1.3 Metals and alloys

AQA 8552 · Calculator allowed · about 35 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 A workshop needs a material for a hand-filed bracket. State whether mild steel is ferrous or non-ferrous, and name the element that makes it ferrous.

(Total for Question 1 is 2 marks)

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2 A prototype workshop needs one complex metal handle with a hollow internal shape. Explain why investment casting could be suitable.

(Total for Question 2 is 2 marks)

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3 A folding camping utensil must be stiff, resist corrosion when washed, and have low mass. Choose either stainless steel or mild steel. Explain your choice using two requirements.

(Total for Question 3 is 3 marks)

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4 A manufacturer must make a small batch of 30 steel mounting plates. Each needs a different hole position for a prototype. Recommend a process from laser cutting, die casting or rolling, and justify it.

(Total for Question 4 is 2 marks)

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5 A designer compares aluminium and copper. Give one useful property of each metal for a product design.

(Total for Question 5 is 2 marks)

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6 A bicycle bell is made from brass, an alloy of copper and zinc. Explain one reason an alloy may be chosen instead of pure copper.

(Total for Question 6 is 2 marks)

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7 A steel garden hook is left outdoors. Describe how rust forms and state one condition needed for rusting.

(Total for Question 7 is 3 marks)

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8 A steel food tin has a continuous tin coating. Explain how the coating protects the steel while it remains unbroken.

(Total for Question 8 is 2 marks)

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9 A product brief requires a lightweight casing that is easy to form and will be used indoors. Choose aluminium or cast iron. Give one justified choice.

(Total for Question 9 is 2 marks)

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10 A fictional supplier quotes steel strip at GBP 1.80 per kg. A design uses 2.4 kg. Calculate the material cost.

(Total for Question 10 is 2 marks)

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11 A fictional design brief gives density as 2.7 g/cm3 for aluminium and 7.8 g/cm3 for steel. A component volume is 50 cm^3. Calculate the mass of an aluminium component.

(Total for Question 11 is 2 marks)

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12 A manufacturer makes 4,000 identical aluminium drink-bottle caps. Choose one suitable production process from sand casting, die casting or hand forging. Explain your choice.

(Total for Question 12 is 2 marks)

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Mark scheme · 1.3 Metals and alloys

Question 1

Ferrous	**B1**
Contains iron	**B1**

Answer: Mild steel is ferrous because it contains iron.

Question 2

Suitable for complex shapes / pattern and mould reproduce detail	**B1**
Explains hollow feature can be formed with suitable core/design	**B1**

Answer: Investment casting can form a complex shape around a sacrificial pattern, including a hollow feature if the pattern and core are designed for it.

Question 3

Chooses stainless steel	**B1**
Links strength/stiffness to utensil use	**B1**
Links corrosion resistance to washing	**B1**

Answer: Stainless steel is a suitable choice: it is stiff/strong enough for a utensil and resists corrosion better than uncoated mild steel when washed. Its mass depends on the design dimensions.

Question 4

Laser cutting	**B1**
Links flexible computer-controlled cutting / no dedicated die to small varied batch	**B1**

Answer: Laser cutting, because it can cut the plate profile and varied hole positions directly from sheet without making a dedicated die.

Question 5

Valid aluminium property	**B1**
Valid copper property	**B1**

Answer: Aluminium: low density or corrosion resistance. Copper: electrical conductivity or ductility.

Question 6

Alloying changes/improves a property such as hardness or strength	**B1**
Links improved property to bell use / shape retention	**B1**

Answer: Adding zinc can make the material harder or stronger than pure copper, which helps the bell keep its shape in use.

Question 7

Iron reacts with oxygen	**B1**
Water is also involved / both oxygen and water needed	**B1**
Rust / hydrated iron oxide formed	**B1**

Answer: Iron reacts with oxygen and water to form hydrated iron(III) oxide (rust). Both oxygen and water are needed.

Question 8

Barrier prevents water and oxygen reaching steel	**B1**
Therefore iron does not rust while coating is intact	**B1**

Answer: The tin layer keeps water and oxygen away from the steel, so the iron cannot rust.

Question 9

Chooses aluminium	**B1**
Links low density / formability to stated requirement	**B1**

Answer: Aluminium: its low density makes the casing lighter, and it can be formed into a casing.

Question 10

1.80 x 2.4	**M1**
GBP 4.32	**A1**

Answer: GBP 4.32

Question 11

2.7 x 50	**M1**
135 g	**A1**

Answer: 135 g

Question 12

Die casting	**B1**
Links reusable die / repeatability / high volume to 4,000 identical caps	**B1**

Answer: Die casting: molten aluminium is forced into a reusable die, making many identical parts efficiently.

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