



General Certificate of Secondary Education  
2025

Centre Number

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Candidate Number

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# Engineering and Manufacturing

Unit 3

*assessing*

Materials, Processes and Systems



**[GEM31]**

\*GEM31\*

**FRIDAY 6 JUNE, MORNING**

## TIME

2 hours.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write outside the boxed area on each page or on blank pages.**

Questions which require drawing or sketching should be completed using an H.B. pencil.

All other questions must be completed using black ink only.

**Do not write in pencil or with a gel pen.**

Answer **all** questions in sections **A** and **B**.

Questions 1, 2, 3, 4 and 5 of Section A refer to the pre-release material, a copy of which has been provided for you.

You may use a calculator for this paper.

Quality of written communication will be assessed in Question **5**.

## INFORMATION FOR CANDIDATES

The total mark for this paper is **100**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

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\*28GEM3101\*

Answer **all** questions

**Section A**

**Questions in this section refer to the pre-release material.**

- 1 (a) State a mechanical property of low carbon steel sheet that makes it suitable to be shaped using the process of press forming.

\_\_\_\_\_ [1]

- (b) Many sheet metal components are manufactured using the punching process.

- (i) State **one** reason for using the punching process to produce sheet metal parts for the pillar drill.

\_\_\_\_\_ [1]

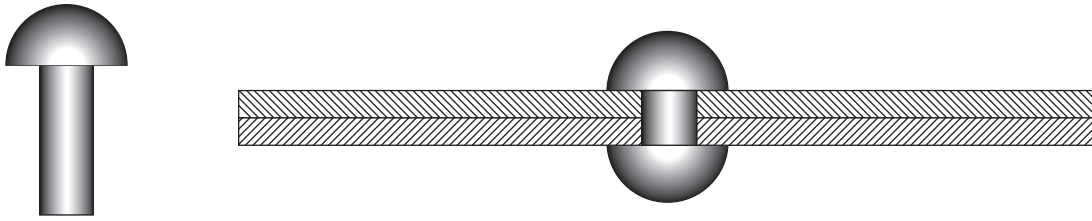
- (ii) In the space below, draw an annotated sketch showing the main features of the process of punching.

[4]



(c) The pillar drill contains several types of fasteners.

**Fig. 1** shows one type of fastener which may be used to join various sheet metal components on the pillar drill.



Source: CCEA

**Fig. 1**

(i) Name the fastener shown in **Fig. 1**.

\_\_\_\_\_ [1]

(ii) Identify **one** other permanent method of joining sheet metal materials.

\_\_\_\_\_ [1]







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**(Questions continue overleaf)**

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**[Turn over**



\*28GEM3105\*

**2 (a)** The pillar drill has a label with symbols which show that it complies with British and European safety standards.

**(i)** Explain the importance of compliance with safety standards for a manufacturer.

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[2]

**(ii)** Explain the importance of compliance with safety standards for a consumer.

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[2]

**(iii)** In the space below, draw a sketch of a symbol which indicates compliance with safety standards.

[1]



(iv) Explain what is meant by the term Factor of Safety.

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[2]

(b) State **two** safety precautions that should be observed when changing the spindle speed of the pillar drill.

1. \_\_\_\_\_

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[1]

2. \_\_\_\_\_

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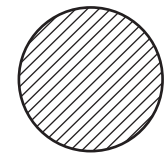
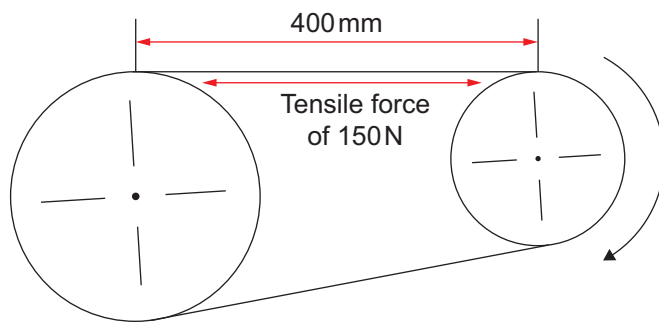
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[1]

[Turn over



3 The belt drive in **Fig. 2** below uses a belt with a circular cross section.



Cross section of drive belt

Source: CCEA

**Fig. 2**

When the belt drive is operating, a tensile force of 150 N is produced in the belt which causes a stress of  $1.9 \text{ N/mm}^2$  in the belt material. Assume  $\pi = 3.14$ .

(i) Calculate the diameter of the belt.

Candidates need to show their working out in the space below.

Belt diameter \_\_\_\_\_ mm [4]



- (ii) Calculate the strain caused by a 400 mm section of drive belt being stretched under a load of 150 N to a length of 407.6 mm.

Candidates need to show their working out in the space below.

Strain \_\_\_\_\_ [2]

- (iii) Calculate Young's Modulus for a material if the stress is  $7 \text{ N/mm}^2$  and the strain is 0.023.

Give your answer in  $\text{N/mm}^2$ .

Candidates need to show their working out in the space below.

Young's Modulus \_\_\_\_\_  $\text{N/mm}^2$  [1]

**[Turn over**



- 4 **Fig. 3** shows the pulley system used in the pillar drill which allows for selection of 5 spindle speeds.



Source: CCEA

**Fig. 3**

In the space provided, use 2D, assembly and exploded annotated sketches, with appropriate terminology, to show how the belt tension may be released and adjusted during the process of changing the spindle speed of the pillar drill.

Marks will be awarded for:  
 Detail contained in the sketches  
 Quality of sketches  
 Annotation

[4]  
 [4]  
 [4]





Show your response to Question 4 in the space below.

[Turn over

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[10]

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[Turn over

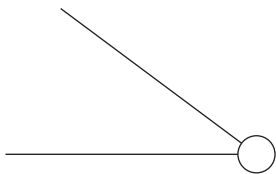


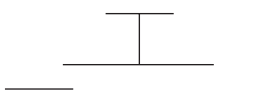


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## Section B

6 (a) Complete **Table 1** by inserting the correct name for each symbol or component.

**Table 1**

Symbol or Component	Symbol or Component Name
 <p>Source: CCEA</p>	
 <p>Source: CCEA</p>	
 <p>Source: CCEA</p>	
 <p>Source: CCEA</p>	

[4]



(b) The Health and Safety Executive (HSE) is a regulator for industry across the United Kingdom.

What is the main responsibility of the HSE?

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[2]

[Turn over



7 Glass reinforced plastic (GRP) is an example of a composite material.

(a) Define the term composite material.

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[2]

(b) Name **one** product manufactured from GRP.

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[1]

(c) (i) How do material properties influence the selection of a material?

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[2]

(ii) Explain the meaning of malleability as a mechanical property of a material.

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[2]





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**[Turn over**



\*28GEM3117\*

8 **Table 2** shows the percentage sales of 2400 headphones made by a manufacturer.

**Table 2**

Colour of headphones	% sold
Black	40
Grey	5
Yellow	15
Pink	25
Blue	

(a) (i) Calculate the percentage of the sales for the blue headphones and insert your answer in **Table 2**.

[1]

(ii) Each pair of headphones was sold for £39.95. As the cost of plastic increases, the selling price of the headphones must increase by 9%. Calculate the new selling price (to the nearest 1p).

Candidates need to show their working out in the space below.

New selling price £ \_\_\_\_\_

[2]



(b) Explain why batch production would be a suitable production method for the headphones.

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[2]

(c) The headphones were designed using computer-aided design (CAD).

(i) State **two** features of CAD which make it suitable for designing the headphones.

1. \_\_\_\_\_

---

2. \_\_\_\_\_

---

[1]

[1]

(ii) State **two** benefits of using CAD for the manufacturer.

1. \_\_\_\_\_

---

2. \_\_\_\_\_

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[1]

[1]

[Turn over



9 Fig. 4 below shows part of a pneumatic circuit.

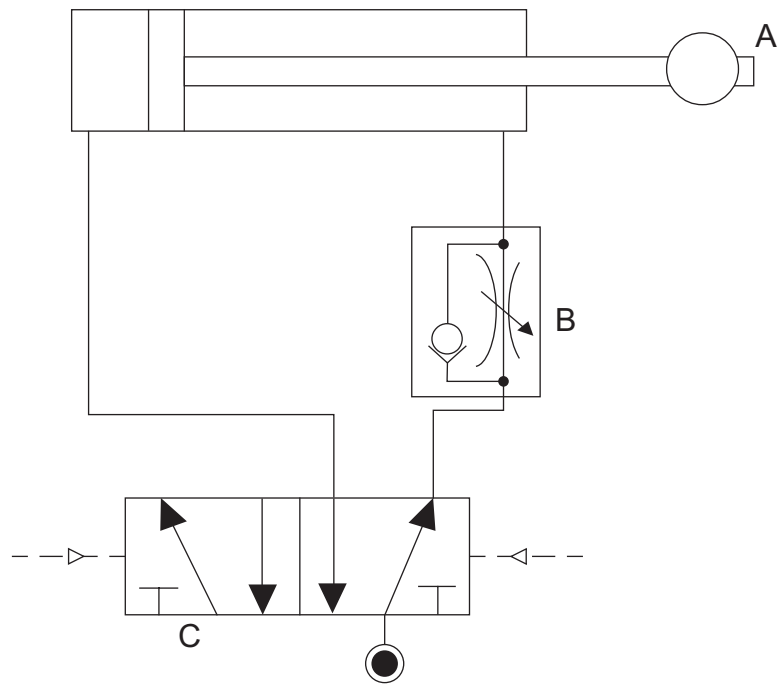


Fig. 4

Source: CCEA

(a) (i) Identify components A, B and C.

A \_\_\_\_\_ [1]

B \_\_\_\_\_ [1]

C \_\_\_\_\_ [1]

(ii) How does the placement of component B affect the operation of component A?

\_\_\_\_\_  
 \_\_\_\_\_ [2]



(b) Fig. 5 below shows a diagram of a tower crane.

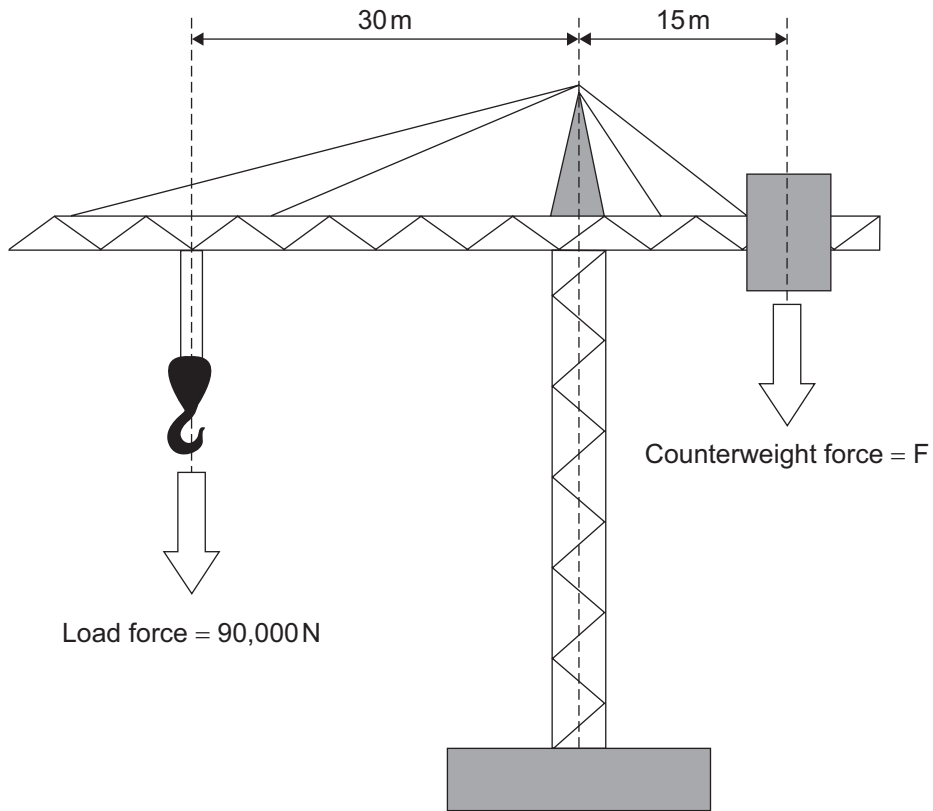


Fig. 5

Source: CCEA

(i) The tower crane in Fig. 5 is an example of which class of lever?

\_\_\_\_\_ [1]

(ii) Explain why a counterweight is required for the tower crane.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]



(iii) With reference to **Fig. 5** and using the Principle of Moments, calculate the force (F) exerted by the counterweight.

Candidates need to show their working out in the space below.

Counterweight force (F) \_\_\_\_\_ N [2]





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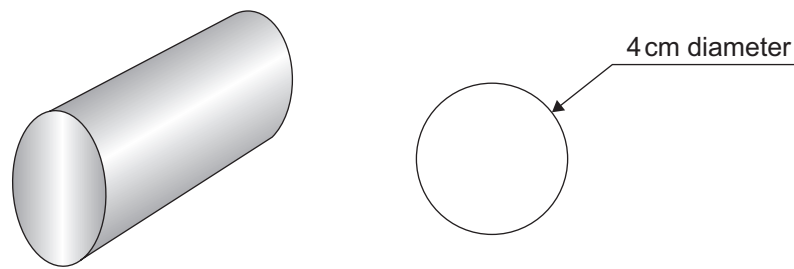
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**[Turn over**



**\*28GEM3123\***

- 10 Fig. 6 shows an acrylic rod which is to be used in a school technology project. The acrylic rod is supplied in a stock length of 1.5 m.



Source: CCEA

Fig. 6

- (a) The volume of the section of acrylic rod shown in Fig. 6 is  $94.26 \text{ cm}^3$ . Using this information, calculate the length of the section of acrylic rod shown in Fig. 6. Assume  $\pi = 3.14$ .

Candidates need to show their working out in the space below.

Length \_\_\_\_\_ cm

[4]



(b) A school requires 300 acrylic rods with a new length of 6 cm to use in a project for year 10 classes. Allowing for 0.2 cm of wastage per rod, how many stock lengths of acrylic will be required to complete this order?

Candidates need to show their working out in the space below.

Stock lengths \_\_\_\_\_ [5]

(c) What finishing technique could be used to achieve a smooth surface on each end of the acrylic rods?

\_\_\_\_\_ [1]

**[Turn over**



**11** Engineers and manufacturers have an important role to play in the research and development of new and emerging technologies which could be vital to protecting the environment.

**(a)** Outline **three** ways a manufacturing company can implement new and emerging technologies to reduce their energy costs.

1. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

2. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

3. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

**(b)** State **two** ways in which the recycling of plastics would impact on a manufacturer's sustainability.

1. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [1]

2. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [1]





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**THIS IS THE END OF THE QUESTION PAPER**

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
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6	
7	
8	
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10	
11	
<b>Total Marks</b>	

Examiner Number

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# **Engineering and Manufacturing**

Unit 3  
*assessing*

Materials, Processes and Systems

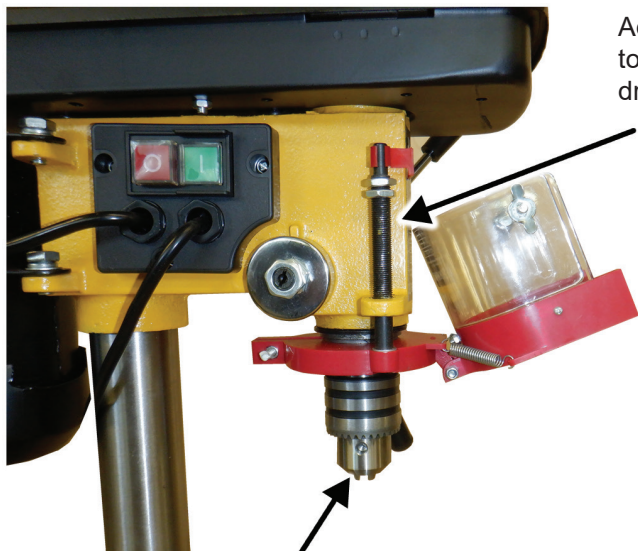
**[GEM31]**

**FRIDAY 6 JUNE, MORNING**

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**PRE-RELEASE  
MATERIAL**

Fig. 1, Fig. 2 and Fig. 3 show a bench mounted pillar drill.

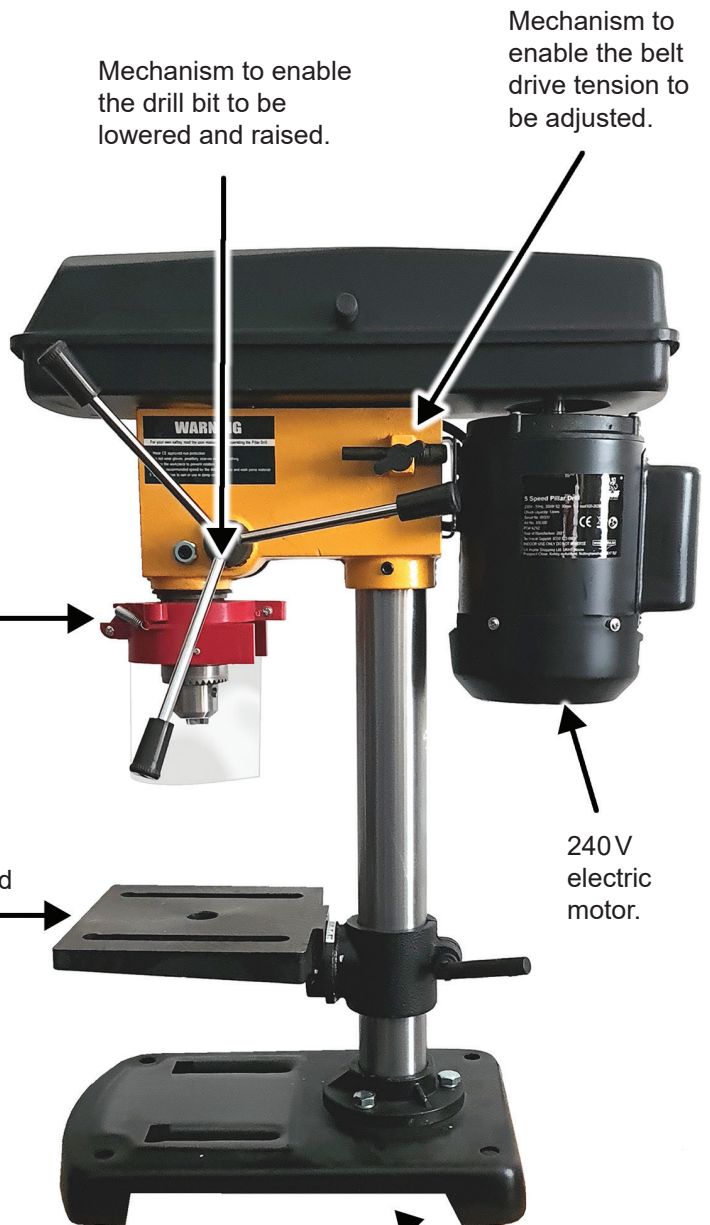


Adjustable mechanism to control the depth of drilling.

High carbon steel three jaw drill chuck.

Fig. 1

Source: Chief Examiner



Mechanism to enable the drill bit to be lowered and raised.

Mechanism to enable the belt drive tension to be adjusted.

Moulded nylon and acrylic safety guard.

240V electric motor.

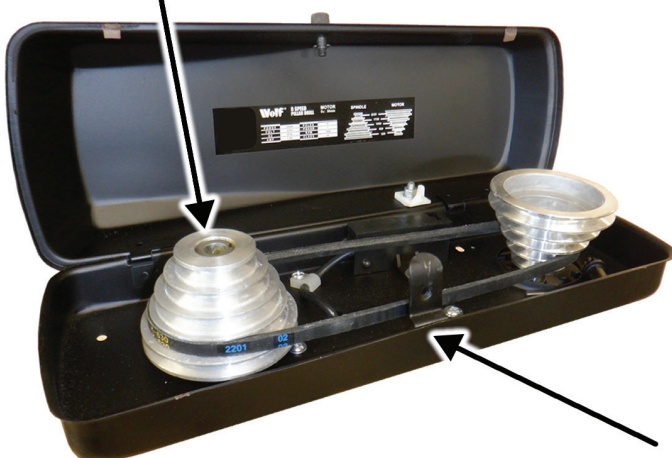
Cast low carbon steel machine table which can be height adjusted and tilted.

Aluminium alloy pulleys which allow a range of spindle speeds to be achieved.

Fig. 2

Source: Chief Examiner

The base is constructed from press formed 4 mm thick low carbon steel sheet.



An electronic switch and a locking screw are fitted to ensure the belt drive is enclosed before the pillar drill can be operated.

Source: Chief Examiner

Fig. 3

**Product features include:**

- Mechanisms to control the motion of the pillar drill spindle.
- Mechanisms to control the cutting speed of the pillar drill spindle.
- Safety features to protect the user.
- Press formed sheet metal components.
- Precision milled and turned components.
- Robust construction with a steel base and tubular stainless steel pillar.
- Dimensions Height (600mm) – Width (200mm) – Length (400mm) and
- Adjustable transparent acrylic and nylon guard for the chuck.

**Pre-release investigation:**

You should investigate the possible impact and use of the following where appropriate, in the design and production of the pillar drill:

- Materials and components: including application, properties, processes, form, supply and types of finish.
- Manufacturing processes: including machining, forming, assembly and the use of jigs and fixtures.
- Quality control and quality assurance.
- Product safety and
- Costing: including direct and indirect costs incurred in the manufacture of the pillar drill.

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