**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)**

**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 then 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.