



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

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Candidate Number

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Technology and Design

Assessment Unit AS 1

assessing

Systems and Control or
Product Design



STE12

[STE12]

THURSDAY 16 MAY, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **both** questions in **either** Section A, B or C.

INFORMATION FOR CANDIDATES

The total mark for this paper is 40.

Figures in brackets printed down the right hand side of the pages indicate the marks awarded to each question or part question.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
Total Marks	

Section A

Electronic and Microelectronic Control Systems

Answer **both** questions in this section.

- 1 (a) The output from a logic circuit is to be connected to an LED as shown in **Fig. 1**. The calculated value for a protective resistor is unavailable, so a number of resistors have been combined as shown to give the required calculated value of 160 ohms.

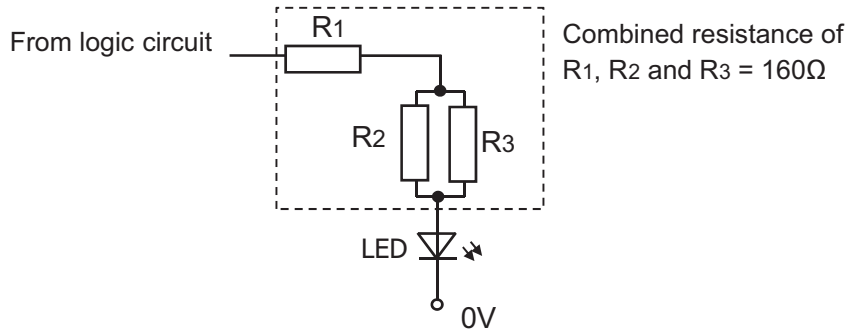


Fig. 1

Source: CCEA

- (i) Calculate the required value for R3 in **Fig. 1** to give a combined resistance of 160 ohms if R1 and R2 each have a value of 100 ohms.

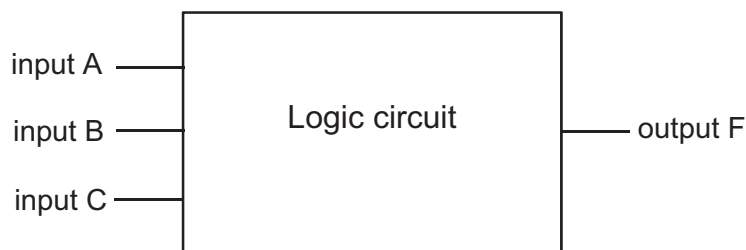
Answer _____ ohms [3]

- (ii) Calculate the total maximum power in mW that could be dissipated by the resistors R1, R2 and R3 in **Fig. 1** if the LED operates at a forward voltage of 2 volts. Assume the voltage from the logic circuit is 6V, the combined resistance of R1, R2 and R3 is 160 ohms and they each have a stated tolerance of +/- 10%.

Answer _____ mW [3]

Examiner Only	
Marks	Remark

- (b) The LED in **Fig. 1** is illuminated by the output F from a logic circuit that has three inputs A, B and C as shown in **Fig. 2**.



Source: CCEA

Fig. 2

- (i) The logic circuit shown in **Fig. 2** is made from a number of logic gates that have been connected to give a logic '1' at output F for the following logic condition:

A AND B OR B AND NOT C

Complete the truth table below, showing the **three** combinations of the inputs A, B and C when output F is logic '1'.

input A	input B	input C	output F
			1
			1
			1

[3]

- (ii) Using the appropriate gate symbols, draw a logic circuit to fulfil the logic condition stated in part (b)(i).

[3]

Examiner Only

Marks Remark

- (iii) The input to a logic circuit consists of a SPDT micro switch and a resistor. Complete the circuit diagram in **Fig. 3** below to enable a logic '1' at the input when the micro switch is moved to terminal 3 and a 'logic 0' when moved to terminal 2.

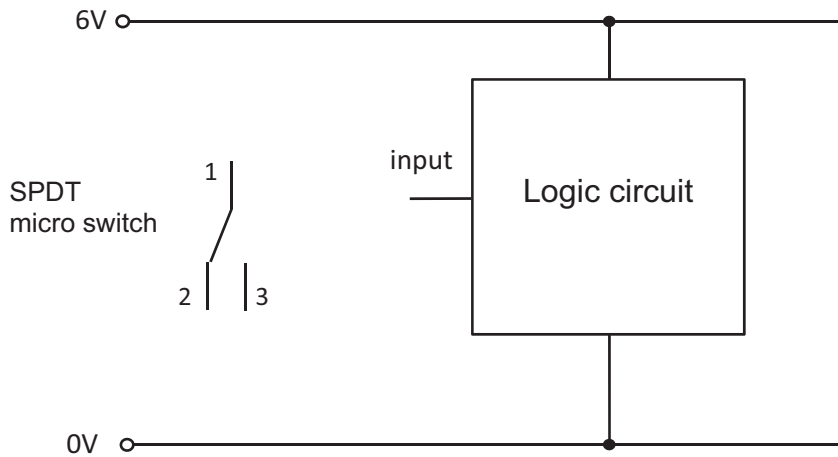


Fig. 3

[2]

- (c) The LED shown in **Fig. 1** is connected to the output of the logic circuit shown in **Fig. 2** and is to be replaced by a transistor and heater arrangement as shown in **Fig. 4**.

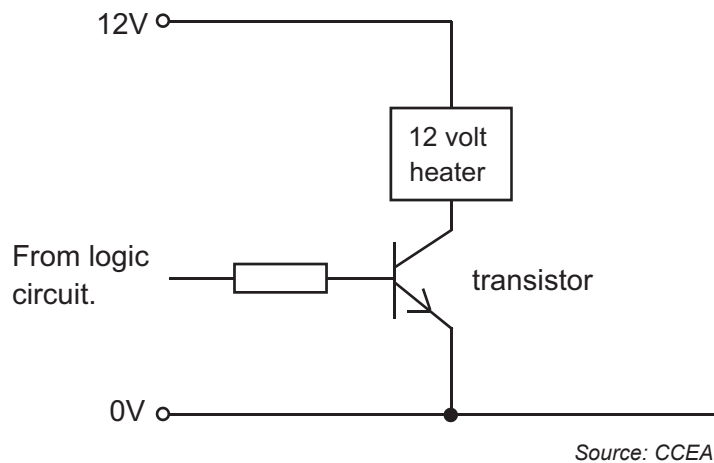


Fig. 4

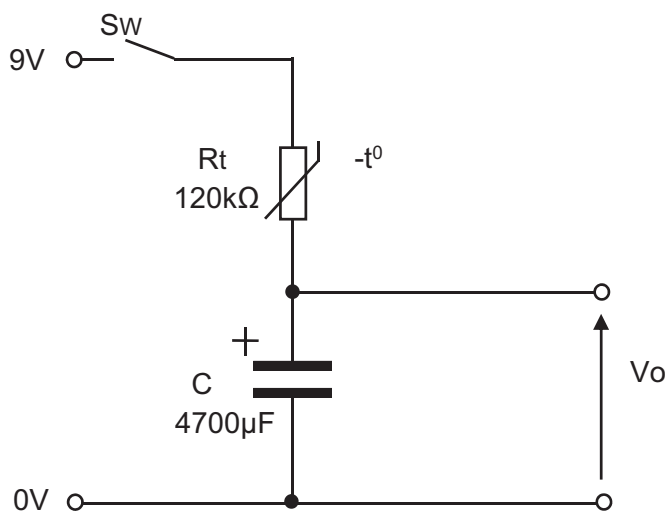
Source: CCEA

- (i) State the formula for transistor current gain:

[1]

Examiner Only	
Marks	Remark

- 2 (a) An RC circuit for timing purposes is shown in **Fig. 6**. It consists of a switch, a thermistor and an electrolytic capacitor.



Source: CCEA

Fig. 6

- (i) State **one** disadvantage (other than cost) of using an electrolytic capacitor compared to a non-polarised capacitor for a timing circuit.

_____ [1]

- (ii) The thermistor shown in **Fig. 6**, has a negative temperature coefficient. Explain what is meant by the term 'negative temperature coefficient' when referring to a thermistor.

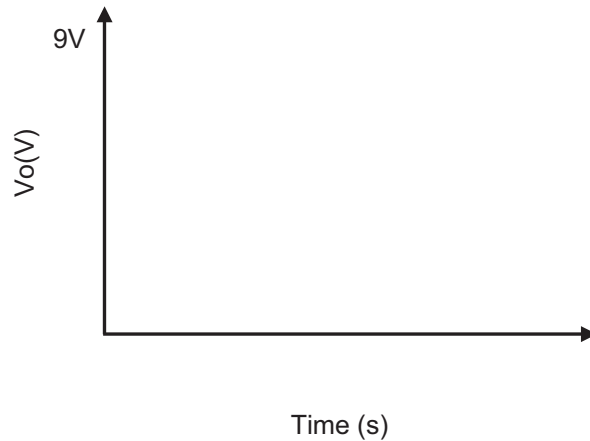
 _____ [2]

- (iii) Using the component values shown in **Fig. 6**, calculate the time constant for the circuit.

Answer _____ seconds [2]

Examiner Only	
Marks	Remark

- (iv) Assuming that the capacitor shown in **Fig. 6** has been fully discharged, sketch and label a graph on the axes in **Fig. 7** below showing V_o against time when switch Sw is closed. Indicate the time constant, labelling the values on both axes.

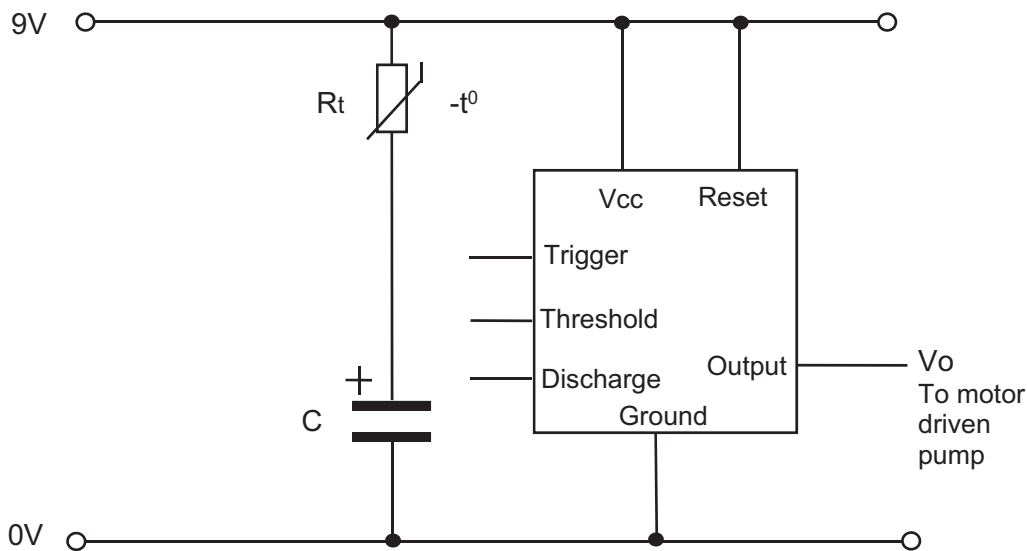


Source: CCEA

Fig. 7

[3]

- (b) An electronic system has been designed to control a pump associated with an industrial process. When required, an operator pushes a switch which in turn will start the motor driven pump. The time the motor operates for is dependent on the temperature of the industrial process. The system is based on a 555 timer and the incomplete circuit is shown in **Fig. 8**.



Source: CCEA

Fig. 8

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(i) Explain the purpose of the discharge pin on a 555 timer.

_____ [2]

(ii) Complete the circuit in **Fig. 8** by connecting the trigger, threshold and discharge pins, using additional components where appropriate so that the circuit will function as outlined. [3]

(iii) Calculate the resistance of the thermistor R_t in **Fig. 8** if the time period of the output V_o is 7.48 seconds and the value of C is $100\mu\text{F}$. Assume the circuit is complete.

Answer _____ ohms [3]

(iv) The timing graph below shows the trigger input for a monostable 555 timer circuit where the switch is pushed and released after 1 second. Add the waveform (using a solid line) for the output V_o which has a time period greater than 1 second. Mark and label the time period.

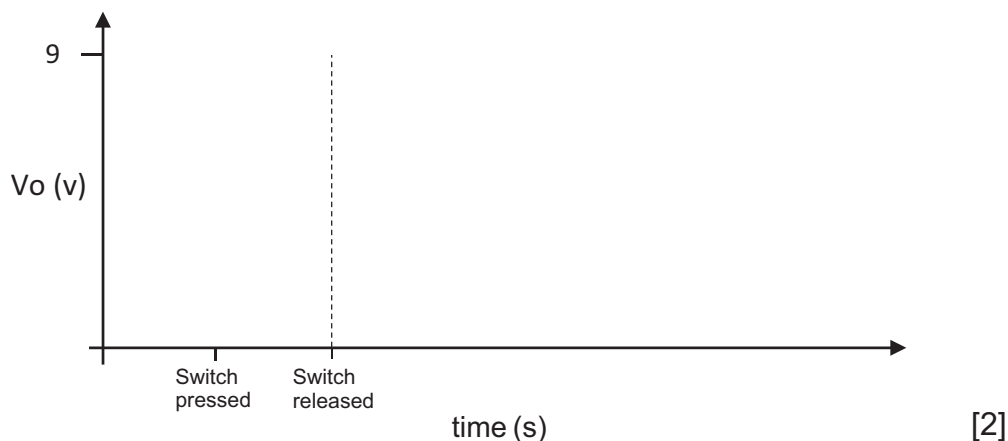


Fig. 9

(v) State **one** safety issue to consider when testing low voltage electronic systems in an educational environment and suggest **one** procedure that could be implemented to prevent injury associated with the issue.

Safety issue

_____ [1]

Procedure

_____ [1]

Section B

Mechanical and Pneumatic Control Systems

Answer **both** questions in this section.

- 3 **Fig. 10** shows an incomplete conveyor belt system which incorporates both mechanical and pneumatic components. Packages activate the air bleed as they move past on the conveyor belt.

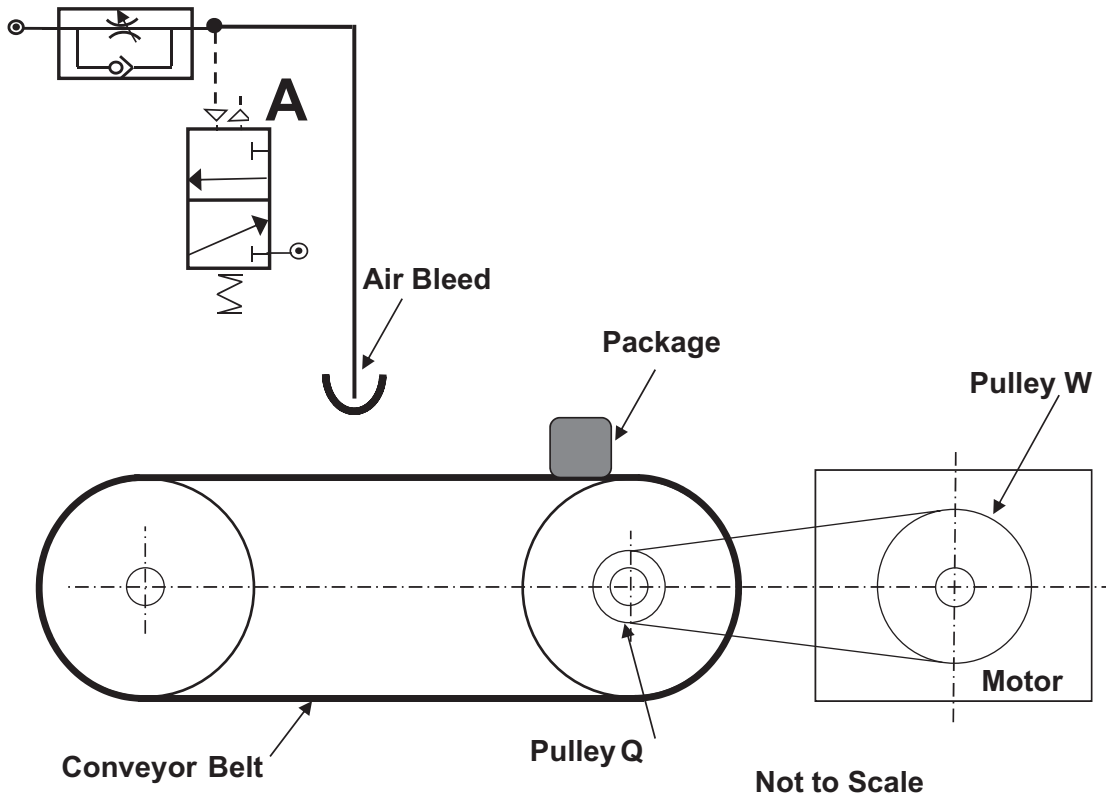


Fig. 10

- (a) Name the activation method at three port valve **A**.

_____ [1]

- (b) To prevent slipping, the belt connecting **Pulley Q** and **Pulley W** is to be fitted with a self-adjusting jockey wheel. Using an annotated sketch, draw the main features of this mechanical component.

[3]

Examiner Only	
Marks	Remark

(c) Valve **A**, shown in **Fig. 10**, forms part of the incomplete pneumatic circuit shown in **Fig. 11**. Add any other necessary components to **Fig. 11** to enable speed control of the outstroke of the double acting cylinder following a delay in time after valve **A** has been activated. [4]

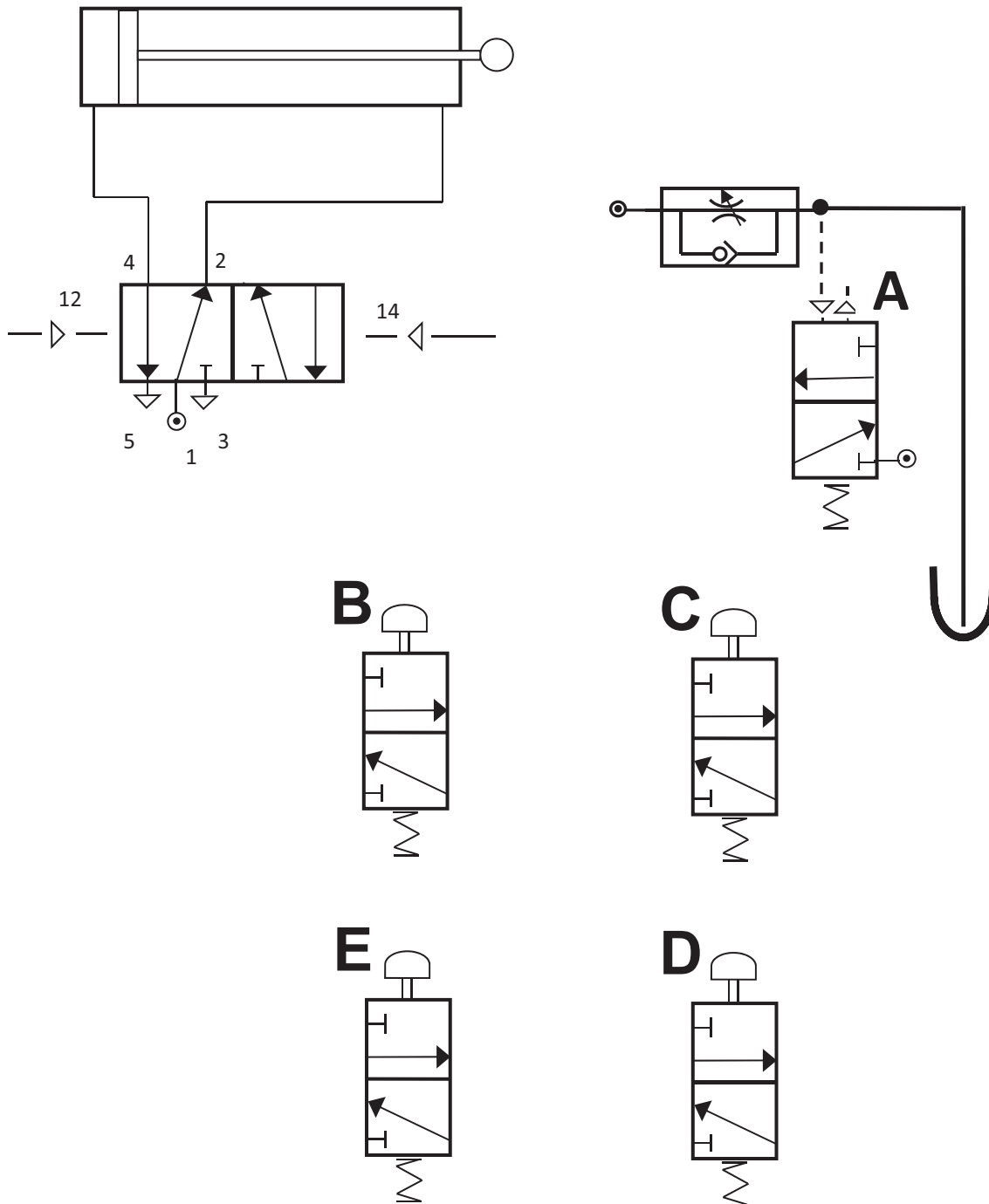


Fig. 11

(d) Add any other necessary components to **Fig. 11** to enable the double acting cylinder to instroke following activations at **B OR C OR D AND NOT E**. [5]

Examiner Only	
Marks	Remark

- 4 Fig. 12 shows a prototype mechanical system used to provide rotary motion to **Shaft X**.

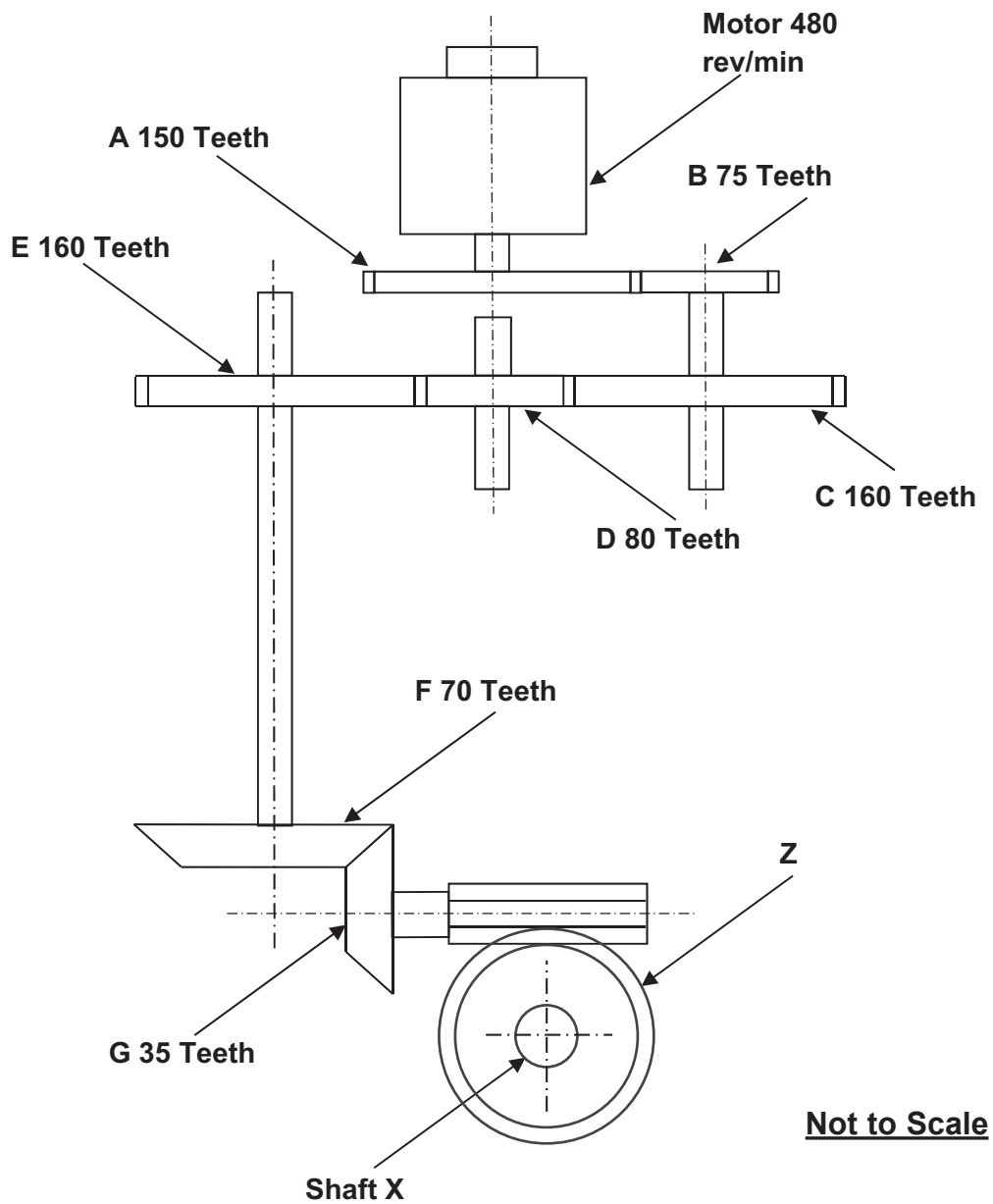


Fig. 12

- (a) What is the specific name of component **Z**?

_____ [1]

Examiner Only	
Marks	Remark

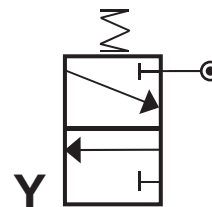
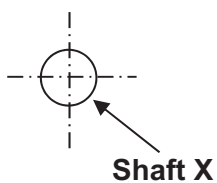
(b) Calculate the velocity ratio between **A** and **G**.

Answer _____ [4]

(c) Calculate the number of teeth required on **Z** to enable it to rotate at 8 rev/min if **E** rotates at 144 rev/min.

Answer _____ [3]

(d) **Fig. 13** shows **Shaft X** and three port valve **Y**. Using an annotated sketch, draw a suitable system which would enable **Y** to be activated once during every four rotations of **Shaft X**. [6]



Not to Scale

Fig. 13

Examiner Only	
Marks	Remark

(e) Fig. 14 shows an incomplete pneumatic circuit incorporating valve Y as shown in Fig. 13. Complete the pneumatic circuit to enable both cylinders T and U to outstroke following an activation at Y. When Y is not activated, the cylinders should return to their instroke positions. Please note that no further three or five port valves are available for use. [6]

Examiner Only	
Marks	Remark

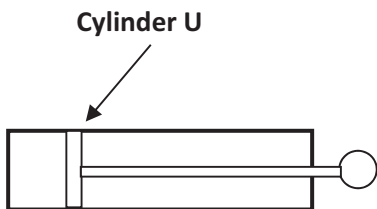
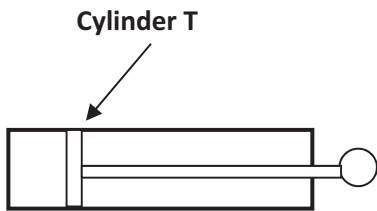
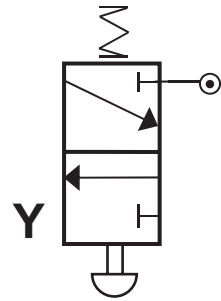
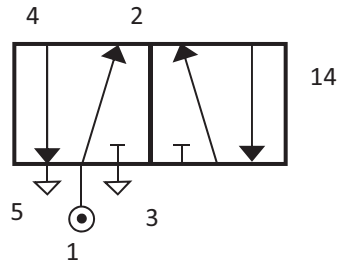


Fig. 14

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(b) One concept that emerged from the thought showers was the idea to produce a holder manufactured from carbon fibre reinforced plastic (CFRP).

(i) State **two** specific properties associated with CFRP which would make it suitable for the holder.

1. _____

2. _____

_____ [2]

(ii) State **one** main specific reason why CFRP may not be a suitable material for the holder.

_____ [1]

(c) When producing the coffee cup holder, employee and consumer safety had to be given careful consideration.

Distinguish between employee and consumer safety.

_____ [2]

(d) The handlebar coffee cup holders are to be mass-produced.

Briefly outline **two** main characteristics associated with mass production.

1. _____

2. _____

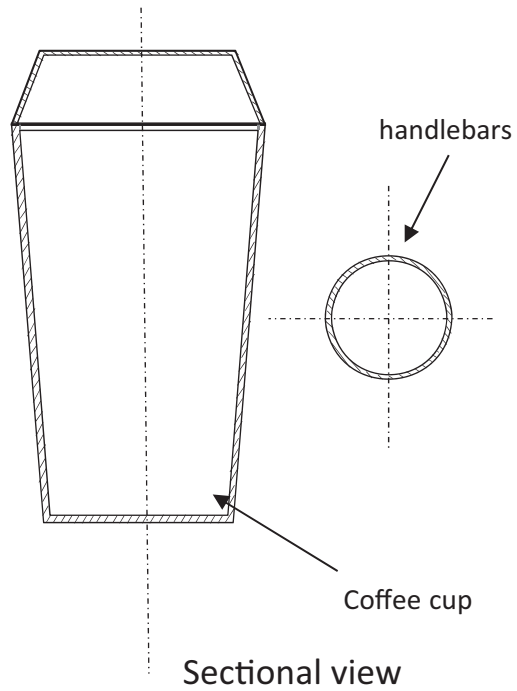
_____ [2]

Examiner Only

Marks Remark

(g) With reference to **Fig. 16** below, and with the aid of an annotated freehand **isometric projection** sketch, complete the following using the blank A4 pro forma (**answer number 5(g)**):

An appropriate low cost design of a coffee cup holder that is easy and quick to secure to the handlebars at the position shown in **Fig. 16** (X – X). [6]



Source: Principal Examiner

Fig. 16

Examiner Only	
Marks	Remark

A4 pro forma answer page (answer number **5(g)**)

- (ii) With reference to a suitable specific product of your choice, outline **one** main cultural change and explain what influence this has had on its design.

Cultural change

[1]

Explanation

[2]

- (f) **Fig. 18** shows photographs of the gas lighter. Using the blank A4 pro forma (**answer number 6(f)**) use detailed annotated sketches to produce one possible solution for the following:

An appropriate design for a secure plastic cover for the end of the gas lighter. The design must allow the user to quickly attach or remove the cover from the end of the lighter, but it must include a means of preventing the cover from getting lost. [4]

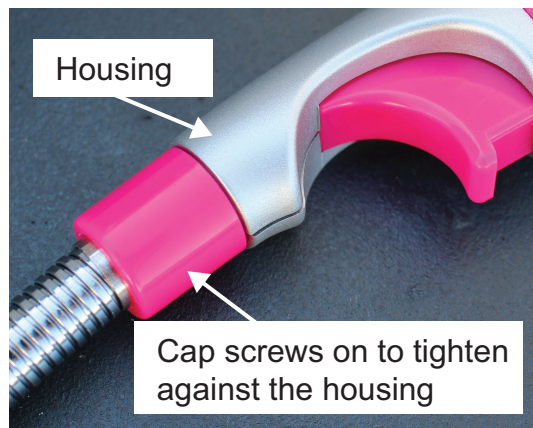
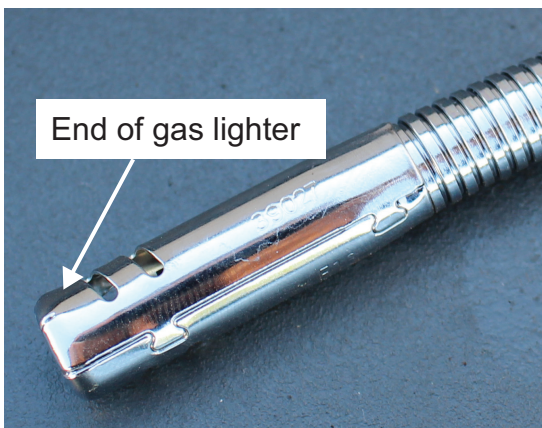


Fig. 18

Source: Principal Examiner

A4 pro forma answer page (answer number **6(f)**)

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