1.15 Responsive materials: 30-minute Pack

AQA 8552 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 A fictional coating changes colour above 38 C in a single laboratory trial. A designer proposes printing 'safe to touch' on a product whenever the coating shows its changed colour. Evaluate this proposal using the supplied information and state one test or evidence need. [4 marks]

(Total for Question 1 is 4 marks)

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2 A fictional reversible shape-change material called LoopForm is proposed for a reusable packaging tab. In a supplied test it bends by 9 mm when warmed from 20 C to 45 C and returns to within 1 mm of its original position after cooling to 20 C. Recommend whether to continue developing it for this use. Give two data-based reasons and one further test. [5 marks]

(Total for Question 2 is 5 marks)

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3 Fictional colour-responsive films are being considered for a reusable display card that should show a colour change between 24 C and 30 C, then return to its starting colour below 22 C. Film P changes colour from 25 C to 29 C and recovers below 21 C. Film Q changes from 18 C to 24 C and recovers below 16 C. Select the closer match and give one reason. These films are not certified safety indicators. [3 marks]

(Total for Question 3 is 3 marks)

4 In a fictional test, four FlexiTrace strips were each warmed to 40 C and then cooled to 20 C. Their measured bends at 40 C were 11, 12, 10 and 11 mm; after cooling they measured 1, 0, 1 and 2 mm. Describe the pattern and explain one conclusion the data support. [3 marks]

(Total for Question 4 is 3 marks)

5 A fictional plate called FlexiTrace curves when heated to 35 C and returns towards flat when cooled to 20 C. Explain why its change is a material response rather than a separate electronic sensor reading, and identify the stimulus and response. [3 marks]

(Total for Question 5 is 3 marks)

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6 A fictional sample of ShapeReturn polymer is 120 mm long before heating. It reaches 132 mm at 50 C and measures 123 mm after cooling to 20 C. Calculate its extension at 50 C and its residual extension after cooling. [3 marks]

(Total for Question 6 is 3 marks)

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7 A fictional reversible colour film was cycled between 20 C and 32 C five times. Its measured colour-change intensity on the five cycles was 80, 78, 75, 71 and 68 arbitrary units. Calculate the decrease from cycle 1 to cycle 5 and state what the results suggest. [3 marks]

(Total for Question 7 is 3 marks)

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Mark scheme · 1.15 Responsive materials: 30-minute Pack

Question 1

States that a colour change above 38 C was observed in one trial	**B1**
Explains that this does not establish a safe-touch temperature or certify safety	**B1**
Identifies a relevant limitation such as one trial, no uncertainty, no surface-temperature calibration or no test across use conditions	**B1**
Proposes relevant additional evidence, such as repeated calibrated surface-temperature tests across conditions and an appropriate safety assessment	**B1**

Answer: The single trial suggests that the fictional coating changed colour above 38 C in that test. It does not show that the product is safe to touch at that colour, or establish a certified safety threshold. Repeat calibrated tests of surface temperature under intended use conditions and an appropriate safety assessment would be needed.

Question 2

Makes a clear conditional recommendation to continue development or not proceed yet	**B1**
Uses the 9 mm warmed bend as evidence of a measurable response	**B1**
Uses the return to within 1 mm after cooling as evidence of near-return in the supplied test	**B1**
Identifies a relevant limitation, such as only one test/sample, unknown cycle durability or untested actual tab loads	**B1**
Proposes a relevant further test, such as repeated heating/cooling cycles under representative tab loads	**B1**

Answer: Continue development as a candidate: it bends by 9 mm when warmed and returns to within 1 mm after cooling in the supplied test. This is promising evidence for a responsive reusable tab, but it does not establish performance in use. Test repeated cycles under representative loads and inspect for loss of movement or damage.

Question 3

Selects Film P	**B1**
Links P's 25 C to 29 C change range to the requested 24 C to 30 C range	**B1**
Notes its below-21 C recovery condition is close to the requested below-22 C condition, or identifies a relevant limitation in the match	**B1**

Answer: Film P is the closer match: its 25 C to 29 C change range lies within the requested 24 C to 30 C range, and it recovers below 21 C, close to the requested below 22 C. The supplied fictional data do not establish safety performance or certification.

Question 4

Describes that all four strips bent substantially more at 40 C than after cooling	**B1**
States that cooled bends were small, from 0 mm to 2 mm, compared with 10 mm to 12 mm when warm	**B1**
Concludes the response largely reversed in these four tests, bounded to these conditions/samples	**B1**

Answer: All four strips bent more when warm (10 mm to 12 mm) than after cooling (0 mm to 2 mm). This supports a largely reversible response for these samples over this test cycle, but does not establish behaviour in other conditions or repeated cycles.

Question 5

Identifies temperature or heating as the stimulus	**B1**
Identifies the plate's own curvature change as the response	**B1**
Explains that the observed response is a physical change in the material itself, with no separate sensor reading described	**B1**

Answer: Temperature increase is the stimulus. The plate's curvature is the response. The described output is the plate itself changing shape, rather than an electronic sensor producing a separate reading.

Question 6

Uses 132 - 120 for extension when heated	**M1**
Heated extension = 12 mm	**A1**
Residual extension = 123 - 120 = 3 mm	**A1**

Answer: Extension at 50 C: 132 - 120 = 12 mm. Residual extension after cooling: 123 - 120 = 3 mm.

Question 7

Subtracts cycle 5 value from cycle 1 value	**M1**
Decrease = 80 - 68 = 12 arbitrary units	**A1**
Recognises a downward trend in measured intensity across these five cycles, without claiming its cause	**B1**

Answer: The measured intensity decreased by 80 - 68 = 12 arbitrary units. The readings show a downward trend over the five tested cycles; they do not explain why it occurred.

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