Now test yourself answers

1 Exploring the context of a design solution
1 Three from: food, water, love, clothing, toilet facilities, interaction/stimulation.
2 A primary user is the main user of a product or service; a stakeholder is a person, group or organisation that has an interest in the product or service.
3 One from: money, education, employment.
4 Designers must consider whether their design is acceptable in society. Does it encourage antisocial behaviour or have harmful effects on the environment? If it does, then it would be wrong to produce that product or service.
5 Inclusive.

2 Usability
1 How easy a product is to use, how clear and obvious the functions are.
2 The relationship between people and the objects they use.
3 Anthropometrics.
4 Inclusive design.
5 Purple.

3 Opportunities and constraints that influence design and making
1 Correct, good or honourable design.
2 Four from:
   - Function, materials and components
   - Methods of construction and manufacture
   - Ergonomic and anthropometric considerations
   - Aesthetics, fashion and style
   - How the product impacts the environment during its use, ease of recycling
   - How the product has been influenced by the work of past and present designers.
3 To promote/advertise or sell a product or service.
4 Looking at how the manufacture of the product might have an impact on the environment, including sourcing of materials and their manufacture.

4 Developments in technology and their influence on design decisions and practice
1 The needs of people and the environment.
2 An obsolete product is one that is no longer of use.
3 Planned obsolescence is deliberately making an item out of date.
4 Any two from: rethink, reuse, recycle, repair, reduce and refuse.
5 A product enhancement is a change or upgrade to a product that increases its capabilities.

5 The impact of new and emerging technologies when developing design solutions
1 For example: Artificial intelligence, such as software that helps us make online transactions, may increase unemployment due to transactions being carried out by computers.
2 For example: Drones have the ability to carry out courier deliveries but there will still be the need for technically skilled people to manage an efficient drone delivery network.
3 People can become addicted to using social networks and become victims of online fraud.
4 A circular economy is an alternative to a traditional linear economy (make, use and dispose) in which:
   - The resources are kept in use for as long as possible.
   - The maximum value is extracted from them while they are in use.
   - Parts and materials are recovered and regenerated at the end of their life.
5 In cradle-to-cradle production (as opposed to cradle-to-grave), all materials and inputs and outputs are seen as either technical or biological nutrients. Technical nutrients can be recycled or reused with no loss of quality; biological nutrients can be composted or consumed.

6 Sources of energy

1 Any two from: oil, natural gas and coal.
2 Kinetic energy is the energy in a moving object.
3 Renewable energy sources can be replenished naturally in a short period of time.
4 Non-renewable energy comes from sources that will run out or will not be replenished in our lifetimes. Most non-renewable energy sources are fossil fuels: coal, petroleum, and natural gas.
5 One mark for any from: carbon dioxide, sulphur dioxide, nitrogen oxide and other volatile organic compounds.

7 Environmental, social and economic influences

1 Fair trade is about establishing better prices, working conditions and terms of trade for farmers and workers.
2 Any two from: tea, coffee, chocolate and rice or similar products.
3 Social awareness means an understanding of how products impact upon people.
4 Ethical awareness is concerned with doing the right thing.
5 The 2016 Paris Agreement or the UK Sustainable Development Strategy.

8 Communicating design solutions

1 Any two from:
   - At the start of a design task to facilitate understanding and analysis of the problem and context.
   - For initial design ideas.
   - To explain a design concept.
   - To help sell or promote the product.
2 Any two from: one point perspective, two point perspective, oblique, isometric or exploded drawing.
3 Front view, end view and plan.
4 Any two from:
   - It is cost effective as no physical components are used.
   - It is quick and can speed up the production process.
   - It can predict stresses so that, if necessary, they can be strengthened before production begins.
   - It can assist with rapid prototyping.
5 Flowcharts can be used to control quality by adding feedback loops to decision boxes.

9 Sources of information and thinking when problem solving

1 Four from: questionnaires; interview focus groups; analyse similar products; surveys; observations; secondary research such as newspapers; internet; books etc.
2 User-centred design.
3 Considering the whole of a problem/product rather than focusing one aspect alone.
4 Collaboration.

10 Categories of materials

1 Thermo polymers and thermosetting polymers.
2 Strong but lightweight, can absorb knocks and bumps, stiff and difficult to bend or fold, especially when folding across the flutes.
3 5 mm.
4 To improve the quality, aesthetics, strength, breathability, absorbency and crease resistance. Blending can also lower the overall cost of a fabric.
5 Any three from:
   - Medium-density fibreboard (MDF)
   - Plywood
   - Hardboard
   - Chipboard
   - Blockboard.
6 To improve the quality, aesthetics, strength, breathability, absorbency and crease resistance. Blending can also lower the overall cost of a fabric.
7 Any of the following:
   - Hardwood trees are deciduous (lose their leaves in winter); softwood trees do not.
   - Hardwood trees have broad leaves; softwood trees have needles.
   - Hardwood trees have thick trunks with branches at the top; softwood trees have branches all the way up.
   - Hardwood trees generally take much longer to grow than softwood trees.
8 Any two from the following:
   - Available in large sheets
   - Less expensive
   - No knots or grain
   - Easy to work with.
9 The three main differences:
- Ferrous metals contain iron; non-ferrous metals do not.
- Ferrous metals are magnetic; non-ferrous metals are not.
- Ferrous metals will rust much quicker than non-ferrous metals.

11 Characteristic properties of materials

1 How well the material can withstand compression forces [squashing forces].
2 When describing the strength of textiles and fabrics.
3 True.
4 Good thermal resistance or porous material.
5 Acrylic, wool or viscose.

12 Controlled movement

1 One mark each for:
   - Rotary motion
   - Linear motion
   - Oscillating motion
   - Reciprocating motion.
2 Newtons.
3 One mark for a sketch of a cam (oval) and one mark for a follower resting against the cam profile.
4 Gear train.
5 One mark for a sketch of a pulley and one mark for a sketch of a belt.

13 Electronic systems

1 Any three of the following:
   - Any kind of finger-operated switch [rocker, slide, push, toggle etc.]
   - Microswitch [a type of push switch]
   - Reed switch [senses magnetic field]
   - Tilt switch [senses movement]
   - Passive infrared [PIR] sensor [senses heat and movement]
   - Light sensor [light-dependent resistor]
   - Thermistor [temperature sensor]
   - Microphone [sound sensor].
2 Speaker or buzzer [sound]
3 A microcontroller takes information received from input devices and processes it into electrical signals that are then sent to different output devices.
4 Embedded programs are programmed into appliances during manufacture and cannot be changed or modified by the user. For example, a washing machine has set programs programmed; the user can select which program they want to run but not change any.
5 A speaker can create a wide range of different sounds and noises including speech. A buzzer just emits a single tone. The tone can be varied in pitch by altering the voltage but this is the only sound it can make.

14 The impact of new and emerging technologies on production techniques and systems

1 One mark for any of the following:
   - Large electronic documents can be transferred instantly, regardless of distance.
   - The internet has enabled online research.
   - Marketing, advertising and sales opportunities have increased greatly.
2 Economies of scale are the cost advantages that a manufacturer gains as a result of the size, output or scale of their production.
3 One mark for each of the following [maximum two marks]:
   - Meets the needs of individual clients more easily.
   - Reacts to fashions and trends.
   - Reduces the costs of storing final assembled products.
4 A disruptive technology is one that displaces an established technology and shakes up the industry, or a ground-breaking product that creates a completely new industry.
5 One mark for each of the following [maximum two marks]:
   - Additive manufacturing
   - Advanced robotics
   - The Internet of Things
   - Virtual reality.

15 Papers and boards

1 Virgin wood.
2 Microns.
3 False.
4 By adding folds, curves or bends to the card/paper shape, or by adding another material or layer.
5 CMYK: Cyan, Magenta, Yellow and Key (black).
16 Natural and manufactured timber
1 Any three from: head type, length, gauge, material and finish.
2 Supports the hinged joint along its full length; can be cut to any size.
3 Rigid joint, connector bolt, cross dowel, cam lock, table plate, block fitting, bench top joiner.
4 Any three from: oiling, lacquering, varnishing, French polish.
5 Model making.
6 Making a series of parallel cuts into the back of timber to help it curve easily.

17 Ferrous and non-ferrous metals
1 Spectacle frames, dental braces.
2 Used to extract metals using carbon or carbon monoxide reduction.
3 Damage to buildings, breathing problems for humans, damage to forest ecosystems.
4 Two from: bench shears, aviation shears, tin snips, nibblers.
5 CNC lathe, CNC milling machine, CNC router.

18 Thermo and thermosetting polymers
1 One mark for any of the following, up to a maximum of two marks:
   - Lightweight
   - Waterproof
   - Tough
   - Electrical and/or thermal insulators
   - Resistant to atmospheric degradation (they will not rot like timber or rust like metal).
2 One mark for any of the following, up to a maximum of two marks:
   - Plasticisers
   - Pigments
   - Stabilisers
   - Fillers
   - Catalysts
   - Antioxidants.
3 One mark for any of the following, up to a maximum of two marks:
   - Sheet
   - Granules
   - Rods
   - Extruded sections
   - Tubes
   - Foamed plastics
   - Powdered polymers
   - Reels.
4 Polymers that are attacked by ultraviolet light fade over time and become brittle.
5 One mark for any of the following, up to a maximum of two marks:
   - GRP layup
   - GRP moulding
   - Fabricating
   - CNC machining
   - 3D printing.

19 Fibres and textiles
1 Muslin, calico.
2 True.
3 A twill weave.
4 Low wages and working conditions for workers; unsustainable materials and/or manufacturing methods; more waste.
5 To provide support, structure or shape.

20 Electronic and mechanical systems and control (design engineering)
1 a) A first class lever: scissors, pliers, hammer extracting a nail, bicycle brake lever.
   b) A second class lever: wheelbarrow, bottle opener, nutcracker.
   c) A third class lever: tweezers, staple remover, salad tongs.
2 a) Driver gear = 25 teeth; driven gear = 75 teeth; gear ratio = 25 : 75 = 1 : 3
   b) Driver pulley = 60 mm diameter; driven pulley = 12 mm diameter; gear ratio = 60 : 12 = 5 : 1
3 A chain is much less likely to slip or snap.
4 Light-dependent resistor (LDR; a light sensor); thermistor (temperature sensor).
5 Speakers can produce different sounds and speech. Buzzers only produce a tone.
Exam practice answers

In this section you will see some examples of the types of questions you may get in your written examination. They show some candidates’ responses and there is an explanation of why the marks were awarded.

Papers and boards

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takeaway pizza box has a flat top and bottom</td>
<td>So the boxes can be easily stacked on top of each other.</td>
</tr>
<tr>
<td>Square-shaped package</td>
<td>Square box so that the circular pizza can fit in and be held securely, reducing damage.</td>
</tr>
<tr>
<td>Corrugated cardboard material</td>
<td>Double-walled material that has good heat insulation.</td>
</tr>
<tr>
<td>Logo and instructions</td>
<td>Logo advertises the company that makes the pizza, heating instructions, allergy or ingredients printed on the box for customer.</td>
</tr>
<tr>
<td>One piece net (development)</td>
<td>Box can be easily and quickly assembled, no need for glue.</td>
</tr>
</tbody>
</table>

b) Grease and food spillage from the pizza may contaminate the box; grease is difficult to remove from fibres as oil resists water. If recycled, the grease causes dark spots on the new paper.

c) 55 per cent.

d) 1 Timber from trees is mechanically chipped into small pieces.

2 Wood chips are soaked in water then ground into fibres (pulp).

3 Pulp is drained and sprayed on to mesh to dry.

4 Pressed through heated rollers to dry and flatten.

Timbers

1 a) Finger joint or comb joint

b) Housing joint

c) Dowel Joint

2 • Mark out positions of channels using pencil square and ruler.

• Set up a suitable fence on the wood or set the fence on the table router to the appropriate position.

• Fit a flat cutter bit into the router.

• Pass the timber along the fence on the table router or pass the router along the fence on the timber.

3 Teak oil, Danish oil
Metals

1 Any three from:

<table>
<thead>
<tr>
<th>Shape</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td><img src="image1.png" alt="Round" /></td>
</tr>
<tr>
<td>Box</td>
<td><img src="image2.png" alt="Box" /></td>
</tr>
<tr>
<td>Tube</td>
<td><img src="image3.png" alt="Tube" /></td>
</tr>
<tr>
<td>T-section</td>
<td><img src="image4.png" alt="T-section" /></td>
</tr>
<tr>
<td>RSJ</td>
<td><img src="image5.png" alt="RSJ" /></td>
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<tr>
<td>Channel</td>
<td><img src="image6.png" alt="Channel" /></td>
</tr>
<tr>
<td>Angle</td>
<td><img src="image7.png" alt="Angle" /></td>
</tr>
<tr>
<td>Hexagon</td>
<td><img src="image8.png" alt="Hexagon" /></td>
</tr>
<tr>
<td>Square</td>
<td><img src="image9.png" alt="Square" /></td>
</tr>
</tbody>
</table>

2 a) Hacksaw, angle grinder  
   b) File, bench grinder

Polymers

1 Any two of:  
- Can easily be moulded into shape.  
- Hygienic – will not contaminate the juice.  
- Impact resistant.  
- Provides a moisture barrier (can hold a liquid).  
- Transparent, so you can see the juice.  
- Can be recycled.
2 One mark for each stage in the process shown with sketches and notes. The sixth mark is for high-quality sketches and notes – must include technical terms such as parison.

3 Acceptable answers:
- Polyethylene
- Low-density polyethylene (LDPE)
- High-density polyethylene (HDPE)
- Polypropylene

4 Initial costs are high due to the cost of producing the injection forming mould. This cost is shared out across the number of products being made, so if you make lots of products the cost per product reduces.

5 a) Anticipated answers include:
- Easy to print on.
- Flexible, so it fits the shape of the bottle.
- Can be recycled.

b) Acceptable answers:
- Provides a glue area.
- Avoids an unsightly joint.

Acceptable answers are likely to focus on the joining method.

c) Pi (π) = 3.142.
120 × 3.142 + 10 = 387 mm.
Marks awarded for:
- Label length of between 350 mm and 400 mm.
- 10 mm overlap added to any length label.
- Correct answer +/− 3 mm.

6 Answers could include:
- Examples of information on labels such as product name, ingredients, weight/volume, recycling symbols, barcode, manufacturer contact details, instructions on use.
- Understanding of why this information would be useful for consumers; for example, weight/volume allows consumers to compare the price of similar products.
- Understanding of how information can protect consumers; for example a list of ingredients allows consumers to avoid substances that they might be allergic to.

**Textiles**

1 a) Wool, silk, cotton or linen

b) Polyester, nylon, acrylic, viscose or elastane

c) A blended fibre is where the fibres of at least two different origins are mixed together to improve the properties of the finished yarn. An example is polycotton, where polyester and cotton are mixed together to have the benefits of both fibres.

d) Felt
e) | Property | Description |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulating</td>
<td>Keeps us warm</td>
</tr>
<tr>
<td>Absorbent</td>
<td>Sucks up moisture</td>
</tr>
<tr>
<td>Durable</td>
<td>Resists wear and tear</td>
</tr>
<tr>
<td>Drape</td>
<td>The way the fabric hangs</td>
</tr>
<tr>
<td>Elasticity</td>
<td>How well the fabric or fibres stretch</td>
</tr>
<tr>
<td>Handle</td>
<td>The level of comfort against the skin</td>
</tr>
</tbody>
</table>

Design engineering (electronic systems)

1. A: Halogen light bulb
   B: Infrared sensor, passive infrared sensor (PIR)

2. **START**

   - Turn light off
   - Is it dark?
     - NO
     - Is there any movement?
       - NO
       - Turn light off
       - WAIT 2 minutes
     - YES
     - Turn light on