

Design & Technology

Eduqas GCSE

The use of programmable components

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. What does a microcontroller combine on a single chip?

- A** A processor, memory and programmable input/output pins
- B** A battery, a switch and an LED
- C** A motor, a gearbox and a sensor

Q2. What does PIC stand for?

- A** Printed Integrated Circuit
- B** Programmable Interface Controller
- C** Processor Input Component

Q3. How is a program usually put onto a microcontroller?

- A** It is soldered onto the chip
- B** It is built into the chip and can never be changed
- C** It is written on a computer, often as a flowchart, then downloaded to the chip

Q4. What is a sub routine (macro)?

- A** A small section of program that carries out one task and can be called whenever it is needed
- B** A sensor that detects light levels
- C** A type of output device

Q5. Why might a microcontroller need a transistor or relay connected to it?

- A** To store the program
- B** To drive high power outputs like motors, as its output current is low
- C** To connect it to Wi-Fi

Q6. Which of the following is a limitation of programmable microcontrollers?

- A** They can be reprogrammed many times
- B** They reduce the number of components needed
- C** They can be damaged by static or the wrong voltage

Q7. This question is about microcontrollers.

Q7a. Describe the difference between a microprocessor and a microcontroller. **(3 marks)**

Q7b. Explain one disadvantage of using a programmable microcontroller. **(2 marks)**

Q8. Most modern electronic devices use programmable microcontrollers.

Q8a. Explain what a microcontroller does. **(2 marks)**

Q8b. Explain one way that the use of programmable microcontrollers in electronic products can benefit consumers. **(2 marks)**

Q9. The circuit board in a child's colour changing mood light is designed with a PIC chip. State a function of the PIC chip. **(1 mark)**

Q10. Give two reasons why programmable microcontrollers are used in electronic products. **(2 marks)**

Q11. A vending machine has a control circuit that uses a microcontroller (PIC). Explain two characteristics of a microcontroller that make it a suitable choice for use in a control circuit. **(6 marks)**

Q12. A microcontroller is a key component of electric bicycles. Define the meaning of the term microcontroller and explain how they can be used in electric bicycles. **(5 marks)**

Answers

Q1. A

Q2. B

Q3. C

Q4. A

Q5. B

Q6. C

Q7a.

Up to three marks for a clear description of a difference. Two marks if the difference is correct but not clearly described. For example (3 marks each):

- A microprocessor is at the centre of a computer system, whereas a microcontroller is at the centre of an embedded system
- A microprocessor has no internal memory, whereas a microcontroller contains its own memory
- A microprocessor needs separate interfacing circuits, timers and counters, whereas a microcontroller has them all on a single chip
- The designer decides the amount of ROM, RAM and I/O ports for a microprocessor, whereas a microcontroller has a fixed amount on the chip
- A microprocessor has higher power consumption; a microcontroller has lower power consumption and power saving modes
- A microprocessor works at high speed; a microcontroller works at lower speed
- A microprocessor is used for general purpose applications (laptops, PCs), whereas a microcontroller is used for specific applications (digital camera, washing machine)

Q7b.

1 mark for a limitation and 1 mark for a justification. For example:

- Some microcontrollers are custom programmed for custom-built machines (1), so can be extremely expensive (1). Regular maintenance can be costly (1)
- Microcontrollers cannot interface high power devices directly (1) and can only perform a limited number of tasks at once (1)

- A microcontroller can't withstand dust (1) or high humidity (1), which limits where it can be used (1)

Q8a.

One mark for what a microcontroller does, one mark for explaining it. Accept suitable product examples. For example:

- Microcontrollers take information from sensors and other inputs (1), then process it to control outputs such as speakers, lights or movement (1)
- They carry out specific tasks/functions (1), e.g. in a kettle a microcontroller switches the heating element on until it senses the water has boiled (1)

Q8b.

1 mark for how the microcontroller benefits the consumer, 1 mark for explaining how/why. OR identify a product that uses a microcontroller (1) and explain how it improves the consumer's experience (1). For example:

- Can be modified or customised (1) to individual customer needs or specific functions (1)
- Follows a sequence of instructions to make consumers' lives easier/safer (1), e.g. alerting them that an alarm has been set off (1), or turning a night light on automatically for security (1)
- Small size allows them to be used in many products (1), e.g. smart watches that help consumers improve their health/fitness (1)

Q9.

1 mark for any of: to be programmed as a timer to change the light sequence; to process the instructions in the program; to carry out tasks in the program.

Q10.

1 mark for each correct reason, up to a maximum of 2 marks:

- One programmable microcontroller can replace several separate integrated circuits (chips)
- Reduced size of circuit boards
- Improved reliability

- Economies of scale: one microcontroller can be bought in bulk and programmed differently for different applications, reducing component costs
- Allows programming upgrades, extending product life

Q11.

Any two explanations that include a characteristic (1) and two linked justifications of that characteristic (1) + (1). For example:

- Microcontrollers can be programmed/reprogrammed/reused (1), so they can be customised to different control systems (1) and updated easily (1)
- Microcontrollers run on low voltage (1), so they can use batteries (1) and therefore can be portable/have a backup supply (1)
- The program can be simulated in software (1), allowing easy editing/updating (1) before being downloaded to the PIC (1)
- Microcontrollers can be configured for digital or analogue inputs (1), allowing keypads/thermostats to be detected (1), removing the need for dedicated circuitry (1)
- Microcontrollers need fewer peripheral components (1) because they are multi-functional (1), reducing the overall size of the board (1)

Q12.

One mark for a simple definition of a microcontroller, for example:

- A microcontroller can be programmed to perform different processing functions
- A single-board computer manufactured as an integrated circuit (IC)
- A control device which incorporates a microprocessor
- A single chip that includes a processor, memory and input/output peripherals

Up to 4 marks explaining how microcontrollers can be used in electric bicycles. For example: microcontrollers can be programmed with sensors that identify how much battery life remains (1), so the cyclist can gauge how much further they can travel (1). A microcontroller can display the time (1), which is safer as it is in clear sight (1). Microcontrollers can:

- Drive/power the bike's motor and control the throttle and acceleration
- Control the brake light, headlights and directional lighting

- Display information via LEDs/LCDs, e.g. battery life
- Monitor battery life and measure temperatures
- Identify/control the speed of the bike and the amount of pedal assist
- Measure distance travelled
- Give warning messages/error signs, detect obstacles, act as anti-theft sensors