1 Fig. 1.1 shows a person using a lamp.



Fig. 1.1

(a) (i) Give two ways that a designer could collect relevant information about users' needs, to assist when designing a lamp.

1. **Online Surveys [1]** - This allows for quick collection of data from a large audience. 2. **Product Analysis [1]** - Analysing existing lamps can provide insight into what users like or dislike.

Market Research; Observation

(ii) Describe a suitable method of analysing the information collected by the designer.

After collecting the information to analyse,

- Define the units and categories of the information [1]
- Record all relevant data in the appropriate categories [1]
- Analyze the results and draw conclusions [1]

[3]

[2]

- (iii) A histogram is a suitable method of presenting information collected by the designer. Name **two** other methods of presenting information.
 - 1. Pie Charts [1] Useful for showing proportions of different categories.
 - 2. Pictorial Presentation [1] Useful for presenting data in a visually appealing way.

Also accept: Bar Chart, Box and Whisker Plot; Scatter Plot, Venn Diagram

(iv) The following information has been collected from potential users of a lamp in response to the question: 'What would be your preferred colour for the lamp?'

| Colour | No. of responses | |
|--------|------------------|--|
| White | 5 | |
| Black | 15 | |
| Blue | 10 | |
| Red | 20 | |

Use this information to complete the histogram.



(b) (i) Fig. 1.2 shows a drawing of the preferred red lamp and base. Sketch an idea to show how the lamp's head can be attached to the base. The idea must also allow for angle adjustments.

You may use the space in Fig. 1.3 for more sketches to communicate your design. Annotate if necessary.



Fig. 1.2

The head of the lamp could be attached to the base using a swivel joint that allows for angle adjustments.



Perspective and proportion [1] Design features

- Details on how head of the lamp is attached to the base [1]
- Swivel Joint allowing angle adjustments [2]
- Overall feasibility [2]

(ii) The red lamp would be more effective if its brightness could be adjusted. Sketch a modification to your design for part (b)(i), that would enable the brightness of the lamp to be adjusted. Annotate if necessary

A dimmer switch integrated into the lamp base would allow the brightness of the lamp to be adjusted.



Perspective and proportion [2] Design features

- Dimmer switch added to the lamp [2]
- Placement of the switch at a suitable location on the lamp [2]

[4]

(c) Describe two ways of evaluating the design of a lamp.

Evaluating against Design Specifications: Compare against the design specifications [1] to see if the requirements have been met [1]. User Testing: Have users interact with the lamp [1] and provide feedback [1] on its functionality and ease of use. 2 (a) Fig. 2.1 shows a person using crutches.



Fig. 2.1

- (i) Label on Fig. 2.1, where each of the following forces is acting.
 - Compression
 - Tension
 - Bending

- Compression: On the vertical parts of the crutches, where the user's weight pushes down. [1]

- Tension: At the top where the user's hands grip, pulling upward. [1]

- Bending: At the point where the horizontal and vertical parts meet, especially when the user leans on them. [1]

[3]

- (ii) Give two reasons why aluminium would be a preferred material for the crutches
 - 1. Lightweight: Aluminium is lighter than many other metals, making the crutches easier to carry. [1]
 - 2. Corrosion-resistant: Aluminium resists rust, which increases the lifespan of the crutches. [1]
- (b) Sketch a tool in use to show how torsional force is used to twist material.

A wrench demonstrates torsional force. It applies a twisting force to turn a bolt or nut

Suitable tool [2] Perspective and proportion [1-2]



(c) Fig. 2.2 shows a beam being used to support a painter.



Fig. 2.2

(i) Use arrows to indicate bending force acting on the beam shown in Fig. 2.2.



[4]

[3]

[2]

(ii) Sketch a beam with a different cross-section that would be more suitable to resist bending forces.

A rectangular beam with a hollow cross-section would be more suitable to resist bending forces.

(d) Figs. 2.3 shows a handrail which is 5m long.



Fig. 2.3

Use sketches and notes to show how the stability of the handrail can be increased.

Appropriate reinforcement sketched [1] and named [1], for example addition of braces to provide more stability.

Annotation explaining that reinforcement increases the strength, rigidity, and stability of the handrail [1]

Clarity of sketch [1]

[2]

3 (a) Fig. 3.1 shows a bottle opener.





| (i) | State which order of lever is used in the bottle opener. | | |
|-------|---|-----|--|
| | Second Order Lever [1] | [1] | |
| (ii) | Name the parts of the lever shown at: | | |
| | A – Effort [1] | | |
| | B – Load [1] | [2] | |
| (iii) |) State a suitable metal for the opener and give a reason for your choice. | | |
| | Suitable metal - stainless steel [1] | | |
| | Reason - A suitable metal for the opener could be stainless steel due to its strength [1] and corrosion resistance [1] | | |

[3]

(iv) The opener used in the bottle opener is shown in Fig. 3.2. The opener has to be made accurately from metal. Use sketches to design a jig for drilling the hole for attaching a key ring to the bottle opener.

The design of the jig should involve a flat surface for the opener material to be laid on and guides to ensure the correct shape and dimensions of the opener.

Perspective and proportion [1] Design of the jig features

- a flat surface for the opener material to be laid on [1]
- guides to ensure the correct positioning of the material for drilling [2]
- Overall feasibility [1]
- (b) Fig. 3.3 shows a belt drive.



Fig. 3.3

State the effect on the output speed of the belt drive in the arrangement shown in Fig. 3.3.

The driven pulley (output) will be moving at a faster speed than the driver pulley (input) [2] [2]

[5]

(c) Fig. 3.4 shows a mechanical music box.





(i) State the types of motion at A and B.

A – Rotary / Circular [1]

B – Reciprocating [1]

(ii) Sketch and label a mechanism that would make the ballerina rise and fall twice for one revolution of the handle.

Appropriate cam profile sketched [2] Mechanism labelled as a cam [1] [2]

4 (a) Complete the table to show a suitable material and electrical property for each electrical use.

| material | electrical property | electrical use |
|------------|---------------------|----------------|
| Copper [1] | Conductor [1] | wires |
| PVC [1] | Insulator [1] | cable covering |

(b) (i) A power supply of 1.5 volts is needed for a torch.

Different batteries are available. Explain the differences in environmental impact between a dry cell battery and a rechargeable battery.

Dry Cell Batteries

Dry cell batteries generate a considerable amount of waste [1] because they are designed to be used once and then thrown away. Many dry cell batteries contain materials which are hazardous [1] to the environment

Rechargeable Batteries

when disposed of improperly.

Rechargeable batteries can significantly reduce waste [1] as they can be recharged and reused many times over.

Rechargeable batteries require energy for recharging, contributing to carbon emissions [1].

(ii) Use a sketch to show how two batteries are connected in parallel. Annotate If necessary.



Correct circuit symbol for battery [1] Circuit diagram shows batteries connected in parallel [1]

[2]

[4]

[4]

- (c) Give two reasons why using a temperature control circuit in an electrical thermal flask is advantageous.
 - 1 To maintain the temperature of the contents for a longer duration. [1]
 - 2 To save energy by only heating when necessary. [1]

(d) A person wants to monitor the temperature in a fish tank to ensure the well-being of the fish. Sketch a design for a simple electronic device that will alert the owner if the temperature in the fish tank becomes too high or too low.

Your sketch should show the position of essential components such as a battery, a switch, and an alarm.

Use the space below it in Fig. 4.2 to communicate your design. Annotate if necessary.



Fig. 4.2

Perspective and proportion of the sketch of the electronic device [2] Essential components such as a battery, a switch, and an alarm are shown [2] Overall feasibility of the design [2]