

Design & Technology

AQA A-Level

Smart materials

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try answer all questions
- Use the space provided to answer questions
- Calculators can be used if necessary
- For the multiple choice questions, circle your answer

Advice

- Marks for each question are in brackets
- Read each question fully
- Try to answer every question
- Don't spend too much time on one question

Good luck!

Q1. Which smart material changes colour reversibly in response to temperature changes, making it suitable for mood rings or baby spoons?

- A** Photochromic pigment
- B** Thermochromic pigment
- C** Phosphorescent pigment

Q2. What external stimulus causes photochromic pigment (used in self-tinting sunglasses) to activate?

- A** Temperature
- B** Light levels
- C** Pressure

Q3. Which smart material emits light when an electric current passes through it, ideal for decorative lighting?

- A** Electroluminescent wire
- B** Piezoelectric material
- C** Phosphorescent pigment

Q4. Why are Shape Memory Alloys (SMAs) like Nitinol used in fire alarm actuators?

- A** They deform and trigger alarms at specific temperatures
- B** They glow when heated
- C** They generate light under pressure

Q5a. Describe how a piezo electric material functions **(2 marks)**

Q5b. Give a specific example of where piezo electric material may be used **(1 mark)**

Q6. State three different stimuli that can cause a change in the property of a smart material **(3 marks)**

Q7. Analyse and evaluate the suitability of phosphorescent pigment for use in indoor emergency signage **(6 marks)**

Answers

Q1. B

Q2. B

Q3. A

Q4. A

Q5a.

1 mark for a simple description:

- piezo electric materials generate a small electrical charge when the material is compressed or deformed.
- piezo electric materials change shape slightly when an electrical current is applied to the material.

2 marks for a detailed description:

- Piezo electric materials generate a small electrical charge when the material is compressed or deformed. The process is also reversible so they can also change shape slightly when exposed to an electric current.

Q5b.

Piezo electric material:

- musical greetings cards
- pressure sensors
- ignition units for lighters, gas stoves and grills
- ink jet printers
- car air bags
- buzzer applications

Q6.

A change in response to:

- light
- temperature
- electricity
- pressure

Q7.

- The phosphorescent pigment will glow in the dark or low light making the signage visible in a power cut or smoke filled environment.
- The pigment absorbs both natural and artificial light so is appropriate for indoor use.

- There is no need to permanently light the sign with electricity which may be isolated in the event of a fire.
- The location of the sign is not restricted by the need for a power supply.
 - The signage can be relocated without damage to structures or rewiring.
- The intensity of the light emitted is low, so is only visible in close proximity limiting the speed of locating an exit or fire extinguisher point.
- The sign must be exposed to a light source in order to absorb the energy needed for the phosphorescent pigment to function.
- The phosphorescent pigment will only glow for a limited period of time when the light source is removed.