DTBase©

Design & Technology
Eduqas GCSE

Systems: sources, origins, properties and footprint

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 of these is Ohm's law?

A $V = I \div R$

B $V = I + R$

C $V = I \times R$

Q2. A resistor has the colour bands brown, black, red, gold. What is its value?

A 102 Ω

B 1 kΩ (1000 Ω)

C 10 kΩ (10 000 Ω)

Q3. Which component is a latching switch that stays on after the trigger pulse is removed?

A Transistor

B Capacitor

C Thyristor

Q4. A 555 timer that switches on and off continuously to flash a bike light is wired as:

A A monostable

B An astable

C A comparator

Q5. Which logic gate gives an output of 1 only when both inputs are 1?

A AND

B OR

C NAND

Q6. Which mechanism changes rotary motion into reciprocating motion, as in a car engine?

A Crank and slider

B Worm drive

C Bevel gears

Q7. This question is about resistors.

Q7a. Identify one reason for the colour bands on resistors. **(1 mark)**

Q7b. The circuit for a building alarm system contains standard components, including resistors and a light emitting diode (LED). Explain two reasons why the manufacturer would use Ohm's law when designing the circuit for the alarm system. **(4 marks)**

Q7c. A student's prototype circuit has an LED and a resistor, R1, connected in series to a 5 V supply. The LED needs 2 V across it, and the current flowing through R1 is 10 mA. Calculate the correct resistor value for R1 to enable the LED to switch on. Use $V = I \times R$. Show all workings. **(2 marks)**

Q8. A wall mounted light switches on a strip of LEDs automatically when it gets dark. A light dependent resistor (LDR) and a variable resistor form a potential divider, which switches a transistor to turn on the LED strip. Explain one benefit of using a variable resistor in the circuit. **(2 marks)**

Q9. A steady hand game sounds a buzzer when the wand touches the wire. The wand touching the wire acts as a push to make (PTM) switch. The game contains a thyristor circuit.

Q9a. Describe one advantage of using a thyristor in the steady hand game. **(2 marks)**

Q9b. Explain two benefits of using a buzzer in the circuit for the steady hand game. **(4 marks)**

Q10. The list below names five components: potentiometer, transistor, fixed resistor, capacitor, LED. State which two components could be used to produce an adjustable time delay in a circuit. **(2 marks)**

Q11. A frost monitor for a greenhouse sounds an alarm when the temperature falls below 3°C. A thermistor and a potentiometer form a potential divider that is connected to an operational amplifier (op-amp). Describe the purpose of the operational amplifier in the frost monitor circuit. **(3 marks)**

Q12. This question is about a reed switch.

Q12a. State how a reed switch is operated. **(1 mark)**

Q12b. Give one benefit of using a reed switch. **(1 mark)**

Q13. A mechanical clock is wound up by turning a key, which tightens the clock spring.

Q13a. Name the mechanism that is used in the clock winding mechanism. **(2 marks)**

Q13b. Describe the reason for using this mechanism. **(2 marks)**

Q14. A compound gear train has a driver gear A with 15 teeth, which meshes with gear B with 30 teeth. A second gear with 15 teeth is locked to gear B by a pin so they turn together. This 15 tooth gear meshes with gear C (60 teeth), and gear C meshes with the driven gear D (30 teeth). Calculate the speed of the driven gear D when the driver gear A rotates at 336 rpm. Show all workings. **(4 marks)**

Q15. A mini fridge contains an electronic circuit and is made from high impact polystyrene (HIPS). Explain two positive effects of the Waste Electrical and Electronic Equipment (WEEE) Directive when disposing of the mini fridge. **(4 marks)**

Q16. Different electronic components use a wide range of materials, for example silver, cadmium, ferric chloride and mercury. Analyse the impact recycling electronic components has on our ecological footprint. **(5 marks)**

Answers

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

Q7a.

Any one (1): the bands give the value of the resistor; they show the tolerance of the resistor.

Q7b.

Two reasons (1 mark each), each with a linked justification (1 mark each). For example:

- Resistance values can be calculated (1), so a suitable value can be chosen, e.g. to protect an LED from blowing (1)
- Currents can be calculated (1), so too much current does not flow, which could damage components or cause overheating (1)
- Voltage requirements can be calculated (1), so the correct supply is used and there is enough voltage to power the circuit (1)

Q7c.

Voltage across R1 = 5 V − 2 V = 3 V (1). $R = V \div I = 3 \div 0.01 = 300\ \Omega$ (1). Credit any appropriate method.

Q8.

A benefit (1) and a linked justification (1). For example:

- The voltage (trigger voltage) at the base of the transistor can be adjusted (1), so the sensitivity of the circuit can be changed (1)
- It makes an adjustable potential divider (1), so the level of darkness that switches the LED strip on or off can be changed (1)

Q9a.

1 mark for an advantage and 1 mark for the description. For example:

- When the wand touches the wire the buzzer sounds (1) and keeps sounding until the reset switch is pressed, because the thyristor latches (1)
- The thyristor acts as a switch to control current (1) and stays latched on after the trigger voltage has gone (1)
- The buzzer keeps sounding even if the wand is moved away from the wire (1); the power has to be disconnected to turn it off (1)

Q9b.

Two benefits (1 mark each), each with a linked justification (1 mark each). For example:

- It gives a loud, audible output (1), so a sound is heard when the wire and wand touch (1)
- It makes an immediate noise (1), which will make the player jump (1)
- Buzzers are very small (1), so they fit easily into the polymer case (1)
- A buzzer does not need to be programmed (1), so the circuit is not very complex (1)

Q10.

Capacitor (1) and potentiometer (1).

Q11.

1 mark for each valid point, up to 3. Allow 2 marks for a full description of a single point. For example:

- The op-amp is set up as a voltage comparator
- It compares the voltages at its two inputs
- If the non-inverting (+) input is higher than the inverting (−) input, the output is high
- If the inverting (−) input is higher than the non-inverting (+) input, the output is low
- The output shows which of the two inputs is greater, so it switches the alarm at the set temperature

Q12a.

By placing a magnet close to the switch (1).

Q12b.

Any one (1): no exterior moving parts; contacts not exposed to the atmosphere; small size or light weight; fast switching action; does not have to be touched to operate.

Q13a.

Ratchet (1) and pawl (1).

Q13b.

The mechanism allows the spring to be tightened (tensioned) by winding it (1), but does not allow the spring to unwind straight away (1).

Q14.

Gear ratio A to B = 30 ÷ 15 = 2 : 1 (1). Gear ratio from the 15 tooth gear to D = 30 ÷ 15 = 2 : 1 (1); gear C is an idler and does not change the ratio. Total reduction = 2 × 2 = 4 : 1 (1). Speed of D = 336 ÷ 4 = 84 rpm (1). Award 4 marks for a correct answer with no working.

Q15.

Two positive effects (1 mark each), each with a linked justification (1 mark each). For example:

- Less toxic material gets into the environment (1), because products have to be disposed of responsibly (1)
- Less pressure on landfill (1), because more products are recycled (1)
- Less air pollution (1), because fewer products are burned (incinerated) (1)
- More materials and components are recovered and fewer resources wasted (1), because products are broken down, separated and reused (1)

Q16. (5 marks)

Indicative content:

Negative

- Electronic products must be disposed of at an approved treatment facility
- E-waste often contains high levels of hazardous or toxic substances
- E-waste is increasing because of new technology and products being replaced sooner
- Products put in normal waste go straight to landfill, where hazardous materials leak into the environment
- Hazardous materials that leak out get into the water system and can cause serious health problems for people

Positive

- The WEEE directive makes all manufacturers and producers take responsibility for what happens to their products at the end of their lives

Band	Marks	Descriptor
3	4 to 5	A coherent answer with detailed, relevant knowledge and understanding of the ecological footprint of electronic products. Relevant examples and a well-developed, logical chain of reasoning, sustained throughout.
2	2 to 3	Some coherence, with partial knowledge and understanding. Mostly relevant examples and a logical chain of reasoning that may not be sustained throughout.
1	1	Basic knowledge and understanding. Limited relevant examples or logical chain of reasoning.
0	0	Incorrect or irrelevant answers.