Please write clearly, in block capitals

Centre number _____ **Candidate number** _____

Surname _____

Forenames(s) _____

Candidate's signature _____

GCSE Design and Technology

Date of Exam _____ **Time allowed: 2 hours**

Materials

For this paper you must have:

- normal writing and drawing instruments
- a calculator
- a protractor

Instructions

- Use black ink or black ball-point pen. Use pencil only for drawing
- Fill in the information at the top of this page
- Answer all questions
- You must answer the questions in the spaces provided. Do not write on blank pages
- Do all rough work in this paper. Cross through any work that you do not want to be marked

Information

- The marks for questions are shown in brackets
- The maximum mark for this paper is 100
- There are 20 marks for Section A, 30 marks for Section B and 50 marks for Section C

SECTION A - Core Technical Principles

Questions 1-10 are multiple choice questions. For multiple choice questions you should shade in one lozenge. If you make a mistake, cross through the incorrect answer and shade the correct response.

1: Which of the following power sources is classed as a fossil fuel? [1 mark]

- ◊ Hydroelectric
- ◊ Natural gas
- ◊ Nuclear
- ◊ Tidal

2: **Figure 1** shows an inflated balloon being held.

Figure 1

What is the force that is acting upon the air inside the balloon? [1 mark]

- ◊ Compression
- ◊ Shear
- ◊ Tension
- ◊ Torsion

3: What is the voltage of a single cell found in a **non**-rechargeable AA battery? [1 mark]

- ◊ 1.5 volts
- ◊ 3 volts
- ◊ 5 volts
- ◊ 12 volts

4: Which of the following materials change state in response to ultraviolet light? [1 mark]

- ◊ Graphene
- ◊ Photochromic pigment
- ◊ Shape memory alloy
- ◊ Thermochromic pigment

5: Which of the following is used as an output component? [1 mark]

- ◊ Heat sensor
- ◊ Lamp
- ◊ Pressure sensor
- ◊ Switch

6: Which motion best describes a child's swing in use? [1 mark]

- ◊ Linear
- ◊ Oscillating
- ◊ Reciprocating
- ◊ Rotary

7: State the value of the weight needed at point **A** in **figure 2** for the scales to balance? [1 mark]

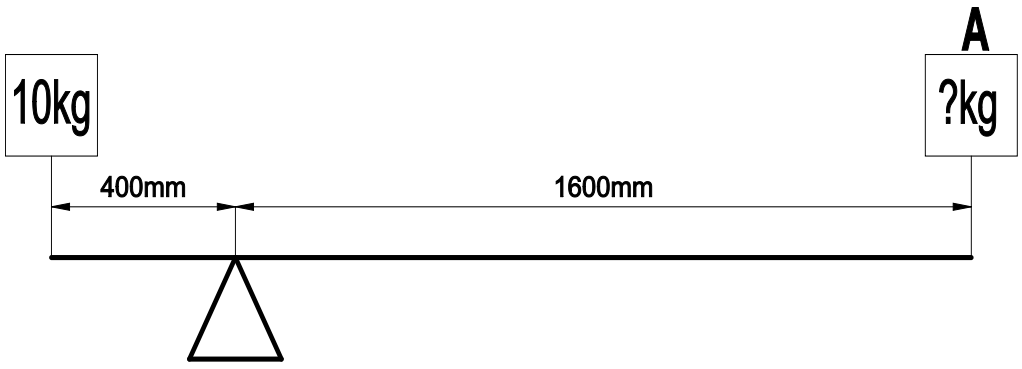


Figure 2

- ◊ 2.5kg
- ◊ 3.3kg
- ◊ 5kg
- ◊ 10kg

8: Which **one** of the following cams can only be rotated in a single direction? [1 mark]

- ◊ Eccentric
- ◊ Heart
- ◊ Pear
- ◊ Snail

9: Which of the following is a ferrous metal? [1 mark]

- ◊ Aluminium
- ◊ Low carbon steel
- ◊ Tin
- ◊ Zinc

10: **Figure 3** shows a rotary system.

Figure 3

What is the name of the rotary system in **figure 3** above? [1 mark]

- ◊ Chain and sprocket
- ◊ Crank and slider
- ◊ Gear train
- ◊ Pulley and belt

11: State **two** properties or characteristics that make medium density fibreboard (MDF) suitable for use in flatpack furniture. [2 marks]

1. _____

_____

2. _____

_____

12: State **two** reasons why high-speed steel (HSS) is used for cutting tools. [2 marks]

1. _____

_____

2. _____

_____

13.1: The Committee on Climate Change state that 40% of the UK's emissions come from households. In 1990 each household produced an average of 12.8 tonnes of $C0_2$, in 2014 this had reduced to 8.1 tonnes.

Give **two** reasons why the amount of CO_2 per household has reduced during this period. [2 marks]

1. _____

_____

2. _____

_____

13.2: The target for household emissions by 2030 is 4.5 tonnes per household.

Explain how households could change their behaviours to help meet this target. [2 marks]

_____

_____

_____

_____

13.3: If the target for 2030 of 4.5 tonnes per household is met, what would be the percentage reduction from the 1990 level of 12.8 tonnes per household? [2 marks]

Show your working out and give your answer to 1 decimal point.

SECTION B - Specialist Technical Principles

Finishing treatments and techniques

Specialist finishing techniques include:

Tanalising	Spot (UV) varnishing	Stain protection
Self-adhesive decals	PCB lacquering (conformal coating)	Plastic dip coating

14.1: Choose **one** specialist treatment or technique from the list above.

Name of chosen specialist treatment or technique _____

Give **one** reason why the treatment or technique is used. [1 mark]

_____

_____

14.2: In the box below, use notes and sketches to explain how your chosen treatment or technique from **14.1** is performed using an appropriate material(s) of your choice. [4 marks]

15: Give **two** reasons why tolerances are used in designing and manufacturing products.

Give **one** example in each of your answers.

1. [2 marks]

2. [2 marks]

16.1: Choose one product, material or component in **figure 4** and describe **two** features that make it suitable for computer aided manufacturing (CAM).

		
Laser cut clothes	Laser cut metal signage	3D printed polymer parts
		
CNC routed furniture	Laser cut card stationary	CNC routed PCB

Figure 4

Name of chosen product, material or component _____

Feature 1 [2 marks]

_____

_____

_____

_____

_____

Feature 2 [2 marks]

16.2: Choose **one** specific computer aided manufacturing process that you are familiar with. This may have been one used on your chosen product/component/material in **16.1**.

Name of chosen specialist CAM process _____

In the box below, use notes and sketches to explain a CAM process in detail. [4 marks]

17.1: Circle **one** of the following and give **two** different reasons why its functional and/or aesthetic characteristics are suited for the intended use.

- **High impact polystyrene (HIPS)** – for moulded yoghurt pots
- **Bleed proof paper** – for drawing rendered designs with marker pens
- **Stainless steel** – for a cutlery set
- **Beech** – for a child's wooden train set
- **Cotton** – for a pair of hiking socks
- **Buzzer** – for use in a battery operated electronic quiz game

1. [2 marks]

2. [2 marks]

17.2: Choose one of the materials or components listed in **17.1** and name **one** of the primary sources it is made from. [1 mark]

18: Manufacturers and designers often conduct a **'lifecycle assessment'** to understand the impact that a product or a service has on the environment.

Describe the five stages of a lifecycle assessment and evaluate how the results could influence the way a product is manufactured. [8 marks]

SECTION C – Designing and Making Principles

Figure 5 shows a pair of walking aids used by teenagers and adults after leg or back injuries.

Figure 5

Specification

- Lightweight
- Provides support to upper arm
- Comfortable hand grip
- Non-slip feet
- Adjustable height

Evaluate the walking aids shown in **figure 5** in terms of the following points.

19.1: Suitability for the user [4 marks]

19.2: Ergonomics [4 marks]

20.1: Explain what is meant by the term '**design fixation'** and suggest strategies that designers could use to avoid it happening. [4 marks]

20.2: Describe and justify **two** tests that might be carried out on the walking aids shown below that would ensure they were fit for purpose.

Justify why each test is appropriate.

1. [2 marks]

2. [2 marks]

21.1: An environmentally conscious entrepreneur is designing and making a solar powered USB charger for use in remote areas of developing countries where electricity is not available.

When deciding which materials, components and manufacturers to use to make the solar chargers, there are many important factors to consider.

Explain and justify **one** way designers can reduce negative global impact on the following factors:

a) Deforestation. [2 marks]

b) CO_2 levels. [2 marks]

c) Poorly paid and unsafe working conditions. [2 marks]

d) Waste going to landfill sites. [2 marks]

21.2: Some of the manufacturing costs of the solar USB charger are listed in the table below. Difficult decisions need to be made regarding the sourcing of materials and components.

Study the table below:

Materials & component costs	**Cost 1**	**Cost 2**	**Cost 2**	**Total**
Casing made from a plant based biopolymer	£0.85			
Casing made from oil-based polymer	£0.55			
Solar cell from an unknown supplier		£1.25		
Solar cell from a reliable supplier		£1.75		
Packaging materials from managed forest (FSC)			£0.30	
Packaging materials from unmanaged forest			£0.20	

a) What is the total cost of the three most environmentally and socially responsible options? Show your working out in your answer. [2 marks]

b) If the designer took the cheapest option, how much cheaper would it be than the option taken in 21.2a? Show your working out in your answer. [2 marks]

c) The designer took the socially and environmentally friendly option to make 2500 solar chargers. Remembering his strategy of giving away one charger for every one sold, how much money did he raise from crowd funding?

Show your working out in your answer. [2 marks]

22.1: Audio and visual recordings are used by designers to find out important information that may influence the design of a product.

Describe **two** different ways that designers could gather information from audio or video recordings and explain why they might use these techniques.

1. [2 marks]

2. [2 marks]

22.2: Explain why designers may use mathematical modelling in the design process. [3 marks]

23.1: Designers often use a combination of primary and secondary data sources to research and investigate how they should design products and services.

Explain the difference between primary and secondary data sources for gathering research, giving **one** example for each. [3 marks]

24: Study **Figure 6**, an exploded drawing of a child's shape sorter toy.

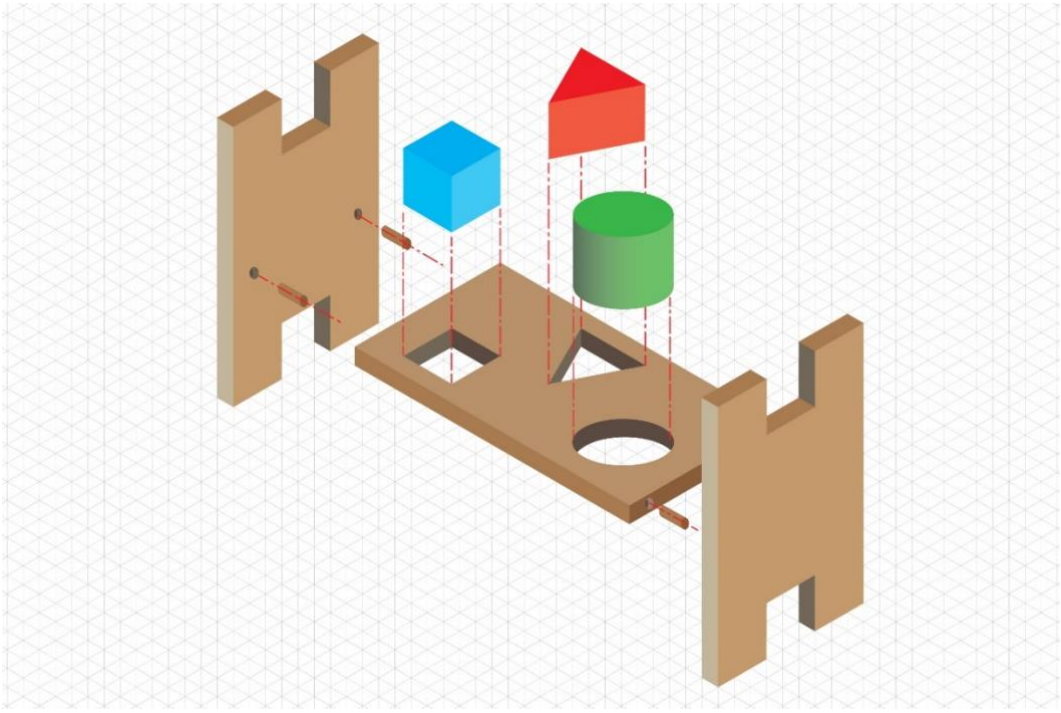


Figure 6

Recreate the shape sorter toy as a **complete product** with the shapes inserted half-way into the appropriate holes. Draw in isometric projection on the grid paper below. Draw the parts to the same scale as the exploded drawing. [4 marks]

Do **not** colour or shade the drawing.

25: Tessellation is a method used to interlock shapes together with little or no waste.

A manufacturer is cutting components from a sheet of material measuring 70mm by 60mm.

The component size is shown in **figure 7**. It can be laid in any position on the sheet.

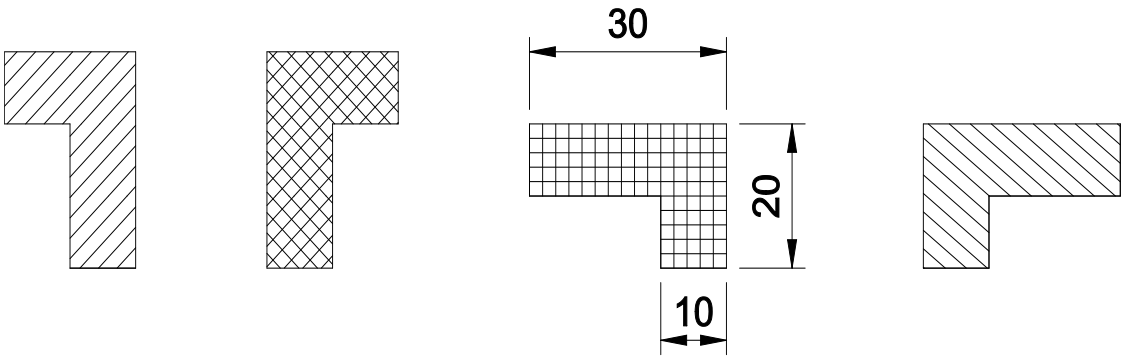
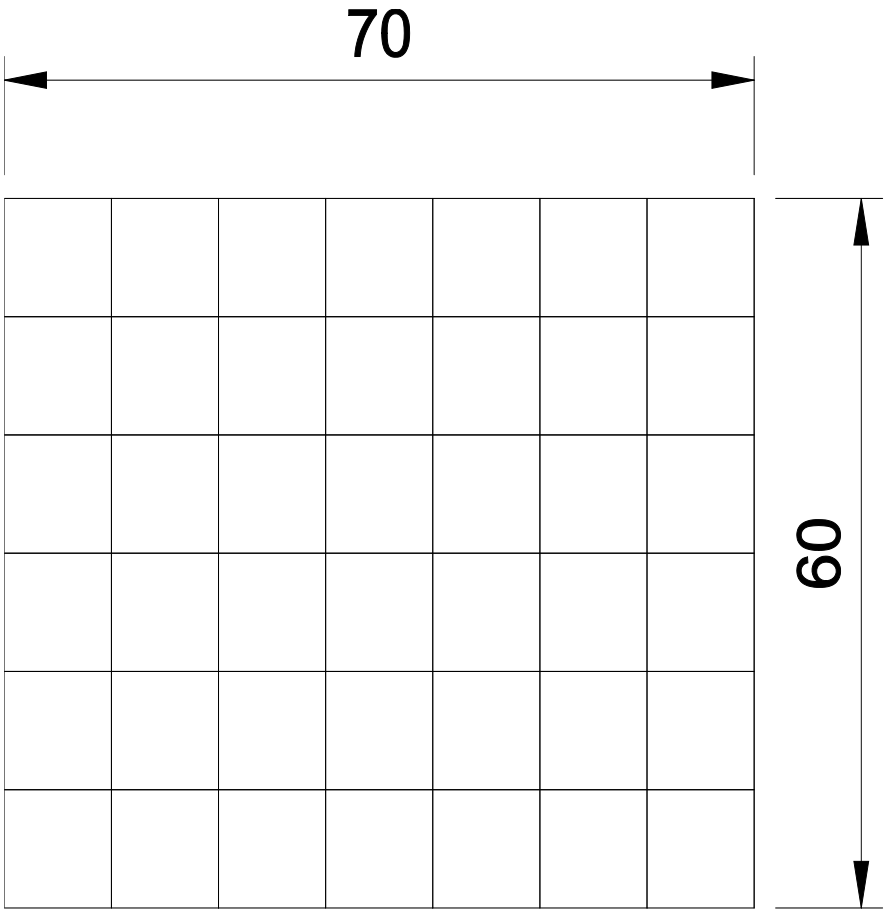


Figure 7

25.1: Tessellate as many of the components above on to the grid below. [2 marks]

Vary the shading of the components, as suggested above, so that they can be identified separately on the sheet.



25.2: The sheet of material used in **25.1** costs £3.78.

Calculate the following and show your working out in your answer:

a) The cost per component in pence. [2 marks]

b) Calculate how much waste material is created and its cost in pence. [2 marks]

END OF QUESTIONS