



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2025

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

MONDAY 12 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.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Questions which require drawing or sketching should be completed using an H.B. pencil.

All other questions must be completed using black ink only.

Do not write in pencil or with a gel pen.

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

For all questions requiring calculations, show your working out.

INFORMATION FOR CANDIDATES

The total mark for this paper is 40.

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

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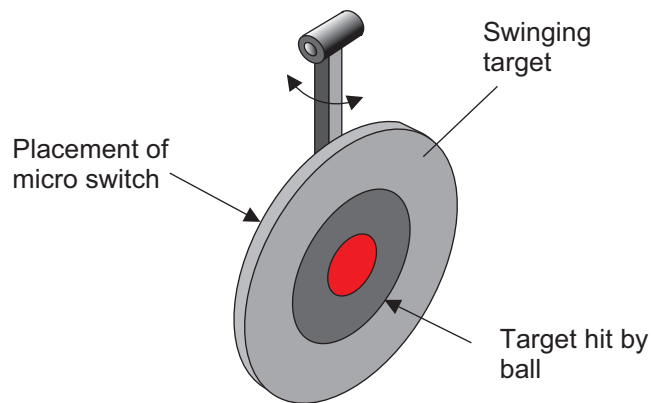
36STE1201

Section A

Electronic and Microelectronic Control Systems

Answer **both** questions in this section.

- 1 (a) A design for a target is shown in **Fig. 1**. A micro switch is to be placed close behind the swinging target in order to detect tennis balls that will be thrown at it.



Source: CCEA

Fig. 1

- (i) Explain **one** main characteristic of a micro switch that makes it suitable for detecting a tennis ball hitting the target shown in **Fig. 1**.

[2]



- (ii) Complete the circuit in **Fig. 2** using a single pole single throw (SPST) micro switch and resistor so that a 6 volt output (V_o) will be produced when the micro switch is operated.

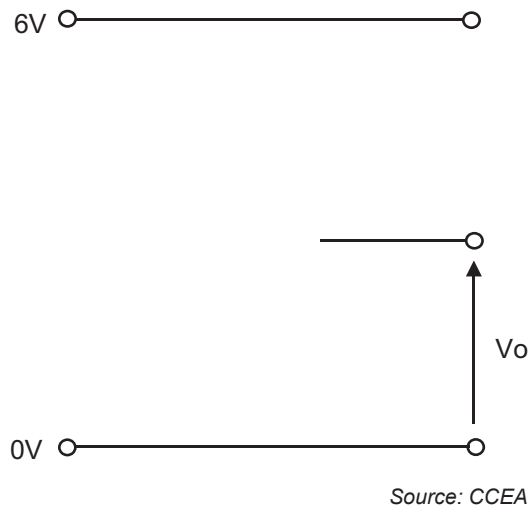


Fig. 2

[2]

- (b) A push to make (PTM) switch is to be used as the input to the open loop system as shown in **Fig. 3**.

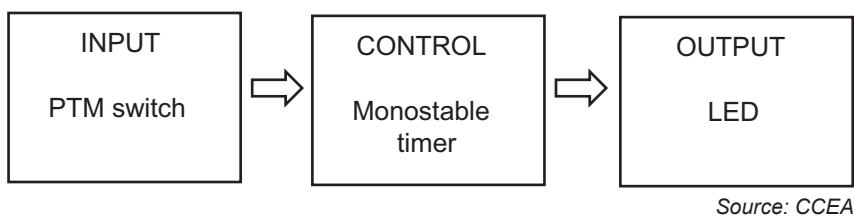


Fig. 3

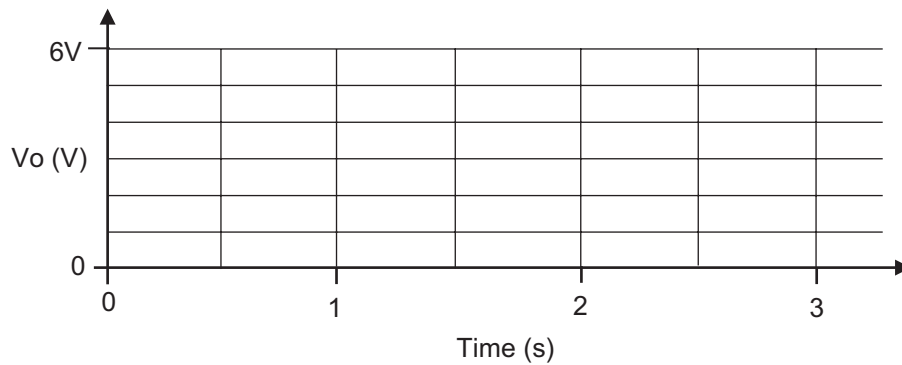
- (i) Explain **one** disadvantage of open loop systems compared to closed loop systems.

[2]

[Turn over



- (ii) Sketch a graph on the axes in **Fig. 4** below to show the output of a monostable timer with a time constant of 1.5 seconds. Assume that the 555 timer has a 6 volt power supply.

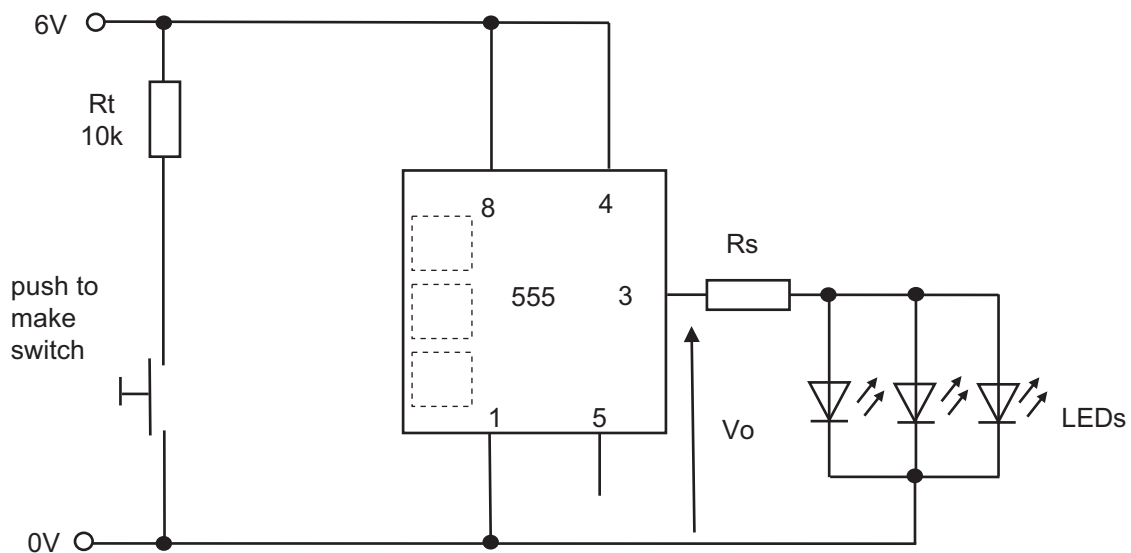


Source: CCEA

Fig. 4

[2]

- (c) An incomplete monostable circuit based on a 555 timer is shown in **Fig. 5**.



Source: CCEA

Fig. 5

- (i) Complete the monostable circuit shown in **Fig. 5** by adding the following:

- a connection that will trigger the monostable timer when the PTM switch is operated
- components and their appropriate values and connections to create a time period of 1.5 seconds
- the missing pin numbers on the symbol for the 555 timer.

[6]



- (ii) The LEDs connected to the output of the 555 timer in **Fig. 5** are each manufactured to operate at a forward voltage of 1.6 V and a current of 15 mA.

Calculate the required value for the series resistor R_s .

Candidates need to show their working out in the space below.

Answer _____ ohms [2]

- (iii) Calculate the power dissipated, in watts, by the series resistor R_s in **Fig. 5**, then choose the most suitable power rating from the following ratings of 0.125 W, 0.25 W and 0.5 W.

Candidates need to show their working out in the space below.

Power dissipated by R_s _____ W [2]

Chosen power rating _____ W [1]

- (iv) Resistors in the E12 series are available for the resistor R_s in **Fig. 5**. Select a value for the resistor R_s (based on your calculation from (c)(ii)) from the E12 series below.

100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820

Selected E12 value _____ ohms [1]

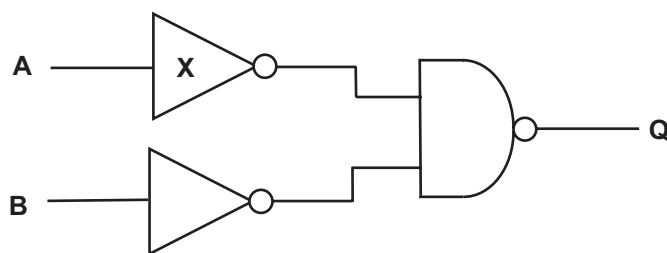
[Turn over

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36STE1205

2 (a) An arrangement of three logic gates is shown in **Fig. 6**.



Source: CCEA

Fig. 6

(i) State the name of the logic gate labelled **X** in **Fig. 6**.

_____ [1]

(ii) An incomplete truth table showing the output **Q** for the input combinations of **A** and **B** for the circuit in **Fig. 6** is shown in **Fig. 7** below. Fill in the missing logic states for **A**, **B** and **Q**.

A	B	Q
0	0	
		1
0	1	
1	1	1

Fig. 7

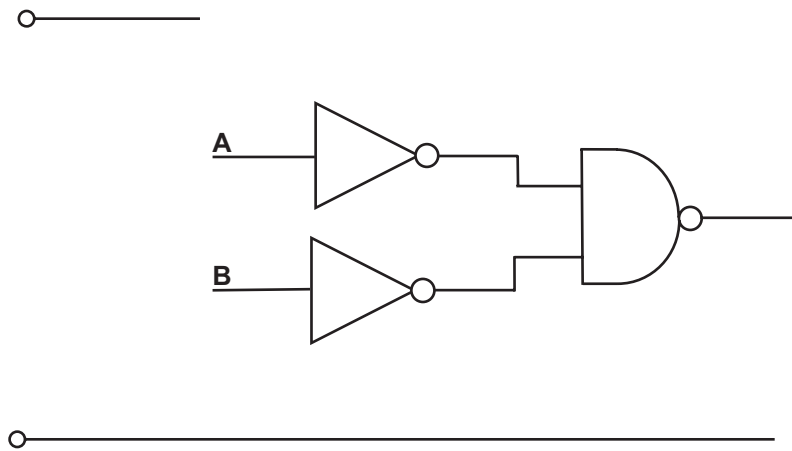
[3]

(iii) Name **one** logic gate that could be used to perform the same logic function as all three gates shown in **Fig. 6**.

_____ [1]



(iv) Complete the circuit in **Fig. 8** by adding push to break switches with resistors to provide individual logic inputs at **A** and **B** so that when each switch is pressed a logic 1 is provided. When each switch is released a logic 0 should be provided.



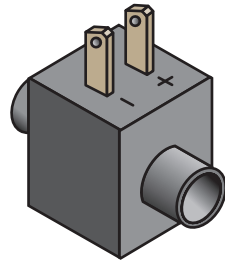
Source: CCEA

Fig. 8

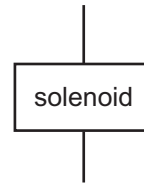
[3]



(b) Fig. 9 shows a typical 24 volt solenoid valve and the symbol that can be used to represent it.



24 volt solenoid valve



symbol

Source: CCEA

Fig. 9

(i) Explain how a solenoid valve operates.

[2]

(ii) The output **Q** from the logic circuit shown in Fig. 6 is to be used to control a 24 volt solenoid valve by means of a transistor which has an h_{fe} of 60 and a V_{be} of 0.6 volts. If logic '1' from the circuit is 5 volts, and the resistance of the solenoid is 150 ohms, calculate the required value for a base resistor when the transistor is used to drive the solenoid valve.

Candidates need to show their working out in the space below.

Answer _____ ohms [4]



- (iii) Complete the circuit diagram in **Fig. 10** to show how the output from the logic circuit in **Fig. 6** can be used in conjunction with a transistor to drive the 24 volt solenoid in **Fig. 9**, showing any additional components required.

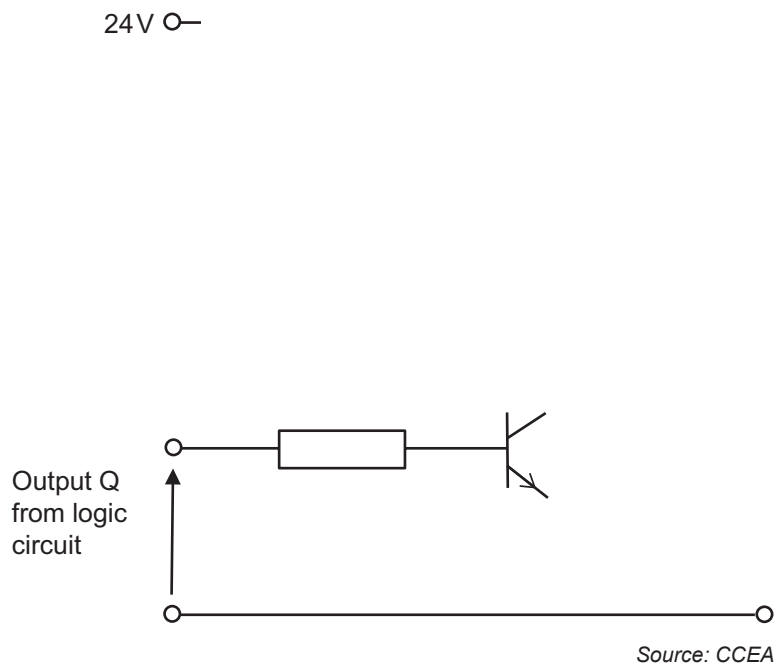


Fig. 10

[2]

- (iv) A peripheral interface controller could be used to make a circuit which would have the same function as the logic gate based system shown in **Fig. 6**. Excluding cost comparisons, explain **one** main advantage and **one** main disadvantage of using a programmed electronic system compared to a hard wired system to replace the logic circuit in **Fig. 6**.

Main advantage _____

_____ [2]

Main disadvantage _____

_____ [2]

[Turn over

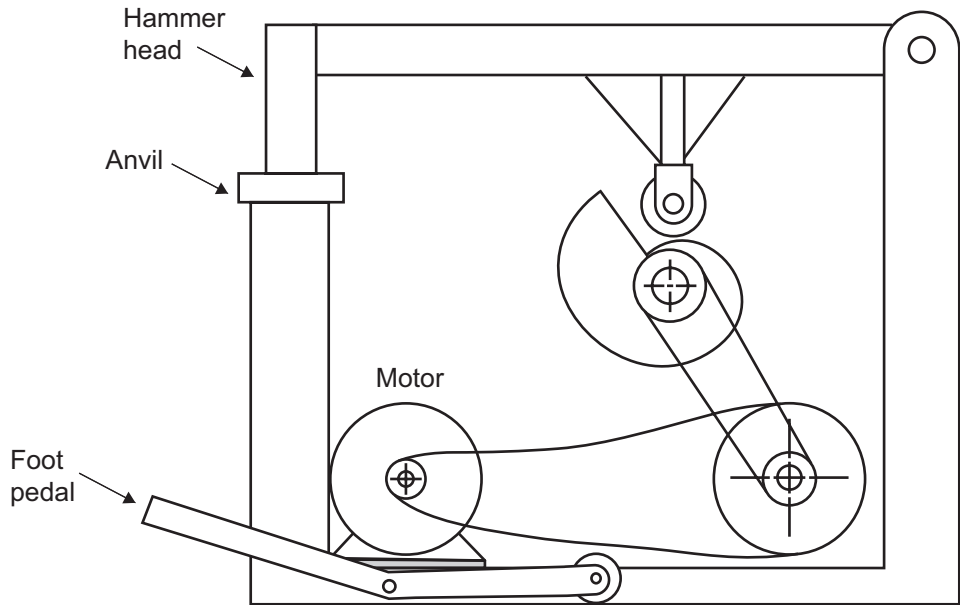


Section B

Mechanical and Pneumatic Control Systems

Answer **both** questions in this section.

- 3 **Fig. 11** shows a prototype design for a powered hammer which uses a mechanical system driven by an electric motor. The hammer is to be used to repair and maintain equipment in a workshop.

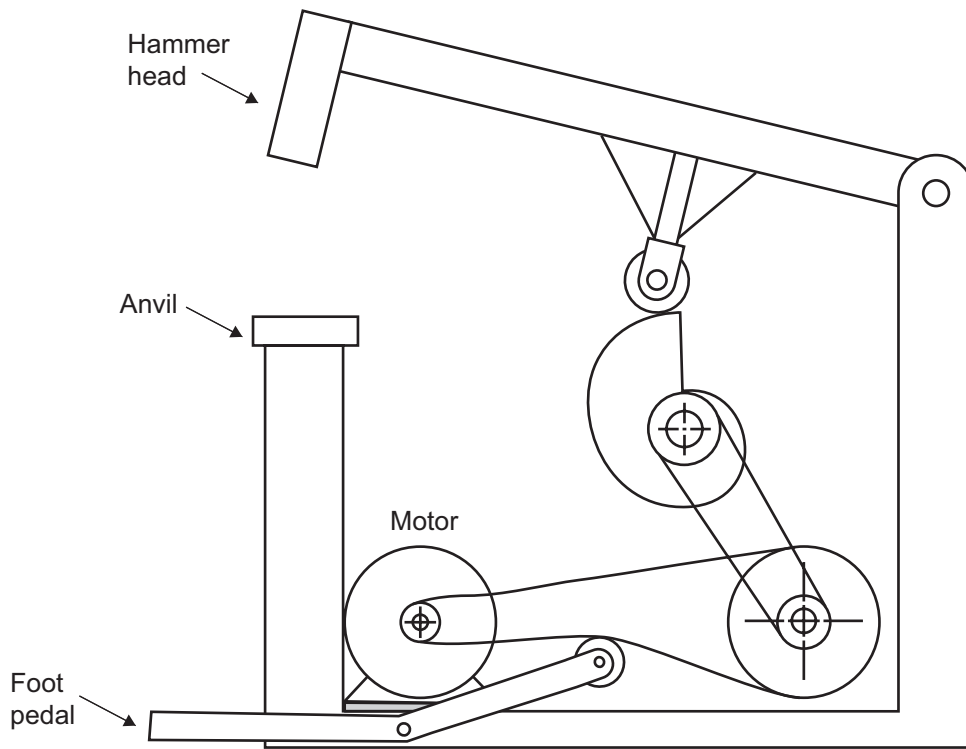


Source: CCEA

Fig. 11



Fig. 12 shows the power hammer with the hammer head in the fully raised position.

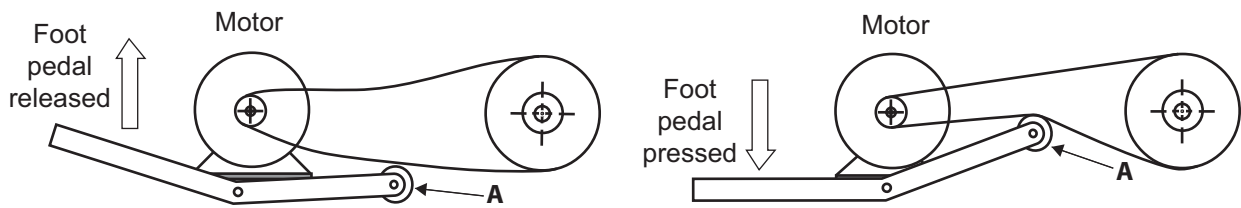


Source: CCEA

Fig. 12



(a) Fig. 13 shows the initial drive of the power hammer with the foot pedal released and with the foot pedal pressed.



Source: CCEA

Fig. 13

Identify the component labelled **A** and explain its function in the operation of the power hammer.

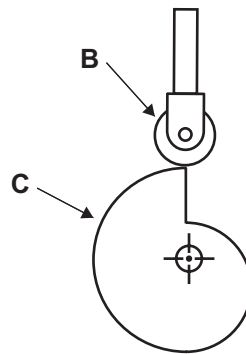
Component **A** _____ [1]

Function _____

_____ [3]



(b) The mechanism shown in **Fig. 14** is used to control the motion of the power hammer.



Source: CCEA

Fig. 14

(i) State the name of the components labelled **B** and **C** and the change in motion they produce.

Component **B** _____ [1]

Component **C** _____ [1]

Change in motion _____ [1]

(ii) State **one** advantage and **one** disadvantage of using belt and pulley systems.

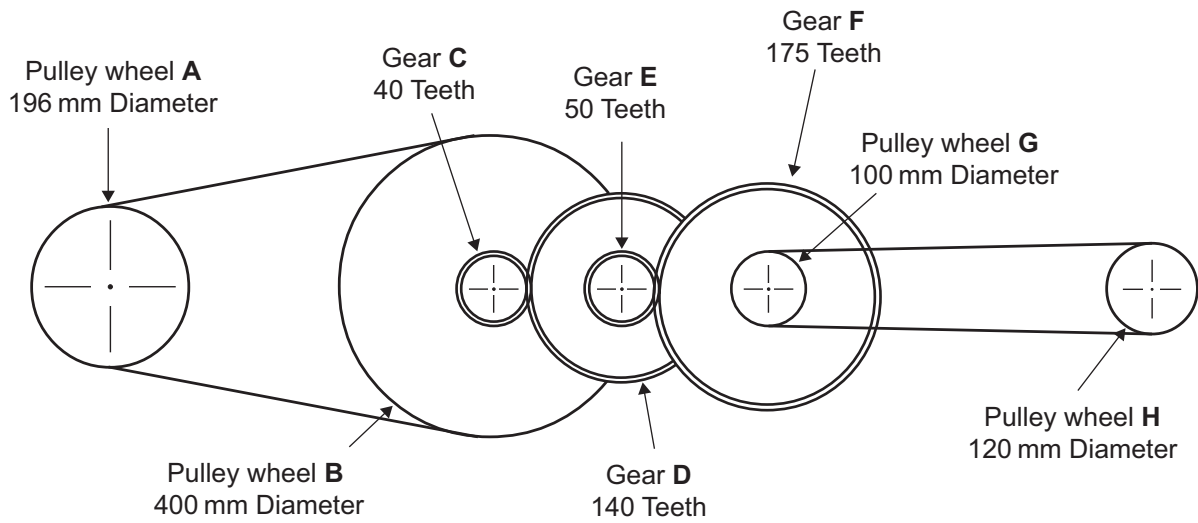
Advantage _____
 _____ [1]

Disadvantage _____
 _____ [1]

[Turn over



(c) The powered hammer is driven by an electric motor which is coupled to **pulley wheel A** in the drive train shown below in **Fig. 15**.



Drawing not to scale

Source: CCEA

Fig. 15

(i) Calculate the velocity ratio between pulley wheel **A** and pulley wheel **H**.

Candidates need to show their working out in the space below.

Answer _____ [5]

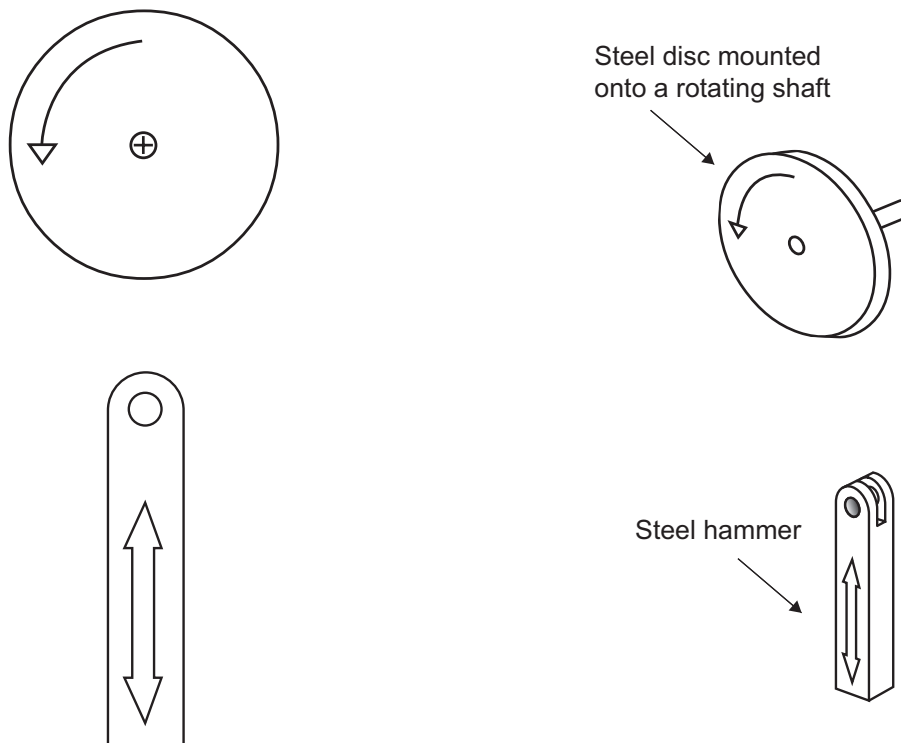


- (ii) Calculate the required input speed in rev/min for a drive train that has a velocity ratio of 45 and when used in the powered hammer will cause the hammer to strike the anvil once every two seconds.

Candidates need to show their working out in the space below.

Answer _____ rev/min [2]

- (d) An alternative design is required to operate the hammer head. Complete and annotate the 2D sketch in **Fig. 16** of a suitable mechanism other than a cam which could be used to convert the motion of a rotating disc into suitable motion for the steel hammer.



Source: CCEA

Fig. 16

[4]

[Turn over

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36STE1215

4 Fig. 17 shows a prototype pneumatic system designed to automate a drilling process.

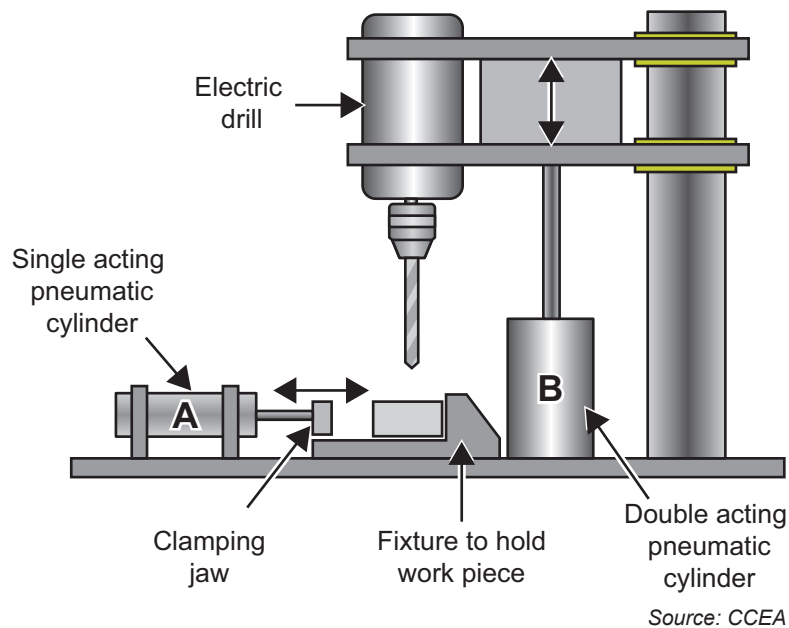


Fig. 17

(a) (i) The single acting cylinder **A** shown in Fig. 17 is supplied with an air pressure of 0.25 N/mm^2 , and has a piston diameter of 50 mm.

Calculate the outstroke force of cylinder **A** if the actual clamping force produced by the outstroke of the cylinder was measured at 319 N. Assume $\pi = 3.14$.

Calculate the efficiency of cylinder **A**.

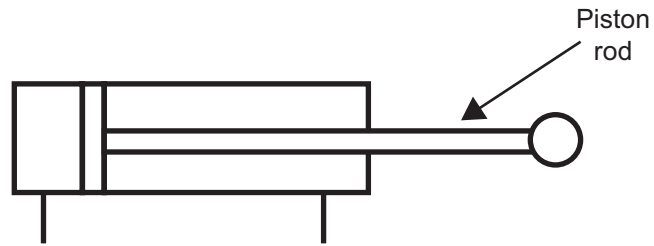
Candidates need to show their working out in the space below.

Outstroke Force _____ N [2]

Efficiency _____ % [2]



- (ii) The double acting cylinder shown in **Fig. 18** produces an outstroke force of 294.4 N and an instroke force of 247.3 N when supplied with an air pressure of 0.15 N/mm^2 .



Source: CCEA

Fig. 18

Calculate the diameter of the piston rod used in the cylinder.
Assume $\pi = 3.14$.

Candidates need to show their working out in the space below.

Answer _____ mm [4]

[Turn over



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36STE1217

(b) State the name of the component symbols shown in **Table 1** and explain the effect component **C** will have when used to control a single acting cylinder.

Table 1

Symbol C	Symbol D
	

Source: CCEA

Symbol C _____ [1]

Symbol D _____ [1]

Explanation

[2]



(c) An incomplete pneumatic circuit is shown in **Fig. 19** and is to be used to control the drilling process in **Fig. 17**. The drill will be operated by the levers on the 5/2 valve **C**.

Complete the circuit shown in **Fig. 19** so that it operates in the sequence **A+**, **B-** when the start lever is operated. When the reset lever is operated the circuit will operate in the sequence **B+**, **A-**. The circuit requires a short time delay between **A+** and **B-**.

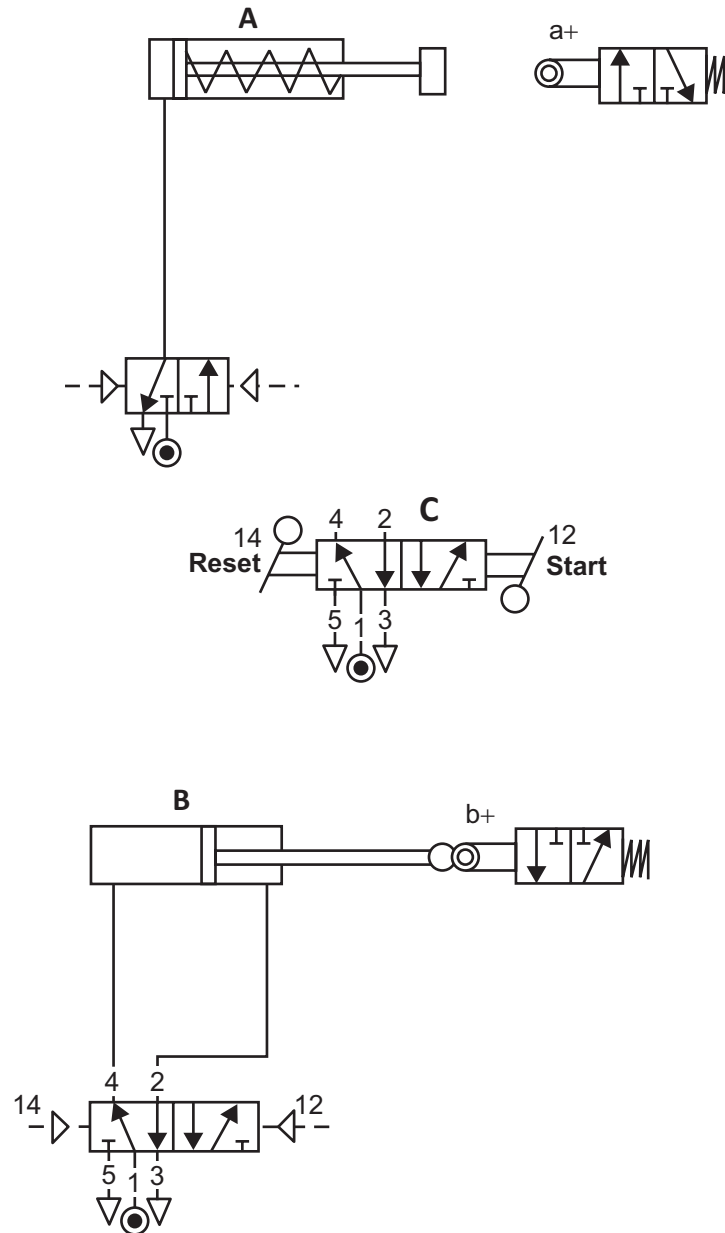


Fig. 19

Source: CCEA

[6]

[Turn over

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36STE1219

(d) State **two** safety procedures which should be employed when using pneumatic circuits.

1. _____
_____ [1]

2. _____
_____ [1]





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36STE1221

Section C

Product Design

Answer **both** questions in this section.

- 5 **Fig. 20** below shows a selection of car accessories a local company produces. In order to develop new products, the company uses both primary and secondary sources of research.



Source: CCEA

Fig. 20

- (a) (i) With reference to an example of your choice, explain what is meant by primary sources of research.

[2]





(ii) With reference to an example of your choice, explain what is meant by secondary sources of research.

[2]

(b) Thought showers can be used by designers in the generation of ideas. Briefly outline **two** main characteristics associated with thought showers.

1. _____

[1]

2. _____

[1]

[Turn over

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36STE1223

(c) To test some of the concepts generated by designers, some parts are to be produced for testing through laser cutting. State **two** advantages and **one** disadvantage of laser cutting.

Advantage 1:

[1]

Advantage 2:

[1]

Disadvantage:

[1]



(d) Some of the car accessories which contain bought-in components may be produced through mass production.

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

1. _____
_____ [1]

2. _____
_____ [1]

(e) The company manufacturing the car accessories is not only restricted by guidelines on COSHH (Control of Substances Hazardous to Health) but also guided by the Trade Descriptions Act.

(i) Briefly outline **two** main characteristics associated with COSHH regulations.

1. _____

_____ [1]

2. _____

_____ [1]

(ii) Briefly outline what is meant by the Trade Descriptions Act.

_____ [1]

[Turn over

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36STE1225

- (f) On long car journeys, parents often use a tablet to show a movie in order to keep small children entertained. With reference to **Fig. 21** below, and with the aid of annotated sketches, design the following in the space provided:

An appropriate rigid bracket attached to the back of the tablet holder. The other end of the bracket should allow the user to quickly attach or remove it from the headrest bars A and B.

Your design must be able to accommodate bars which can span from 180 mm to 240 mm apart to suit different vehicles.

State a suitable material for the bracket.

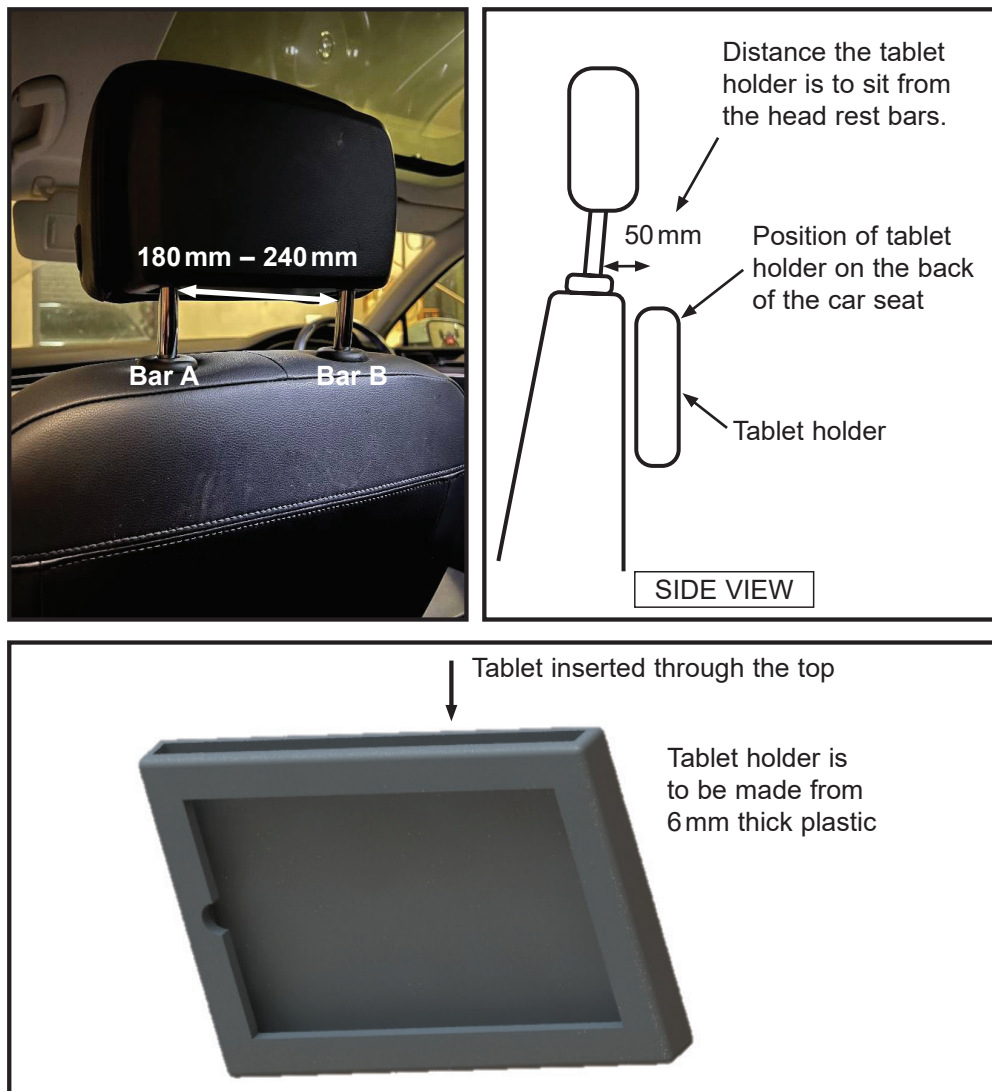


Fig. 21

Source: CCEA

[6]





Show your response to Question **5(f)** in the space below.

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36STE1227

- 6 (a) A company responsible for the production and development of computer accessories employs the SCAMPER technique.

State what the letters C and E represent in the acronym SCAMPER and briefly explain how they help in the generation of ideas.

C _____

_____ [2]

E _____

_____ [2]

- (b) Glass reinforced plastic (GRP) display stands are to be used in the company's showroom to display their new products.

Briefly outline **two** advantages of GRP.

1. _____
_____ [1]

2. _____
_____ [1]



- (c) Shape Memory Alloys (SMAs) are smart materials that the company is currently investigating for future use.

Give **one** specific application of Shape Memory Alloys and briefly outline **one** characteristic which makes them suitable for the given application.

Application: _____ [1]

Characteristic:

_____ [1]

- (d) Cell production is the manufacturing system employed by the company responsible for the production of the computer accessories. Explain what is meant by cell production.

_____ [2]

- (e) Scientific advancements have had considerable influences on product development.

With reference to a scientific advancement of your choice, explain how it has improved the design of products.

_____ [2]

[Turn over

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36STE1229

(f) A critical part of the design process for the company is product review and testing.

(i) Briefly explain **two** different reasons why it is important to undertake a product review.

1. _____
_____ [1]

2. _____
_____ [1]

(ii) Explain what is meant by the term testing, in relation to a product of your choice.

_____ [2]



(g) With reference to **Fig. 22** below and with the aid of annotated sketches, design the following in the space provided on the next page:

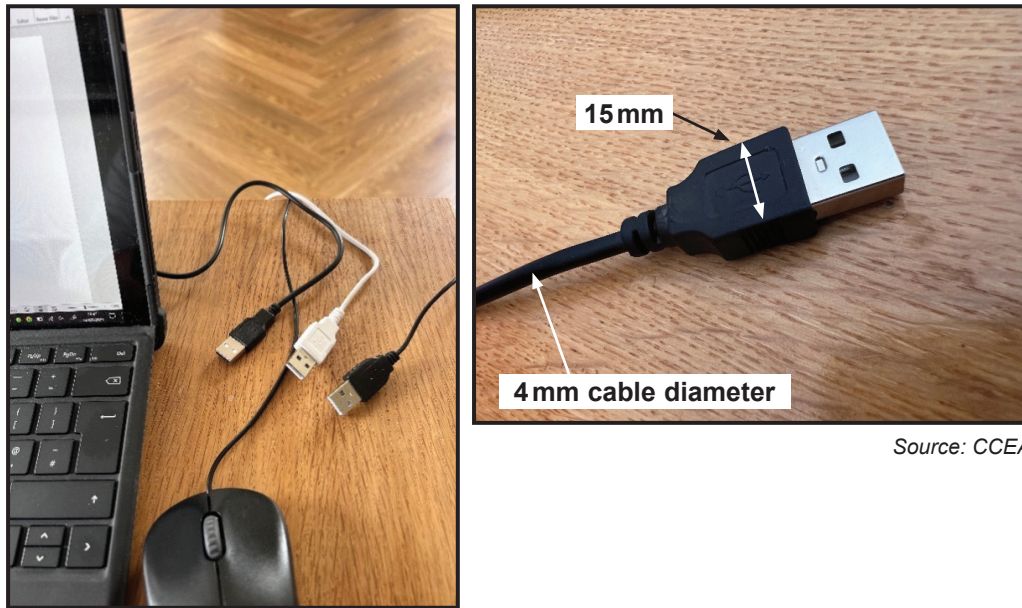


Fig. 22

An appropriate freestanding work surface design that will securely hold up to three 4mm diameter USB cables to prevent them falling on the floor. The cables must be easily inserted or removed and the design must consider the safety of the user.

Include dimensions to show how you have minimised the use of materials whilst maintaining the functional requirements of the design. [4]

Show your response to **6(g)** on the next page.

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36STE1231

Show your response to Question **6(g)** in the space below.

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36STE1232





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Question Number	Marks
1	
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Total Marks	

Examiner Number

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