1.8 Design, testing and production

AQA 8552 · Calculator allowed · about 55 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 A community workshop needs a folding stool for users aged 12 to 16. Brief: carryable and stable on level indoor floors. Specification: seat height 430 mm, mass at most 2.8 kg, supports 900 N for 60 seconds, folds to a maximum thickness of 85 mm. A plywood prototype weighs 3.1 kg, folds to 92 mm and supports 1,050 N for 60 seconds without permanent bending. Suggest two justified design improvements.

(Total for Question 1 is 4 marks)

2 A portable display stand is made from 1.2 kg of aluminium and lasts 8 years in a client trial. A proposed recycled-plastic version uses 0.8 kg but lasts 3 years and cannot be repaired; both use the same delivery distance. Evaluate the trade-off and recommend a version for a client prioritising long service life and lower material use.

(Total for Question 2 is 4 marks)

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3 A plywood toy car has a wheel axle hole specified as 6.0 mm ± 0.2 mm. Five measured holes are 5.8, 5.9, 6.0, 6.2 and 6.3 mm. Calculate how many are within tolerance and state the acceptable range.

(Total for Question 3 is 3 marks)

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4 A client orders 350 flat-pack book stands. Specification: assembled width 240 mm ± 2 mm; each stand must hold 4 kg for 1 minute; packaging must be recyclable and the stand must be repairable with a replaceable crossbar. Prototype width is 243 mm and it holds 4.5 kg for 1 minute. Evaluate compliance and propose a production and lifecycle improvement.

(Total for Question 4 is 4 marks)

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5 A school lunch tray has a 12 mm rim. Three prototypes were tested by pouring 250 ml water into each tray and tilting it to 10 degrees for 5 seconds. Prototype A leaked at 8 degrees, B at 12 degrees, C at 11 degrees. Requirement: no leak at 10 degrees. Identify the successful prototypes and propose one improvement to make the test more reliable.

(Total for Question 5 is 3 marks)

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6 A bicycle-light bracket must clamp to a 31.8 mm handlebar, resist a 120 N pull for 10 seconds and be removable without tools. Prototype clamp internal diameter is 32.4 mm and slips at 95 N. Recommend one change and describe a measurable retest.

(Total for Question 6 is 3 marks)

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7 A small batch of 40 personalised wooden desk organisers is required, each with three 6 mm slots and a different name. Compare a CNC router with hand sawing and filing, then choose a method. Include batch size, repeatability and personalisation.

(Total for Question 7 is 4 marks)

8 A reusable plant label needs 600 units for a garden centre, each 150 mm long, with rounded corners and a raised logo. Compare vacuum forming and injection moulding for this production quantity, then recommend a process.

(Total for Question 8 is 4 marks)

9 A batch of 24 foam camera cases must fit a supplied camera measuring 118 x 72 x 46 mm. A prototype cavity measures 116 x 70 x 44 mm. State whether it meets the fit requirement and give the three cavity dimensions needed for a 2 mm clearance on every side of the camera.

(Total for Question 9 is 3 marks)

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10 A design team tests a 3D-printed phone stand. Requirement: hold a 210 g phone at 65 degrees for 30 minutes without tipping; charging cable must pass through a 12 mm opening. Results: 3 of 5 units tipped by 18 minutes; all openings measured 11.5 mm. Explain what the evidence says and identify a design improvement for each failure.

(Total for Question 10 is 4 marks)

11 A batch of 2,000 identical polypropylene storage hooks is planned. Each hook needs a 5 mm hole and a 20 mm curved profile. Select a suitable production method from injection moulding, one-off hand forming and laser cutting sheet, and justify the choice.

(Total for Question 11 is 3 marks)

12 A walking-stick handle is made from hardwood. In a test with 10 users, 7 report discomfort after 5 minutes; the handle width is 28 mm and has sharp edges. State a justified ergonomic improvement and a test to check it against user needs.

(Total for Question 12 is 3 marks)

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Mark scheme · 1.8 Design, testing and production

Question 1

Suggests a mass reduction, such as cut-outs or optimised sections, while preserving load paths. **B1**

Links that change to the 3.1 kg prototype exceeding the 2.8 kg maximum. **B1**

Suggests changing the hinge or leg geometry, or adding a folding stop, to reduce folded thickness. **B1**

Links that change to the 92 mm prototype exceeding the 85 mm maximum; recognises the 1,050 N support test already passes. **B1**

Answer: Reduce mass with cut-outs or thinner/optimised sections while retaining load paths, because prototype exceeds 2.8 kg. Alter hinge/leg geometry or add a positive folding stop so folded thickness is 85 mm or less. Support test already passes; retain strength.

Question 2

States that the recycled-plastic version uses 0.4 kg less material initially (1.2 - 0.8 = 0.4 kg). **B1**

Compares service life: recycled plastic lasts 3 years versus 8 years for aluminium, or 3/8 as long. **B1**

Explains that the plastic version cannot be repaired, so replacement may increase material use over the service life. **B1**

Recommends aluminium for the stated priority of long service life and weighs this against the lower initial material mass of plastic. **B1**

Answer: Recycled plastic uses 0.4 kg less material, but lasts only 3/8 as long and is not repairable, so replacement may increase lifetime material use. Aluminium better meets service life; repair or use recycled content if available.
Recommendation depends on priority, with life-cycle duration and repairability weighed against lower initial mass.

Question 3

Calculates the acceptable range as 5.8 mm to 6.2 mm inclusive (6.0 ± 0.2 mm). **B1**

Counts the readings from 5.8 mm through 6.2 mm as within tolerance, including both limits. **B1**

States that 4 holes are within tolerance, excluding the 6.3 mm reading. **B1**

Answer: Range 5.8 mm to 6.2 mm inclusive. Four holes are in range; 6.3 mm is outside.

Question 4

States the acceptable width range is 238 mm to 242 mm and identifies the 243 mm prototype as outside tolerance. **B1**

Identifies that the stand passes the load test because 4.5 kg exceeds 4 kg for the required 1 minute. **B1**

Proposes a suitable production method for 350 stands, such as CNC routing with repeatable cutting dimensions adjusted to give widths within 238 mm to 242 mm. **B1**

Proposes a lifecycle improvement such as removable crossbar fasteners to allow repair, or recyclable card packaging to support end-of-life recycling. **B1**

Answer: Width range 238 to 242 mm, so 243 mm fails; load test passes. Adjust cutting jig/CNC dimensions to reduce width to range. For 350, CNC routing sheet material offers repeatability and nesting; design crossbar with removable fasteners and use recyclable card packaging to support repair and end-of-life sorting.

Question 5

Identifies prototype B as successful because it did not leak at 10 degrees. **B1**

Identifies prototype C as successful because it did not leak at 10 degrees. **B1**

Improves reliability by repeating trials under controlled conditions, such as the same measured volume, angle and timing, and recording results. **B1**

Answer: B and C; repeat each trial several times using same measured volume, angle gauge and timing, then record results.

Question 6

Recommends a change that improves grip, such as reducing the internal diameter or adding a compliant textured liner. **B1**

Specifies a measurable retest on a 31.8 mm handlebar using a force gauge up to 120 N. **B1**

States the 120 N pull should be held for 10 seconds with no slip, while checking the bracket remains removable without tools. **B1**

Answer: Reduce internal diameter/add compliant textured liner to improve grip; retest on a 31.8 mm bar with force gauge, increasing pull to 120 N and holding 10 seconds; confirm no slip and hand removal.

Question 7

Chooses CNC routing as suitable for making the three 6 mm slots. **B1**

Links CNC routing to repeatable, consistent slots across the batch of 40. **B1**

Explains that names can be changed digitally to personalise each organiser. **B1**

Compares hand sawing and filing as lower setup but slower or less consistent for repeated narrow slots, and relates CNC setup to the batch. **B1**

Answer: CNC router is suitable: programmed slots are consistent and names can vary digitally; setup is justified across 40 units. Hand work has lower setup but slower and less consistent for repeated narrow slots.

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Question 8

Compares injection moulding as repeatable and capable of detailed features, including a raised logo. **B1**

Notes the high mould tooling cost for injection moulding. **B1**

Compares vacuum forming as lower cost or quicker to set up, but requiring trimming and potentially giving a less crisp raised logo. **B1**

Makes a recommendation for 600 units and justifies it against tooling cost and the required logo detail, allowing either process when the trade-off is explained. **B1**

Answer: Injection moulding gives repeatable detailed features at high volume but mould tooling is costly; vacuum forming has lower tooling cost and quicker setup but may not form a crisp raised logo and needs trimming. At 600, recommend vacuum forming if logo can be simplified, or injection moulding if detail/repeatability justifies tooling.

Question 9

Identifies the prototype cavity as too small to fit the camera. **B1**

Calculates the required cavity dimensions as 122 x 76 x 50 mm by adding 2 mm clearance on each opposing side. **B1**

States that each prototype cavity dimension must increase by 6 mm. **B1**

Answer: No, it is undersized. Required cavity dimensions are 122 x 76 x 50 mm: add 4 mm to each overall dimension for 2 mm on both opposing sides.

Question 10

Uses the results to state the stand fails the duration requirement because 3 of 5 units tipped by 18 minutes, before 30 minutes. **B1**

Uses the measurements to state the cable opening fails because 11.5 mm is below the 12 mm requirement. **B1**

Suggests a relevant improvement to prevent tipping, such as widening or deepening the base or lowering the centre of mass. **B1**

Suggests enlarging the cable opening to at least 12 mm. **B1**

Answer: Does not meet either requirement: tipping before 30 min and opening below 12 mm. Widen/deepen base or lower centre of mass; enlarge cable opening to at least 12 mm. Retest all units under stated duration and measure opening.

Question 11

Selects injection moulding for the batch of 2,000 hooks. **B1**

Justifies the choice by repeatable production and spreading tooling cost across the large batch. **B1**

Links injection moulding to producing the required curved three-dimensional profile and 5 mm hole; recognises hand forming is slow or inconsistent and laser cutting is limited to a flat profile. **B1**

Answer: Injection moulding: repeatable complex curved 3D profile and hole across large batch; tooling cost spread across 2,000. Hand forming is slow/inconsistent; laser cutting is flat profile only.

Question 12

Suggests a relevant ergonomic change, such as reshaping or widening the grip to suit users and rounding its sharp edges. **B1**

Links the change to reducing discomfort or improving grip for users. **B1**

Tests the change with representative users for at least 5 minutes and records comfort feedback or ratings to check user needs. **B1**

Answer: Increase/reshape grip to suit user hand sizes and round edges, perhaps add a soft grip surface. Test with representative users for at least 5 minutes and collect comfort ratings, checking reduced discomfort and secure grip.

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