intricate, with high precision (about ±0.1 mm)
- The sheet can also be engraved
- Needs little manpower; safe, as it will not run with the lid open

Disadvantages

- The size of sheet is limited by the size of the laser bed
- Some polymers, such as PVC, cannot be cut as they give off toxic fumes
- Staining from the bed can mark the polymer surface
- A ventilation system is needed, and its filters need replacing
- Expensive to buy, install, service and repair; training is needed
- Settings differ for each thickness, and wrong settings damage the edge

Band	Marks	Descriptor
3	4 to 5	A coherent answer with detailed, relevant knowledge and understanding of the advantages and disadvantages of laser cutting sheet polymers. Relevant examples and a well-developed, logical chain of reasoning, sustained throughout.
2	2 to 3	Some coherence, with partial knowledge and understanding. Mostly relevant examples and a logical chain of reasoning that may not be sustained throughout.
1	1	Basic knowledge and understanding. Limited relevant examples or logical chain of reasoning.
0	0	Incorrect or irrelevant answers.