Design & Technology
A-Level

Smart materials
Multiple Choice

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
- Use a cross in the box to mark you 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 **one** of the following is a smart material?

A Shape memory alloy (SMA) ☐

B Polyester resin ☐

C Medium density fibreboard (MDF) ☐

Q2. Which one of the following materials will respond quickly to a change in Ultra Violet (UV) light?

A Shape memory alloys ☐

B Reactive glass ☐

C Carbon nanotubes ☐

Q3. What is the definition of a smart material?

A A material that has been engineered to have additional properties ☐

B A material whose physical properties change in response to external stimuli ☐

C A material that is available in large sheets ☐

Q4. Smart materials have?

A Properties that can significantly change ☐

B Good conducting properties ☐

C Weak covalent bonds ☐

Q5. What material is used to make dental braces?

A	Nitinol	☐
B	Zinc	☐
C	Aluminium	☐

Q6. What properties does phosphorescent pigment have?

A	Never ending light source	☐
B	Absorbs heat, heat energy released in dark	☐
C	Absorbs light and releases it in the dark	☐

Q7. Why might quantum tunnelling composites be used in a winter coat?

A	They have excellent thermal capacity	☐
B	Allow user to use electronics without hands	☐
C	Protect user from UV radiation	☐

Q8. Reactive glass could reduce energy consumption by?

A	Storing heat energy and turning it into electricity	☐
B	Changing transparency with light to keep room temperatures constant	☐
C	Increasing incident light rays into houses creating more heat energy	☐

Q9. Explain **three** features in the design of the smartphone shown in Figure 12 that have been impacted by smart materials and the miniaturisation of components **(9 marks)**

1.

2.

3.

Q10a. Phosphorescent pigments have many practical applications. What are phosphorescent pigments? **(2 marks)**

10b. Describe **one** applications of phosphorescent pigments **(3 marks)**

Q11. Shape Memory Alloys (SMA) are often used in fire alarms and air-conditioning units.

Explain the smart property of a Shape Memory Alloy (SMA) that makes it suitable for these applications. **(2 marks)**

Q12. What is polymorph? Your answer must include a reference to a practical application **(3 marks)**

Q13. Thermochromic pigments have many innovative applications.

Q13a. Outline the household applications of thermochromic pigments. **(4 marks)**

Q13b. Discuss the advantages and disadvantages of thermochromic pigments. **(4 marks)**

Q14. New technologies have transformed products in innovative ways.

Smart glasses often used in the glazing of buildings, discuss the benefits of using smart glass in this application **(3 marks)**

Answers

Q1. A
Q2. B
Q3. B
Q4. A
Q5. A
Q6. C
Q7. B
Q8. B

Q9.

- The phone is thin (1) as developments in battery technology have allowed the miniaturisation of the battery pack (1) while maintaining battery life/reducing weight/less bulky to carry (1).
- Increased functionality/storage capacity features, e.g. camera, torch, pay scan, etc. (1) due to miniaturisation of electronics (1) so the consumer can use it for a greater range of tasks/store more data, pictures, videos, music, games, etc. (1).
- Smart materials have been used to develop the colour LCD screen (1) enabling clear/detailed/high-quality images (1), resulting in increased consumer appeal.
- Smart material is used in the piezo-electric transducers (1), enables reasonable quality sound/music without the use of bulky speakers (1) so consumers can access their music anywhere (1).
- The development of touch screen technology (1) has reduced the need for physical buttons/keyboards on the phone (1), allowing improved looks, clean aesthetic lines/leading to easier use of the phone /improved ergonomics (1).

Q10a.

- Phosphorescent pigments are manufactured from phosphors
- Material absorbs light and emits it slowly over time
- Pigment is often used in novelty toys, safety signs

10b.

Application 1 – luminous watch:

- Absorbs suns and artificial lights energy
- In the dark, energy is slowly released
- Light is actually also released during the day however we do not notice it
- An advantage of it is the glow allows the user to read the time in the dark
- It is also aesthetically pleasing

Application 2 – glow in the dark toys

- Material it is made from contains phosphorescent pigment
- Absorbs light energy during day time
- Slowly releases energy in form of light
- More apparent at night time

Q11.

- A change in stimulus (temperature/electricity) (1)
- produces a change in shape/movement (1)

Q12.

- Polymorph is a thermoplastic material
- Can be shaped and reshaped any number of times
- Normally supplied as granules looking like small plastic beads
- When heated with hot water, granules become a solid material that can be moulded
- Applications include: ergonomic handles, 3D modelling

Q13a.

- Used as a safety indicator in products that might be used in the kitchen (1)
- Used as a safety indicator in products such as cutlery used by children (1)
- Used as a safety indicator in products used in the bathroom e.g. bath toys (1)
- Used on containers to register correct temperatures for the storage of foods (1)
- Used as a thermometer e.g. forehead thermometer/room thermometer/fish tank thermometer (1)
- Used for novelty effect e.g. décor/children's toys / mugs / cups (1)
- Used in food storage / fridges to indicate correct/safe temperature (1)
- Radiator warning label / sticker (1)

Q13b.

Advantages

- Colour changes give an indication of safe temperature (1)
- Removes need for external thermometer (1)
- Encourages children to make safety checks (1)
- Gives novelty value (1)
- Clear visual warning / indication of temperature (1)
- Ease of use (1)
- Thermochromic temperature indicators are cheaper than conventional thermometers (1)

Disadvantages

- Difficult to achieve a precise temperature reading (1)
- Limited range of colours (1)
- Become less effective over time (1
- Can lead to complacency (1)
- Can be slow to react for some applications (1)
- Products can be more expensive than conventional products (1)

*Do not accept answers that state 'cheaper' or 'more expensive' unless qualified

Q14.

- Provides shade from harmful UV rays reduce glare (1)
- Glass can change opacity properties / tint the window (by the application of electric input) (1)
- Provides privacy when made opaque (1)
- Can be used for energy saving windows to prevent heat passing (1)
- Can reduce secondary greenhouse emissions through excessive heating/a-c (1)
- Can be used for advertising/promotion/gimmick (1)
- Eliminates need to blinds/curtains (1)
- Reduces gold fish bowl effect in/out side (1)

- Allows control of natural light levels (1)