

Thursday 9 June 2022 – Afternoon

A Level in Design and Technology: Product Design

H406/01 Principles of Product Design

Time allowed: 1 hour 30 minutes



You can use:

- a ruler (cm/mm)
- a scientific calculator
- geometrical instruments



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **80**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE

- Read each question carefully before you start your answer.

Answer **all** the questions.

- 1 Toothbrushes are used to clean the teeth and gums of children and adults.

Fig. 1.1 shows two views of a manual toothbrush.

Fig. 1.2 shows two views of an electric toothbrush which has a battery powered oscillating brush.

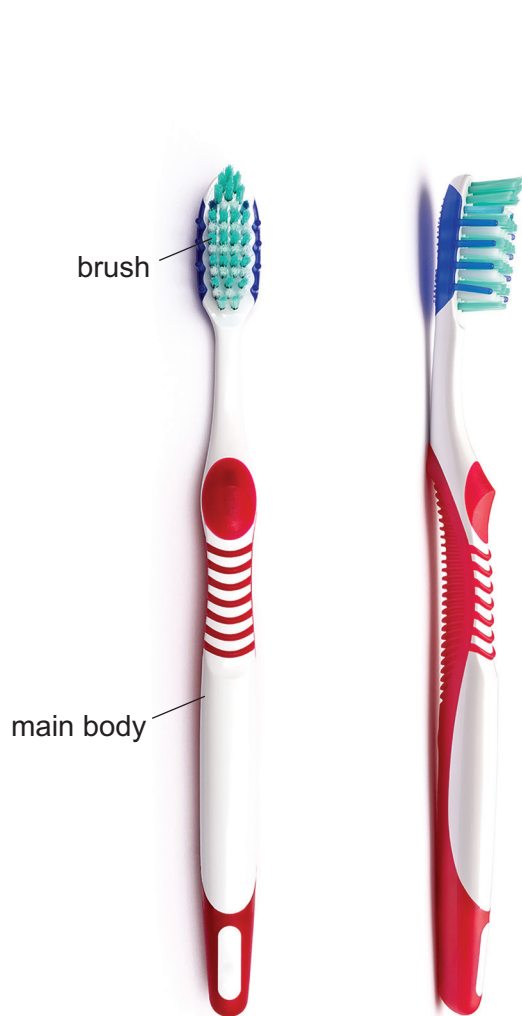


Fig. 1.1



Fig. 1.2

(a) Both toothbrushes use injection moulding in the manufacture of the handle.

(i) Identify a suitable specific material for the main body of the manual toothbrush in **Fig. 1.1**.

..... [1]

(ii) Give **two** reasons why the material identified in **part (a)(i)** is suitable.

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[2]

(iii) Describe how the handle of the electric toothbrush in **Fig. 1.2** would be manufactured to incorporate two different colours of plastic.

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..... [2]

(b) The electric toothbrush in **Fig. 1.2** is manufactured using a fully automated process.

(i) Describe what is meant by fully automated manufacture.

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..... [2]

(ii) Justify why this process is suitable.

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..... [1]

(c) Describe **one** way in which the toothbrush shown in **Fig. 1.2** could be made more inclusive for a wider range of users.

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..... [2]

(d) (i) Identify **three** possible environmental issues that could be caused by the design of the toothbrush shown in **Fig. 1.1**.

Justify **each** of your answers.

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[6]

- (ii) Explain **three** ways in which the design of the toothbrushes could be developed to further reduce their environmental impact.

Refer to **Fig. 1.1** and/or **Fig. 1.2** in your answer.

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[6]

- 2 Musicians in an orchestra are usually seated to play their instruments. They use a music stand to hold the sheet music.

Fig. 2.1 shows a music stand with an adjustable height. The music holder is made from sheet metal.



Fig. 2.1

- (a) Identify a suitable metal for the music holder.

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..... [1]

- (b) Identify a suitable surface finish for the metal you have identified in part (a). Describe the method of application.

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..... [2]

The music holder has 45 holes punched through it.

Fig. 2.2 shows an orthographic drawing of the music holder.

Fig. 2.3 shows an isometric drawing of the music holder.

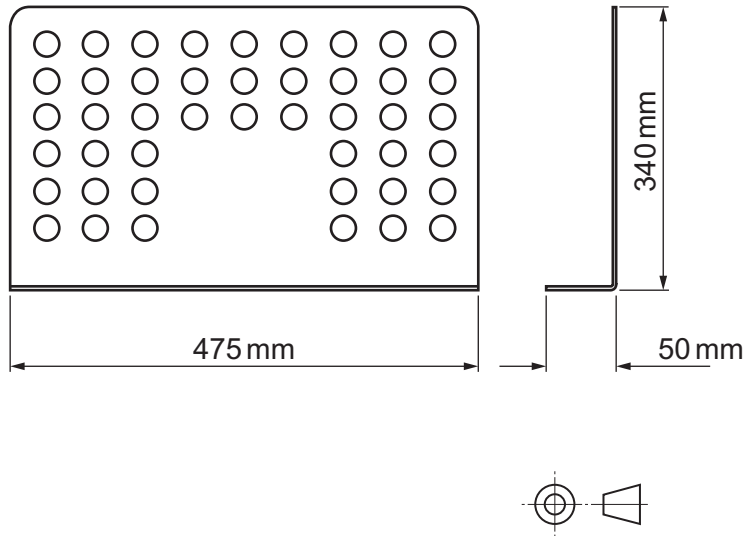


Fig. 2.2
(not to scale)

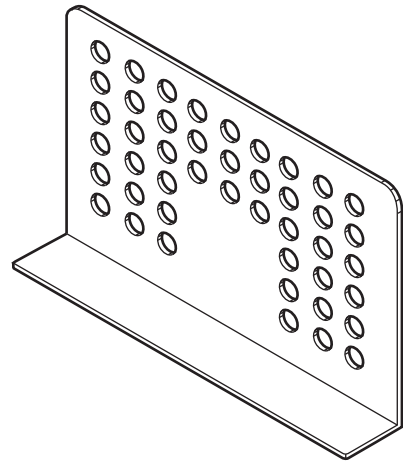


Fig. 2.3

- (c) (i) The diameter of each hole in the music holder is 20 mm.

Calculate the total area of the 45 holes in the music holder. Give your answer in mm^2 and show your working. **[3]**

Total area of 45 holes mm^2

Fig. 2.4 shows part of the music holder.

Fig. 2.5 shows a close up of one of the rounded corners of the music holder.

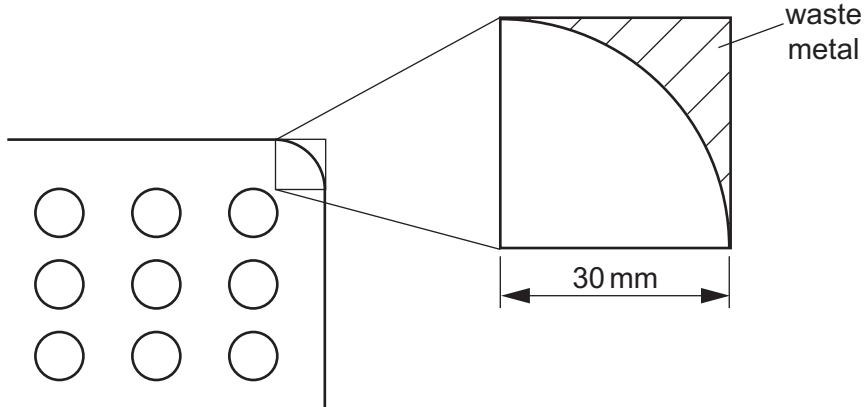


Fig. 2.4

Fig. 2.5
(not to scale)

(ii) The thickness of the metal used is 1 mm.

Calculate the total amount of waste metal that would be created when shaping the top corners of the music stand. Give your answer in mm^3 to 2 decimal places and show your working.

The formula for calculating the area of a curve = $\pi r^2 / 4$

[5]

Total amount of waste metal mm^3

- (iii) Use your calculations in **part (c)(i)** and **part (c)(ii)** to calculate the overall surface area of the music holder as shown in **Fig. 2.2** and **Fig. 2.3**. Give your answer in mm^2 and show your working. [3]

Repeat of Fig. 2.2/ Fig. 2.3:

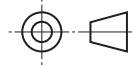
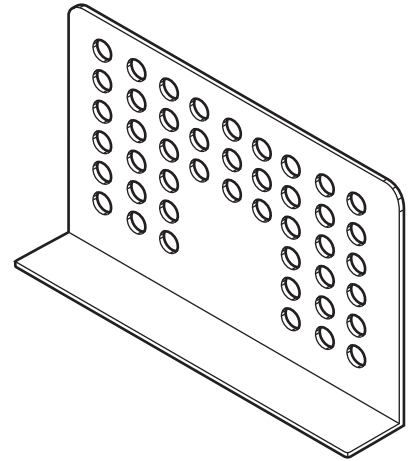
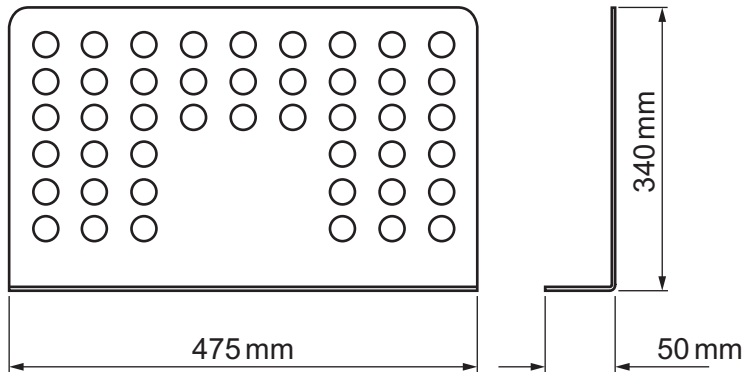


Fig. 2.2
(not to scale)

Fig. 2.3

Overall surface area mm^2

Fig. 2.6 shows the arrangement of holes for the music holder.

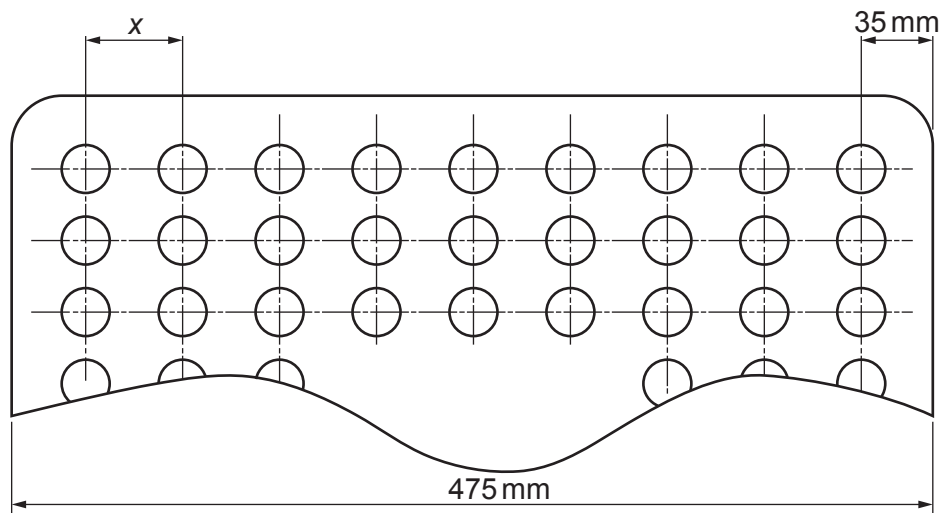


Fig. 2.6
(not to scale)

(d) Calculate distance x in mm if the holes are evenly distributed. Show your working. [2]

Distance x mm

11
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Fig. 2.7 shows anthropometric data in a table and reference diagrams.

Dimensions (mm)	Age Range 5–9			Age Range 13–19			Age Range 19–65					
	Combined (Percentiles)			Combined (Percentiles)			Men (Percentiles)			Women (Percentiles)		
	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
10 Sitting height	594	694	797	774	908	968	860	915	970	800	855	910
11 Sitting eye height	446	570	648	640	759	834	740	800	860	700	750	800
12 Sitting shoulder	315	390	440	520	575	635	570	615	660	530	580	630
13 Sitting elbow height	120	160	205	185	232	285	210	250	290	190	235	280
14 Thigh thickness	81	116	169	116	153	178	130	155	180	120	150	180
15 Popliteal height (lower leg length)	220	295	340	360	435	485	410	450	490	370	410	450
16 Knee height	315	393	481	456	525	558	490	535	580	460	495	530
17 Buttock-popliteal length	230	300	350	430	480	545	450	510	570	440	500	560
18 Buttock-knee length	321	410	511	490	571	628	560	605	670	520	585	650
19 Abdominal depth	140	165	195	185	215	270	220	275	330	200	270	340
20 Chest depth	125	140	170	210	230	265	210	245	280	210	250	290

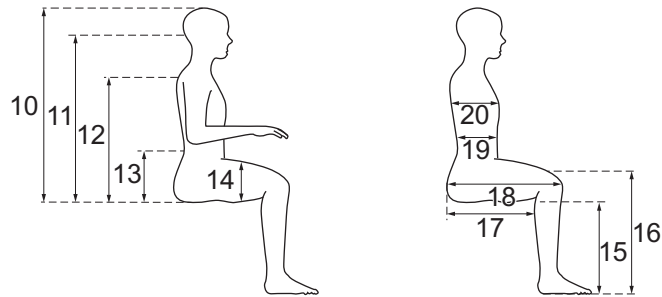


Fig. 2.7

- (e) (i) The music stand will have an adjustable height and the sitting eye height of the users must be considered.

Use the information in Fig. 2.7 to identify the minimum and maximum sitting eye height for 90% of both adults and children over 13. [2]

Minimum sitting eye height mm

Maximum sitting eye height mm

- (ii) Justify your answer to part (e)(i).

.....

..... [1]

(iii) The music stand will be used by equal numbers of men, women and children over 13.

Use the information in **Fig. 2.7** to calculate the mean sitting eye height. Give your answer to the nearest mm. Show your working.

[2]

Mean sitting eye height mm

3 Designers assess whether a design solution meets its stakeholder requirements.

(a) (i) State **two** organisations that issue standards that need to be met in the design of products.

1

2

[2]

(ii) Explain **two** ways in which product designers and manufacturers could test their products to ensure they meet relevant standards.

Make reference to products in your answer.

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[4]

4 Fig. 4.1 shows a swing seat manufactured from hardwood.

The swing seat has three main parts which include the seat, the frame and the chains. The chains allow the seat to hang and swing.

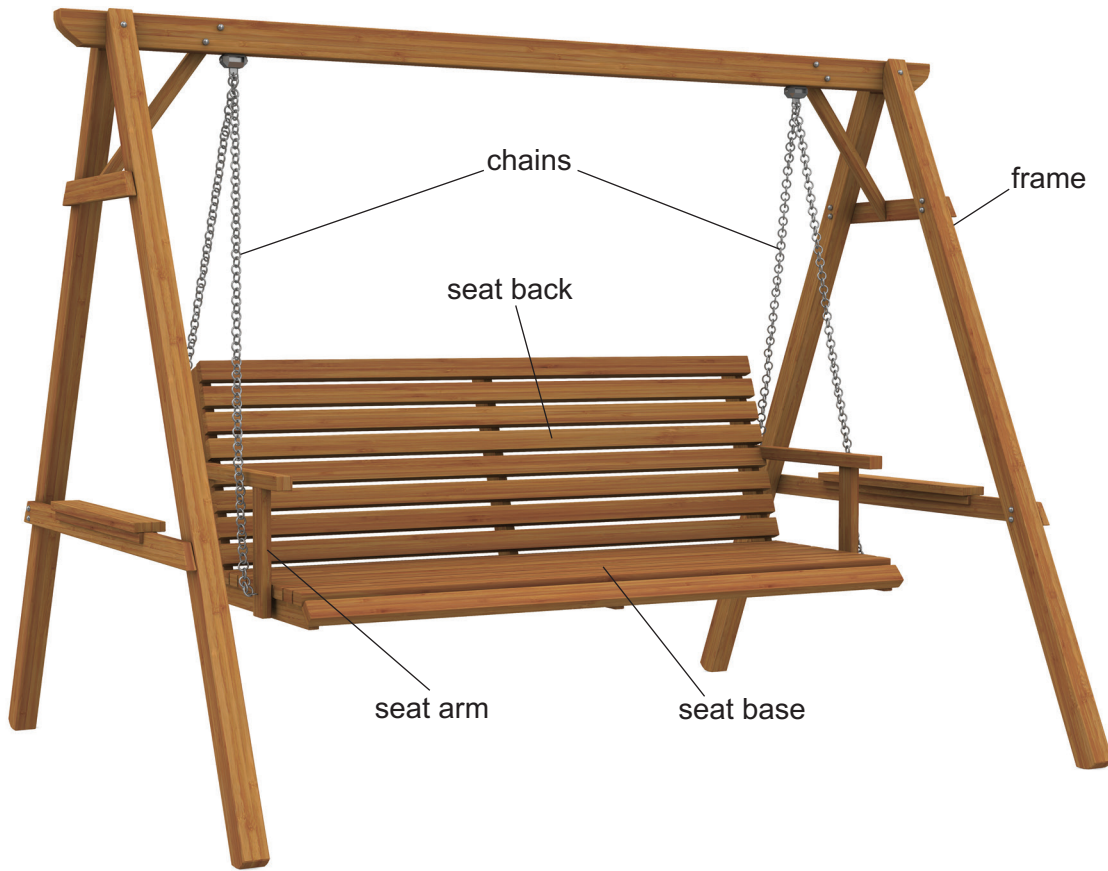


Fig. 4.1

(a) Describe **two** features of the frame of the swing seat that improve its structural integrity.

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[4]

(b) Identify a suitable hardwood for the manufacture of the swing seat.

Justify your answer.

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..... [2]

(c) The swing seat shown in **Fig. 4.1** is manufactured as a batch of 100 from hardwood.

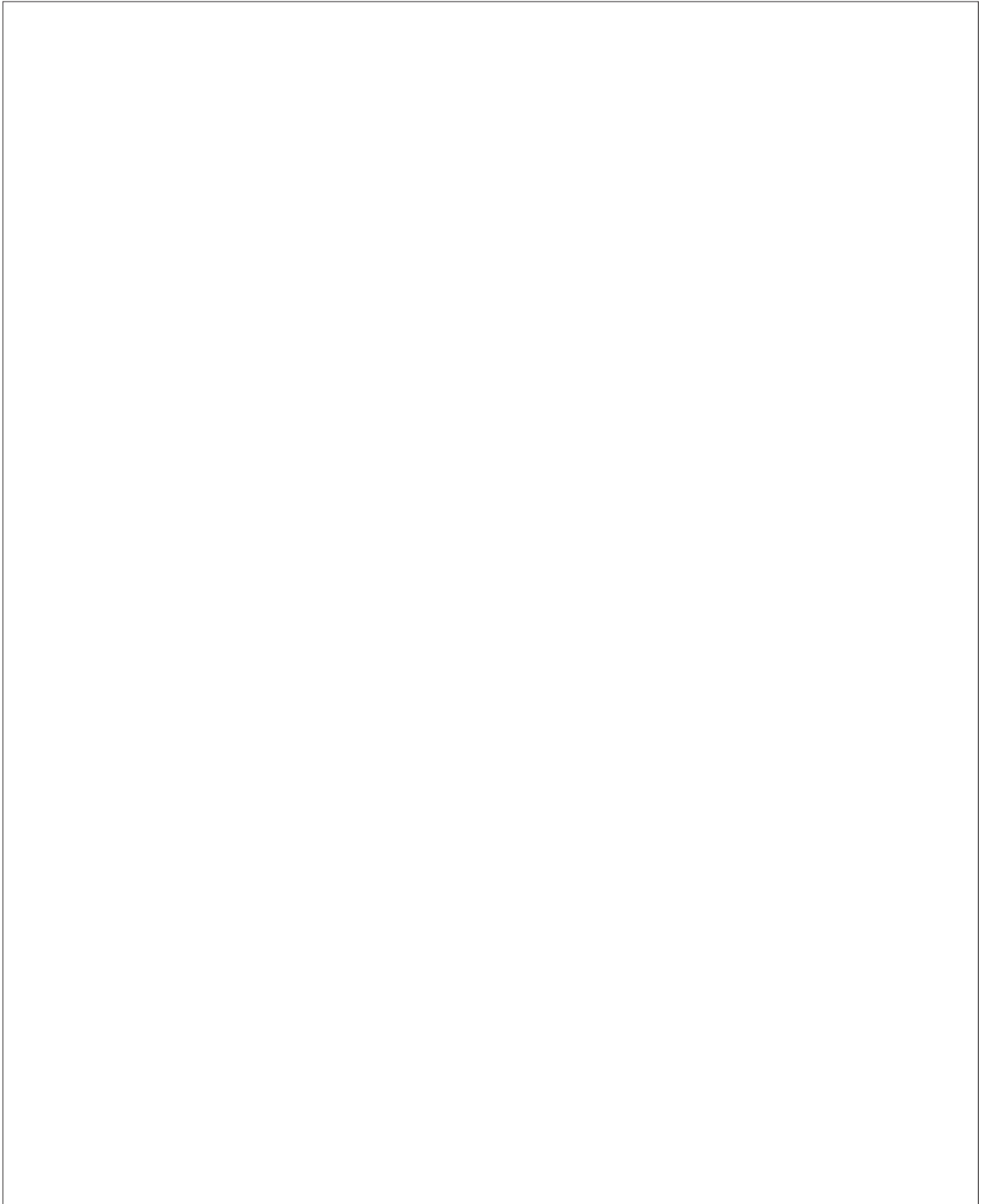
Use annotated sketches and/or notes to show how the **seat** could be manufactured.

Your answer **must** include the following:

- seat base and back
- seat arms.

Identify any relevant equipment, machinery and materials.

[8]



(d) A metal chain connects the swing seat to the frame.

(i) Identify a suitable metal for the manufacture of the chain.

Justify your answer.

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..... [2]

(ii) Name a synthetic fibre that could be used in the form of a rope to hang the swing seat from the frame, as a possible alternative to the chain.

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..... [1]

- (e) Discuss the sustainability issues that would need to be considered in the design and manufacture of the swing seat.

Refer to specific examples from the swing seat in your answer.

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[6]

END OF QUESTION PAPER



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