**Design & Technology**

**AQA A-Level** Logo

Description automatically generated with low confidence

**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

**Q5**a.

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.