1.9 Electrical Systems

AQA 8552 · Calculator allowed · about 40 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 A battery-powered cupboard light uses a light-dependent resistor (LDR), a control circuit and an LED. Identify the input, process and output in this system.

(Total for Question 1 is 3 marks)

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2 A fictional buzzer is rated 5 V and 0.12 A. Calculate its power using P = V x I.

(Total for Question 2 is 2 marks)

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3 A fictional control board requires 5 V and draws 0.30 A. A regulator is rated to provide 5 V at up to 0.40 A. Decide whether it meets both requirements and explain.

(Total for Question 3 is 2 marks)

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4 A fictional automatic plant-watering product must detect soil moisture, switch a 12 V pump drawing 1.4 A, and indicate when watering is active. Available parts: moisture sensor (analogue output, 0 to 3 V); controller (analogue input, 5 V supply); driver X (12 V, 1.0 A maximum); driver Y (12 V, 2.0 A maximum); green LED (2 V, 20 mA). Describe a suitable input-process-output arrangement and choose a suitable pump driver, using the supplied data.

(Total for Question 4 is 4 marks)

5 A fictional desk lamp switches on when its sensor reading is below 300 lux. At 280 lux it switches on; at 340 lux it switches off. State the input, output and the role of the 300 lux value.

(Total for Question 5 is 3 marks)

6 A fictional temperature sensor table gives: 10 C = 1.0 V, 20 C = 2.0 V, 30 C = 3.0 V. State the sensor output voltage at 25 C, assuming a linear change between readings.

(Total for Question 6 is 2 marks)

7 A fictional pressure sensor provides 0.5 V at 0 kPa and 4.5 V at 100 kPa. The controller receives 2.5 V. Assuming a linear response, calculate the pressure.

(Total for Question 7 is 3 marks)

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8 A fictional proximity sensor has a reliable operating range of 5 cm to 80 cm. A product must detect a hand at 12 cm. State whether the sensor meets the requirement and justify your answer.

(Total for Question 8 is 2 marks)

9 A fictional controller needs a digital input. A sensor datasheet states: output type = digital; logic low = 0 to 0.8 V; logic high = 2.0 to 5.0 V. The sensor outputs 3.3 V when active. State the logic state and explain.

(Total for Question 9 is 2 marks)

10 A fictional indicator LED is rated at 2.0 V and 15 mA. A 6.0 V supply is used with a series resistor. Calculate the resistor value needed, using R = V / I.

(Total for Question 10 is 3 marks)

11 A fictional fan draws 0.42 A in normal operation. The controller output is rated for a maximum of 0.50 A. Decide whether it can drive the fan directly and justify your decision.

(Total for Question 11 is 2 marks)

12 A fictional motor draws 0.8 A while running and 1.6 A at start-up. A driver is rated for 1.2 A maximum. Choose whether this driver is suitable and justify your choice.

(Total for Question 12 is 2 marks)

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Mark scheme · 1.9 Electrical Systems

Question 1

input: LDR sensing light level	**B1**
process: control circuit compares or uses the sensor signal	**B1**
output: LED producing light	**B1**

Answer: Input: LDR light sensor. Process: control circuit. Output: LED light.

Question 2

substitution P = 5 x 0.12	**M1**
0.60 W	**A1**

Answer: 0.60 W

Question 3

yes: output voltage matches 5 V requirement	**B1**
0.30 A required is less than 0.40 A capacity	**B1**

Answer: Yes. It supplies the required 5 V and its 0.40 A capacity exceeds the 0.30 A draw.

Question 4

moisture sensor is the input and supplies analogue moisture data to the controller analogue input	**B1**
controller processes/uses moisture reading to decide when watering is needed	**B1**
controller output switches pump via driver Y; 12 V matches pump and 2.0 A rating exceeds 1.4 A	**B1**
green LED is an output indicator when watering is active	**B1**

Answer: The moisture sensor is the input to the controller analogue input. The controller processes the reading and switches the pump through driver Y: its 12 V rating matches and its 2.0 A limit exceeds the pump 1.4 A draw. The green LED indicates watering.

Question 5

input is measured light level	**B1**
output is lamp on/off state	**B1**
300 lux is the switching threshold	**B1**

Answer: Input: light level. Output: lamp state. 300 lux is the threshold.

Question 6

recognises 0.1 V per C or interpolates halfway between 2.0 V and 3.0 V	**M1**
2.5 V	**A1**

Answer: 2.5 V

Question 7

voltage change is 4.0 V across 100 kPa, giving 25 kPa per V	**M1**
uses the 2.0 V rise above the 0 kPa output	**M1**
50 kPa	**A1**

Answer: 50 kPa

Question 8

yes, 12 cm is within the stated 5 cm to 80 cm range	**B1**
the sensor is specified to operate reliably at that distance	**B1**

Answer: Yes. 12 cm is inside its stated reliable range.

Question 9

logic high	**B1**
3.3 V lies within the stated 2.0 V to 5.0 V high range	**B1**

Answer: Logic high, because 3.3 V is in the specified high range.

Question 10

resistor voltage = 6.0 - 2.0 = 4.0 V	**M1**
converts current: 15 mA = 0.015 A; uses R = 4.0 / 0.015	**M1**
about 267 ohm	**A1**

Answer: About 267 ohm

Question 11

yes, 0.42 A is below the 0.50 A maximum	**B1**
the stated current rating is not exceeded	**B1**

Answer: Yes. The 0.42 A fan current is below the 0.50 A output limit.

Question 12

not suitable	**B1**
start-up current 1.6 A exceeds 1.2 A maximum	**B1**

Answer: Not suitable: the 1.6 A start-up current exceeds its 1.2 A rating.

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