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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

**MV18**

**[STE12]**

**THURSDAY 16 MAY, AFTERNOON**

### Time

1 hour, plus your additional time allowance.

### 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.

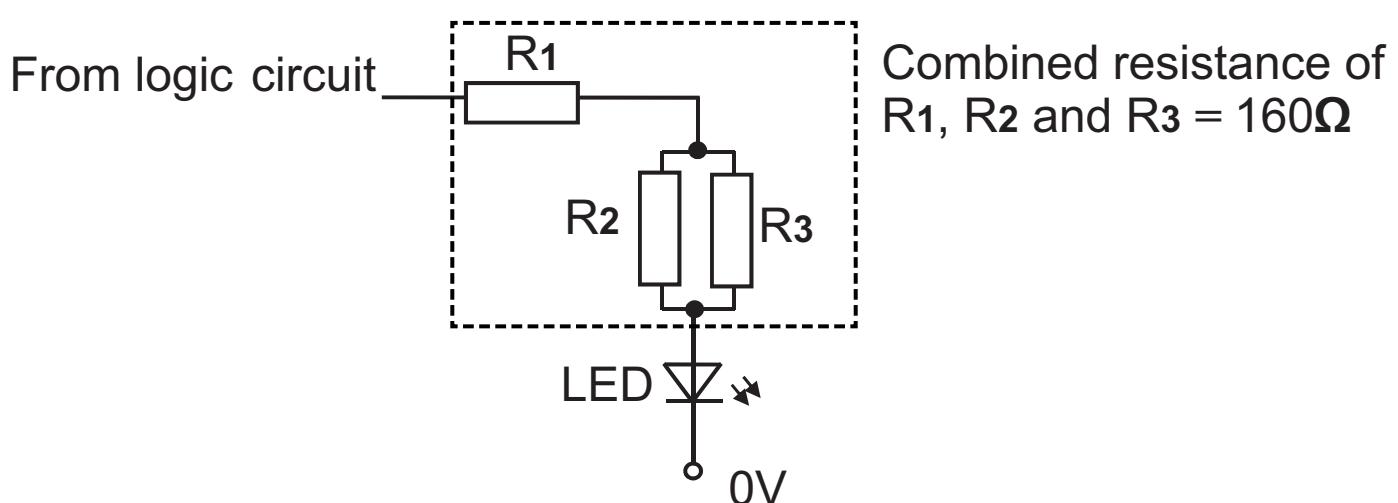
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

## 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**

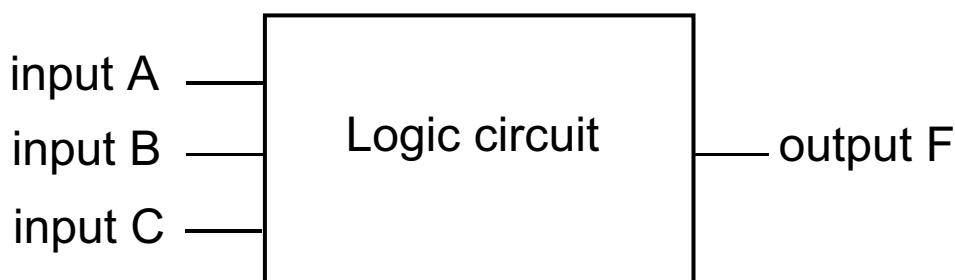
(i) Calculate the required value for R<sub>3</sub> in **Fig. 1** to give a combined resistance of 160 ohms if R<sub>1</sub> and R<sub>2</sub> each have a value of 100 ohms. [3 marks]

Answer \_\_\_\_\_ ohms

(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  $\pm 10\%$ . [3 marks]

Answer \_\_\_\_\_ mW

(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**.



**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:

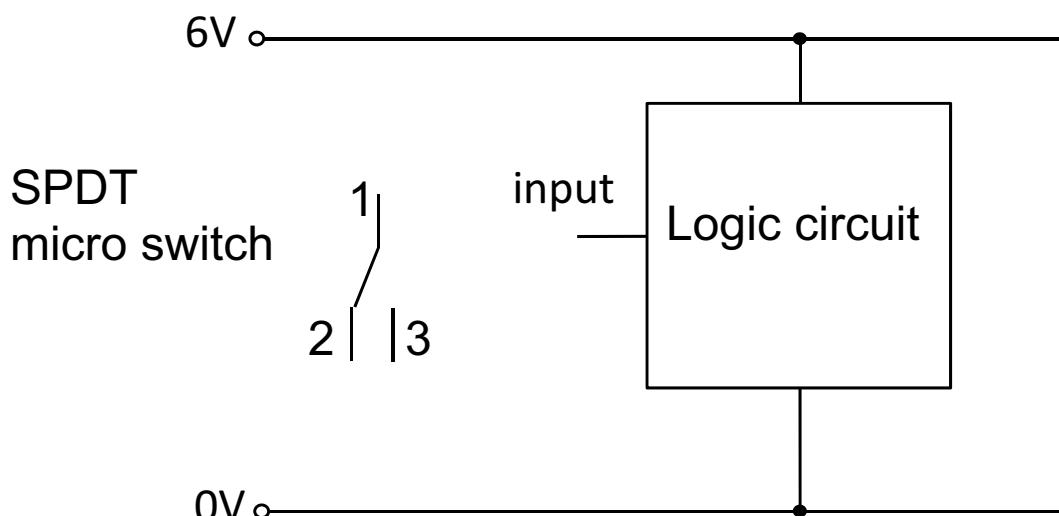
**A AND B OR B AND NOT C**

Complete the truth table below, showing the **three** combinations of the inputs A, B and C when output F is logic '1'. [3 marks]

<b>input A</b>	<b>input B</b>	<b>input C</b>	<b>output F</b>
			1
			1
			1

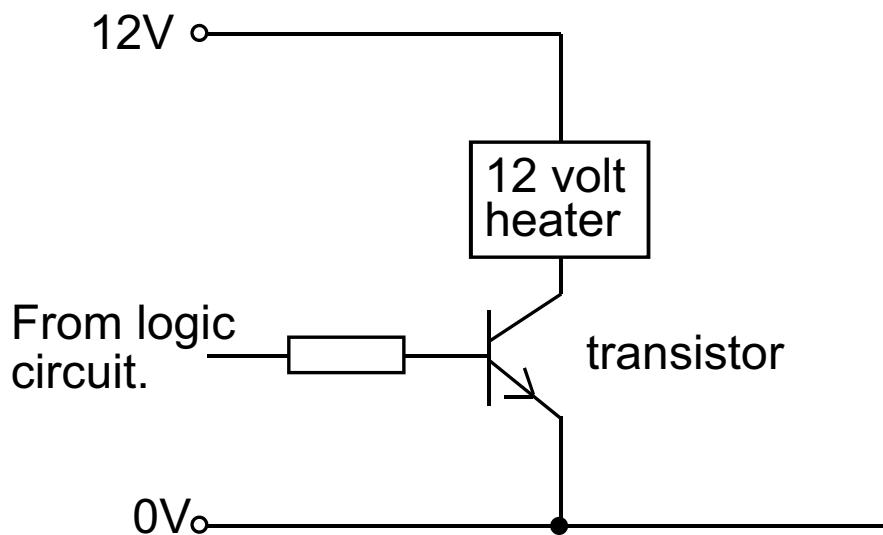
(ii) Using the appropriate gate symbols, draw a logic circuit to fulfil the logic condition stated in part (b)(i). [3 marks]

(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. [2 marks]



**Fig. 3**

(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**

(i) State the formula for transistor current gain:  
[1 mark]

(ii) Explain what is meant by the term **I<sub>c(max)</sub>** when referring to transistors. [2 marks]

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(iii) If the resistance of the heater shown in **Fig. 4** is 25 ohms and the transistor base current is 2mA, calculate the gain required for the transistor and choose an appropriate transistor from one of the four types shown in the table in **Fig. 5**.  
[2 marks for gain, 1 mark for transistor]

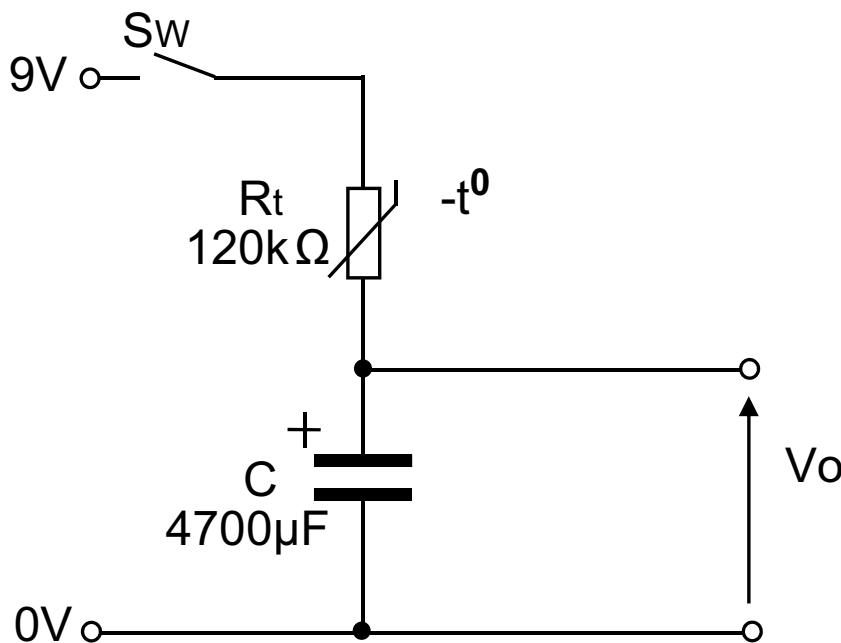
Transistor	$I_c(\text{max})$	$h_{fe}$
Type A	1.2A	100
Type B	600mA	200
Type C	500mA	300
Type D	400mA	400

**Fig. 5**

Gain required = \_\_\_\_\_

Chosen transistor type = \_\_\_\_\_

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



**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 mark]

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(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 marks]

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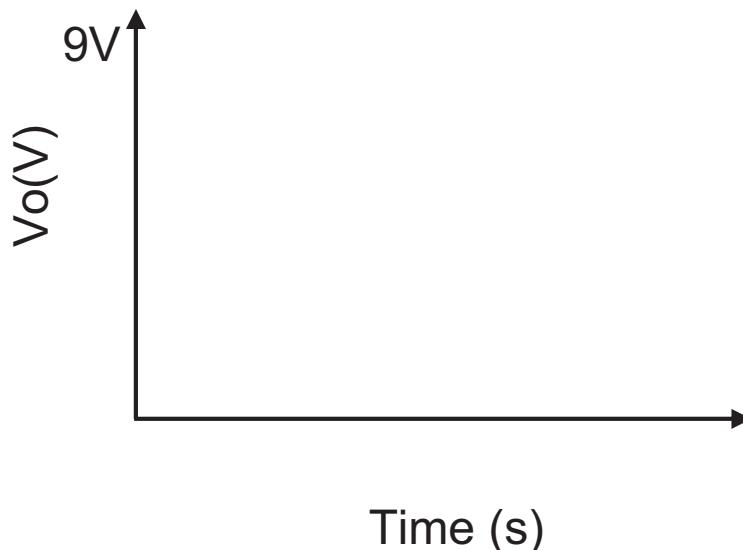


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(iii) Using the component values shown in **Fig. 6** on page 8, calculate the time constant for the circuit. [2 marks]

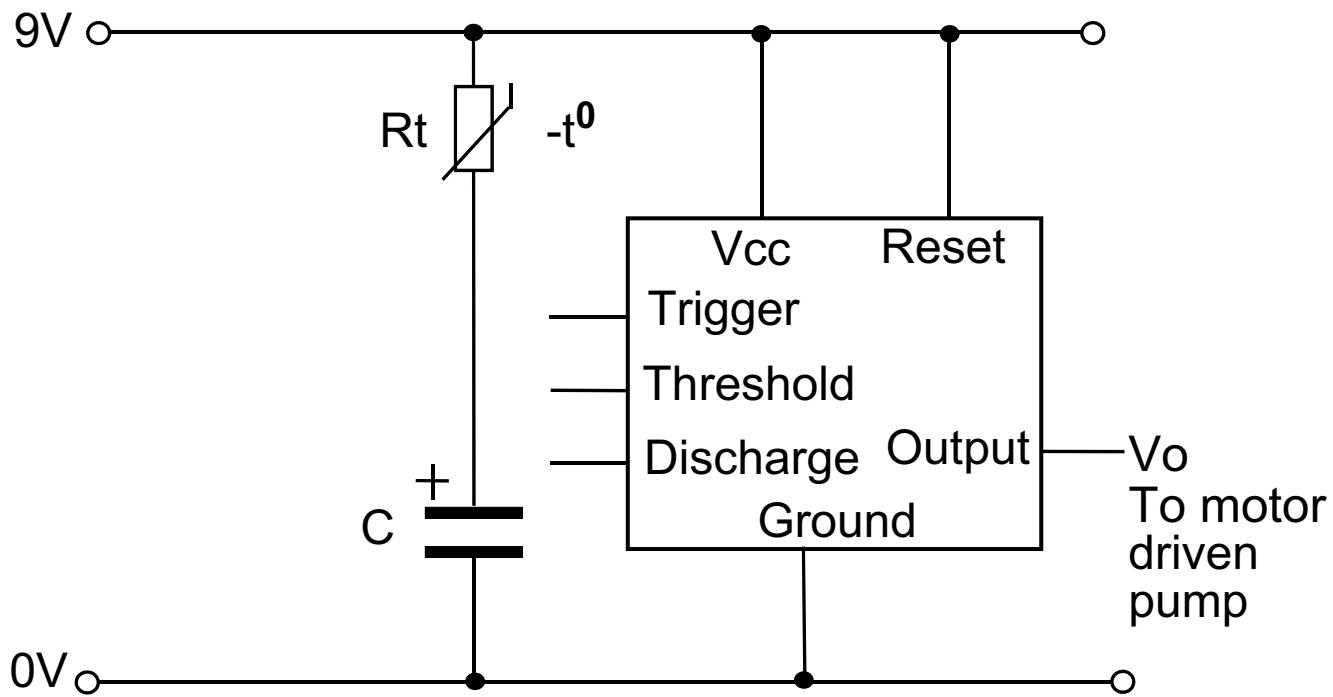
Answer \_\_\_\_\_ seconds

(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  $S_w$  is closed. Indicate the time constant, labelling the values on both axes. [3 marks]



**Fig. 7**

(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**.



**Fig. 8**

(i) Explain the purpose of the discharge pin on a 555 timer. [2 marks]

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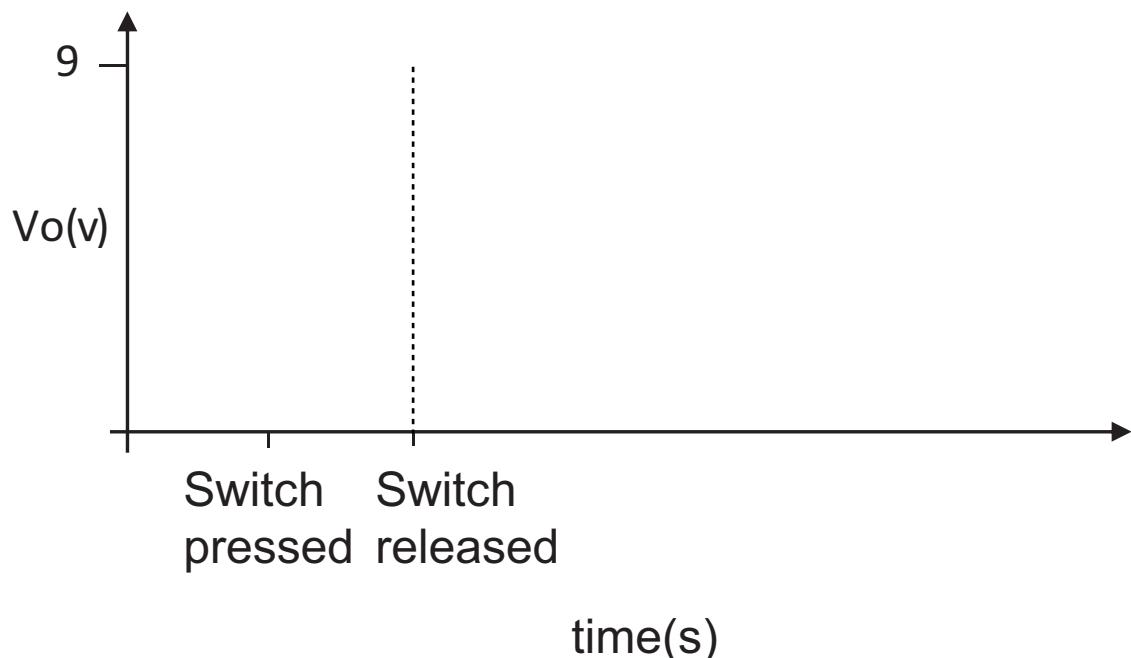
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(ii) Complete the circuit in **Fig. 8** by connecting the trigger, threshold and discharge pins, using additional components where appropriate so that the circuit will function as outlined. [3 marks]

(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  $100\ \mu F$ . Assume the circuit is complete. [3 marks]

Answer \_\_\_\_\_ ohms

(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. [2 marks]



**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. [1 mark for each]

Safety issue

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Procedure

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**(Questions continue overleaf)**

## 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.

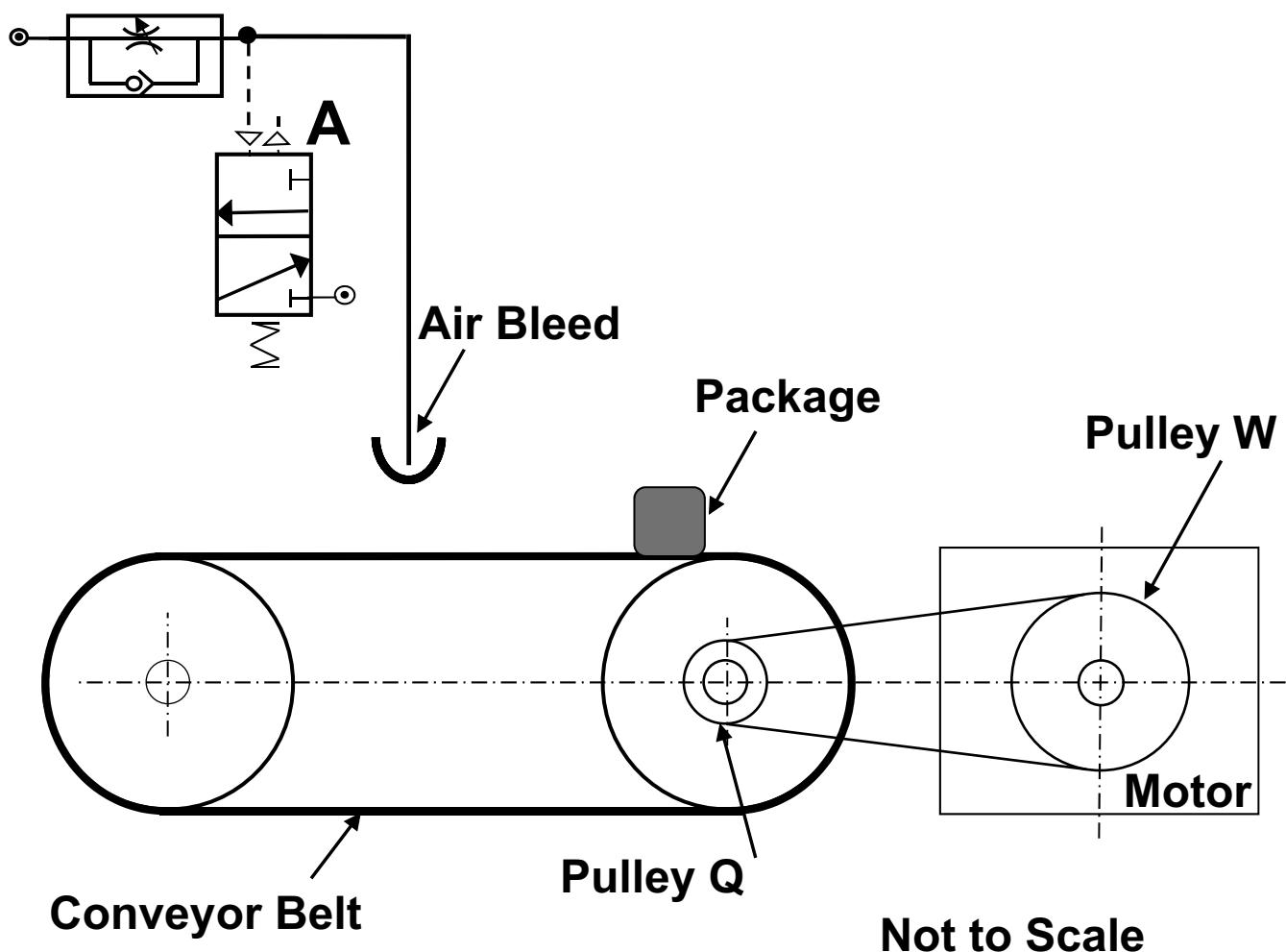


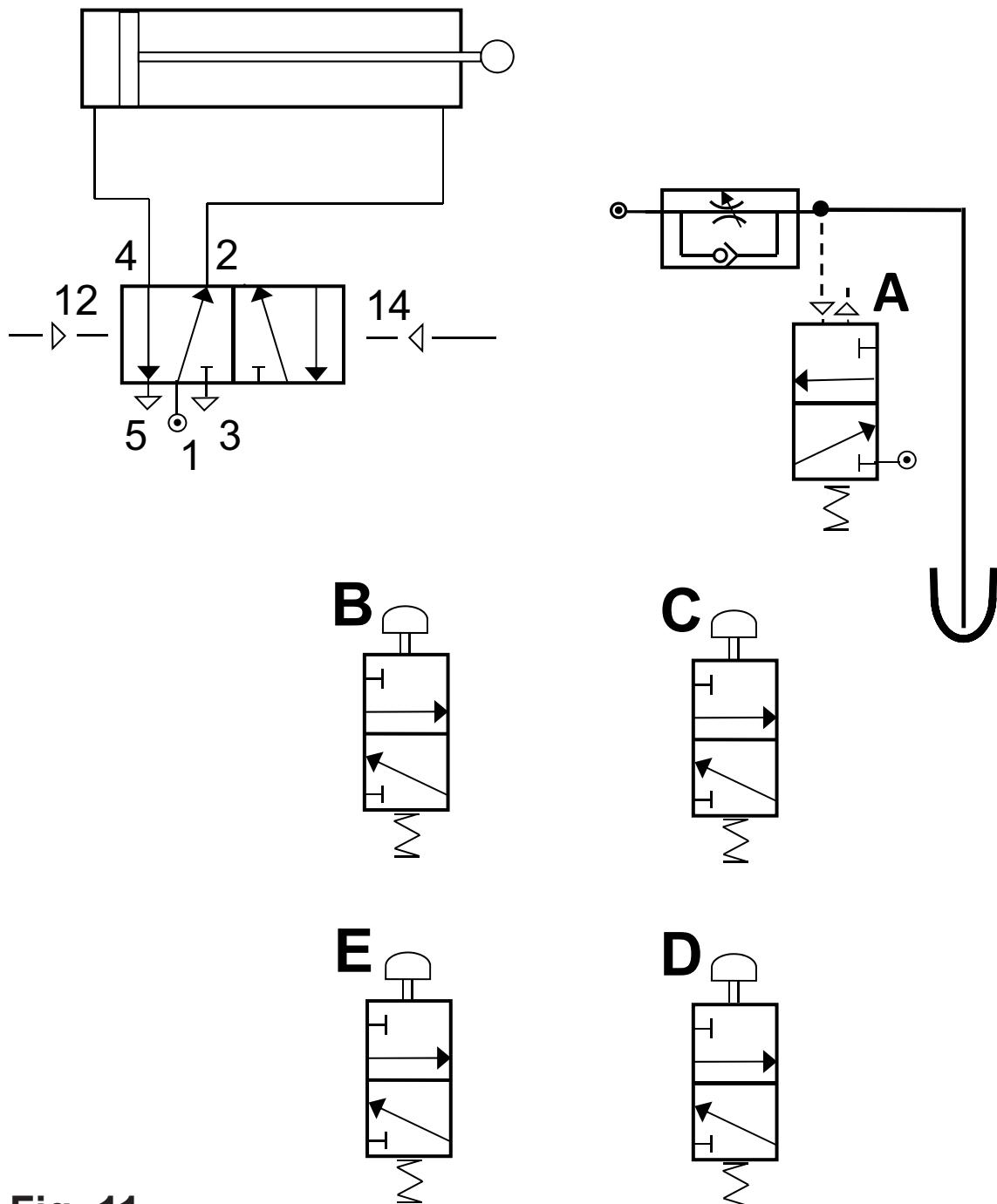
Fig. 10

**(a)** Name the activation method at three port valve **A**.  
[1 mark]

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**(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 marks]

(c) Valve A, shown in **Fig. 10** on page 14, forms part of the incomplete pneumatic circuit shown in **Fig. 11**. Add any necessary additional 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 marks]



**Fig. 11**

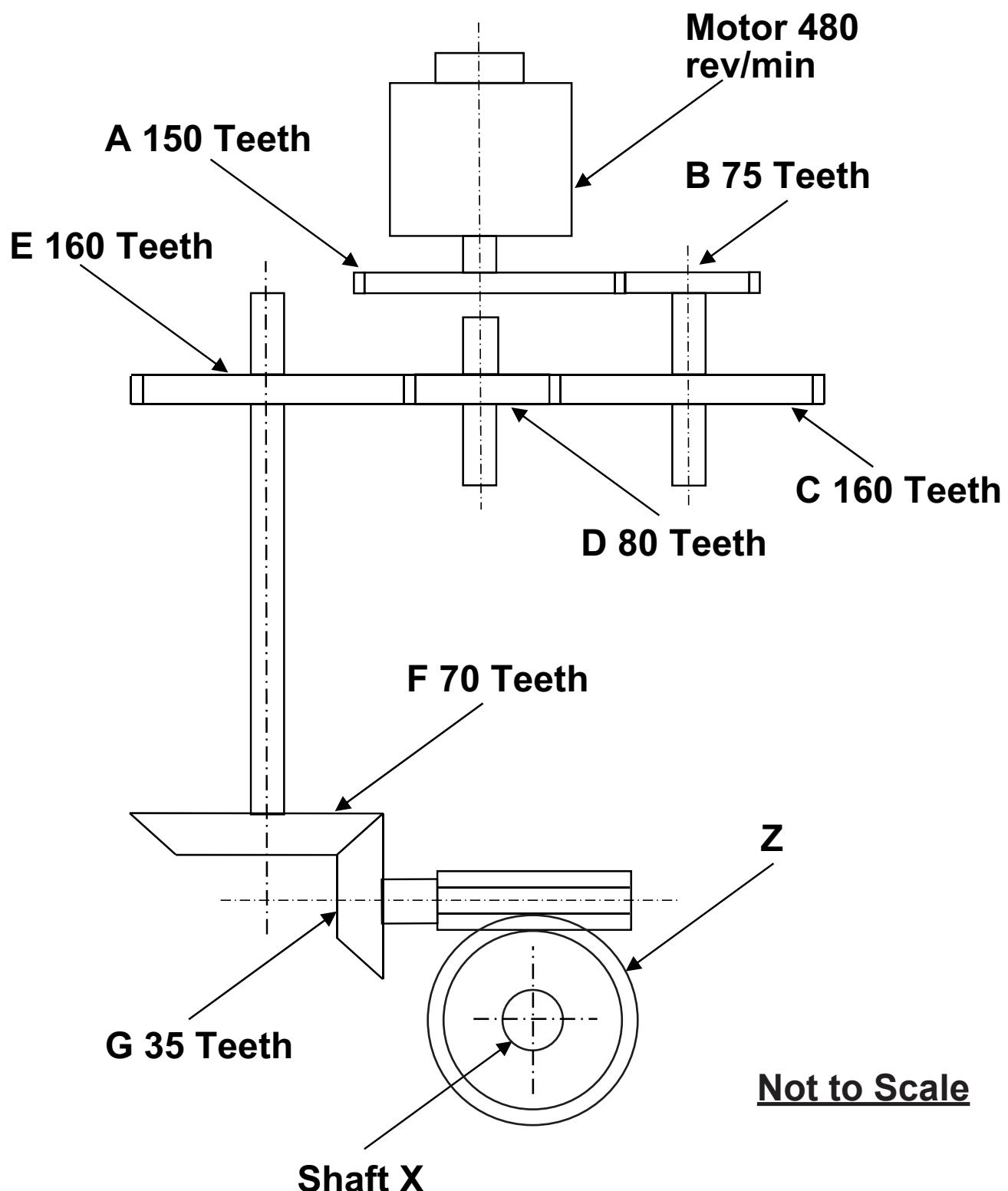
(d) Add any necessary additional components to **Fig. 11** to enable the double acting cylinder to instroke following activations at B **OR** C **OR** D **AND NOT** E. [5 marks]

(e) Pulley W, shown in **Fig. 10**, is attached to the motor shaft using a key and keyway. Using an annotated sketch, show the main features of this fixing method. [3 marks]

(f) The double acting cylinder, shown in **Fig. 11**, operates with an air pressure of  $0.5 \text{ N/mm}^2$ , produces a force of  $100\text{N}$  during the outstroke and a force of  $74.88\text{N}$  during the instroke. Calculate the piston rod radius. Please assume  $\pi = 3.14$ . [4 marks]

Answer \_\_\_\_\_ mm

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 mark]

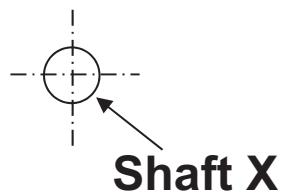
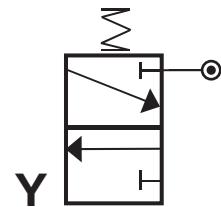
**(b)** Calculate the velocity ratio between **A** and **G**.  
[4 marks]

Answer \_\_\_\_\_

**(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.  
[3 marks]

Answer \_\_\_\_\_

(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 marks]



**Fig. 13**

**Not to Scale**

(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 marks]

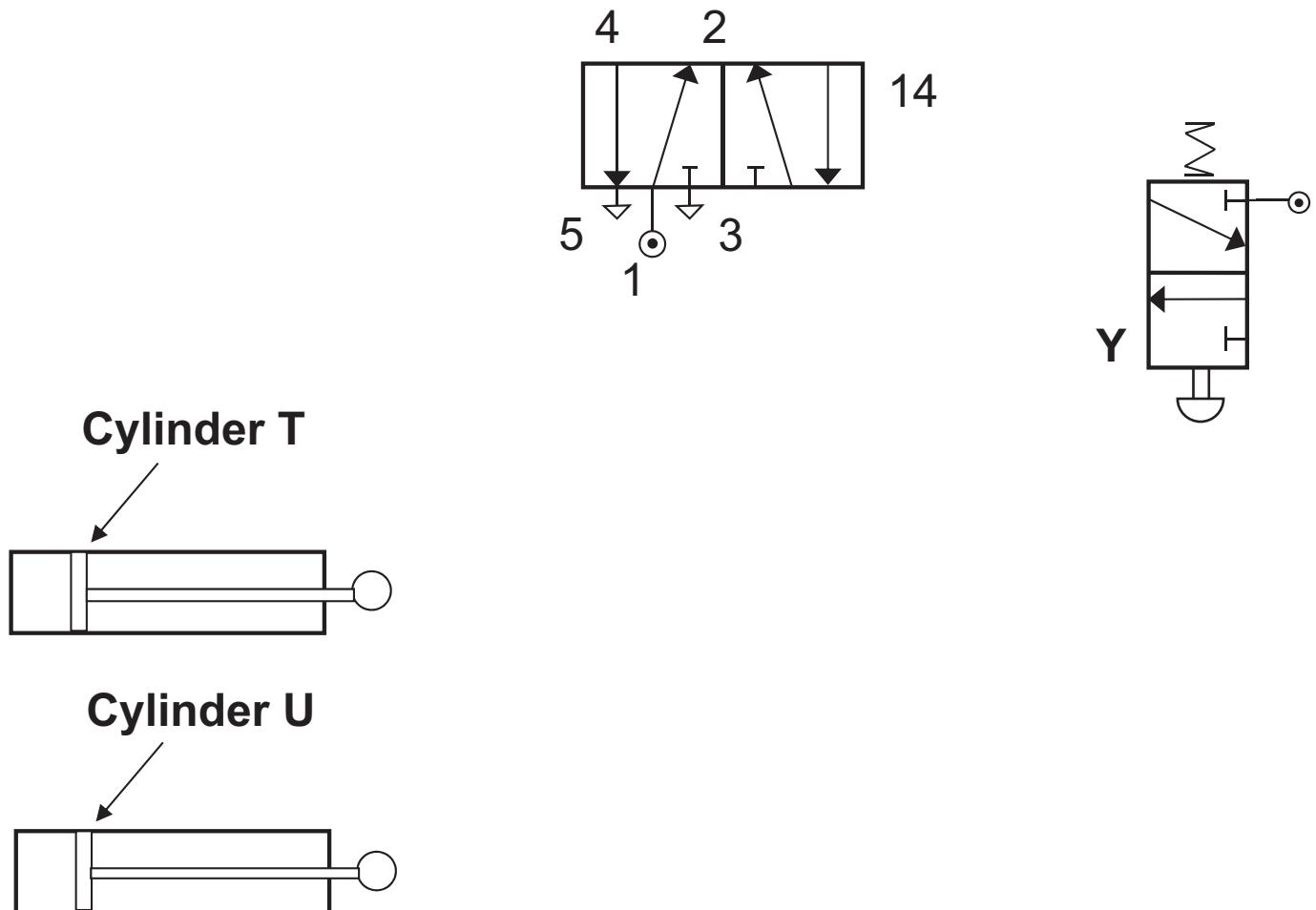


Fig. 14

## Section C

### Product Design

Answer **both** questions in this section.

5 Fig. 15 below shows the dilemma that many city cyclists face as they attempt to explore their surroundings whilst consuming a cup of coffee on the go. A handlebar coffee cup holder that is easy to install and use could provide the cyclist with a possible solution.



**Fig. 15**

(a) When generating ideas for a handlebar coffee cup holder, designers employed the technique of thought showers.

State **two** specific characteristics associated with thought showers. [2 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

(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.  
[2 marks]

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(ii) State **one** main specific reason why CFRP may not be a suitable material for the holder. [1 mark]

\_\_\_\_\_

\_\_\_\_\_

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

Distinguish between employee and consumer safety.  
[2 marks]

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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

Briefly outline **two** main characteristics associated with mass production. [2 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

(e) After discussing the intellectual property rights of the new design for the handlebar coffee cup holder, the design team decided to apply for a registered design.

Briefly outline **three** different characteristics associated with a registered design. [3 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

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**(Questions continue overleaf)**

(f) An important part of the design process for any company is to undertake a product review.

Explain what is meant by a product review. [2 marks]

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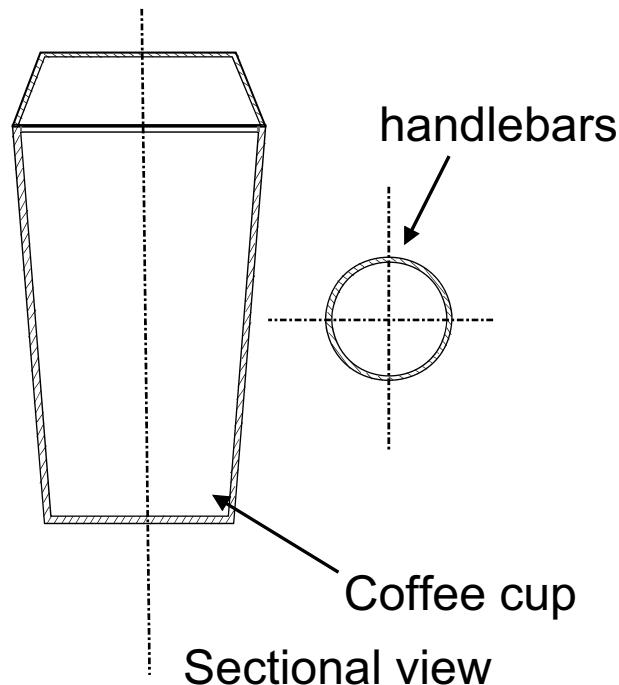
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(g) With reference to **Fig. 16** below, and with the aid of an annotated freehand **isometric projection** sketch, complete the following using the blank A4 pro forma (**answer number 5(g)**):

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 marks]



**Fig. 16**

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

6 Fig. 17 shows a low cost gas lighter which will provide a safe and effective way to light gas cookers, fires and barbecues.



Fig. 17

(a) When designing the gas lighter shown in Fig. 17, the designers generated a manufacturing specification for the housing of the lighter.

Briefly outline **two** specific criteria that the designer would need to include in a manufacturing specification for the housing of the lighter. [2 marks]

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

**(b)** A 2D model of the gas lighter is to be laser cut from acrylic. With the use of an annotated sketch, explain the process of laser cutting which could be used to cut the model of the gas lighter. [5 marks]

**(c)** Prior to production of the gas lighter, a work order was created. Briefly outline what is meant by a work order. [1 mark]

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**(d)** When producing the gas lighter, the requirements of the Trade Descriptions Act had to be considered.

Briefly outline **two** main requirements of the Trade Descriptions Act that the gas lighter company would need to comply with when deciding upon the information for the packaging. [2 marks]

1. \_\_\_\_\_

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2. \_\_\_\_\_

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(e) It may be argued that the design of the gas lighter shown in **Fig. 17** has not been influenced by cultural or social change to the same extent as many other specific products.

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

Social change [1 mark]

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Explanation [2 marks]

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(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 mark]

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Explanation [2 marks]

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**(Questions continue overleaf)**

(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 marks]



Fig. 18

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

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**This is the end of the question paper**

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**SOURCES:**

Q1(a) ....Source: CCEA  
 Q1(b) ....Source: CCEA  
 Q1(c).....Source: CCEA  
 Q2(a) ....Source: CCEA  
 Q2(a)(iv) Source: CCEA  
 Q2(b) ....Source: CCEA  
 Q5.....Source: Principal Examiner  
 Q5(g) ....Source: Principal Examiner  
 Q6.....Source: Principal Examiner  
 Q6(f) .....Source: Principal Examiner

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Question Number	Marks
1	
2	
3	
4	
5	
6	
<b>Total Marks</b>	

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