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ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
January 2012

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## Technology and Design

### Assessment Unit AS 1

*assessing*

Product Design and  
Systems and Control

[AV111]



TUESDAY 17 JANUARY, MORNING

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#### TIME

2 hours.

#### INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided and on the A3 pro forma answer page provided.

Answer **all eight** questions in Section A, and both questions in **either** Section B **or** Section C **or** Section D.


An A3 pro forma is provided for Question **12(c)** and **(d)**, Question **13(b)(i)** and **(ii)** and Question **14(e)**.

You are provided with an insert for use with Question **13** and **14**.

At the conclusion of the examination, attach the A3 pro forma answer page securely to the Answer Booklet with the treasury tag supplied.

#### INFORMATION FOR CANDIDATES

The total mark for this paper is 80, including a maximum of 4 marks for quality of written communication.

 Marks for quality of written communication (QWC) will be awarded for Questions **6**, **9(b)(iii)**, **10(c)**, **11(b)(v)**, **12(e)**, **13(a)(i)** and **14(b)**.

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

All questions do not carry equal weighting.

## Section A

### Product Design and Practice

Answer **all** questions in this Section.

You are advised to spend approximately **1 hour** on this Section.

1 Briefly explain what is meant by the following terms:

- Density
- Strength
- Electrical conductivity
- Thermal conductivity

[4]

2 Ferrous and non ferrous metals such as stainless steel and zinc are commonly used in everyday products.

(i) Briefly explain the difference between ferrous and non ferrous metals.

[1]

(ii) Outline **two** main properties of stainless steel which make it suitable for cutlery.

[2]

(iii) Give **one** specific application for zinc and outline **one** main property of zinc which makes it suitable for your chosen application.

[2]

3 PVC and acrylic are used in a wide range of products.

(i) Give **two** main reasons, other than cost and availability, why PVC is used for windows and doors.

[2]

(ii) Give **two** main reasons, other than cost and availability, why acrylic is used for the lens cover on car lights.

[2]

4 Domestic radiator panels can be produced by the process of press forming.

(i) Give **one** specific mechanical property of mild steel which makes this material suitable for press forming.

[1]

(ii) With the aid of an annotated sketch describe the press forming process.

[4]

- 5 (i) Distinguish between permanent and semi-permanent methods used to join materials. [2]
- Metals can be joined using soldering or welding.
- (ii) Briefly outline **two** main, specific characteristics associated with soldering. [2]
- (iii) Briefly outline **two** main, specific characteristics associated with welding. [2]
- 6 A report into a company which manufactures and assembles secretarial swivel arm chairs made reference to the following terms:
- Computer-aided design (CAD)
  - Mass production
- (i) Outline **two** main advantages for this company of using Computer-aided design (CAD). [2]
- (ii) Outline **two** main advantages for this company of using mass production. [2]
- Quality of written communication [2]
- 7 Designers and manufacturers of electronic products need to be aware of employee and consumer safety, British Standards and the Trades Description Act.
- (i) Distinguish between employee and consumer safety in the design and manufacture of electronic products. [2]
- (ii) Briefly explain what is meant by British Standards. [2]
- (iii) Briefly outline **two** main characteristics associated with the Trades Description Act. [2]
- 8 Sustainability and life cycle analysis can influence the decisions taken by product designers.
- (i) Explain what is meant by the term sustainability in relation to product design. [2]
- (ii) Explain what is meant by the term life cycle analysis in relation to the environmental influence on product design. [2]

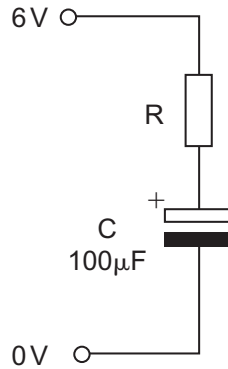
## Section B

### Electronic and Microelectronic Control Systems

Answer both questions in this Section **or** both questions in Section C **or** both questions in Section D.

You are advised to spend approximately **1 hour** on this Section.

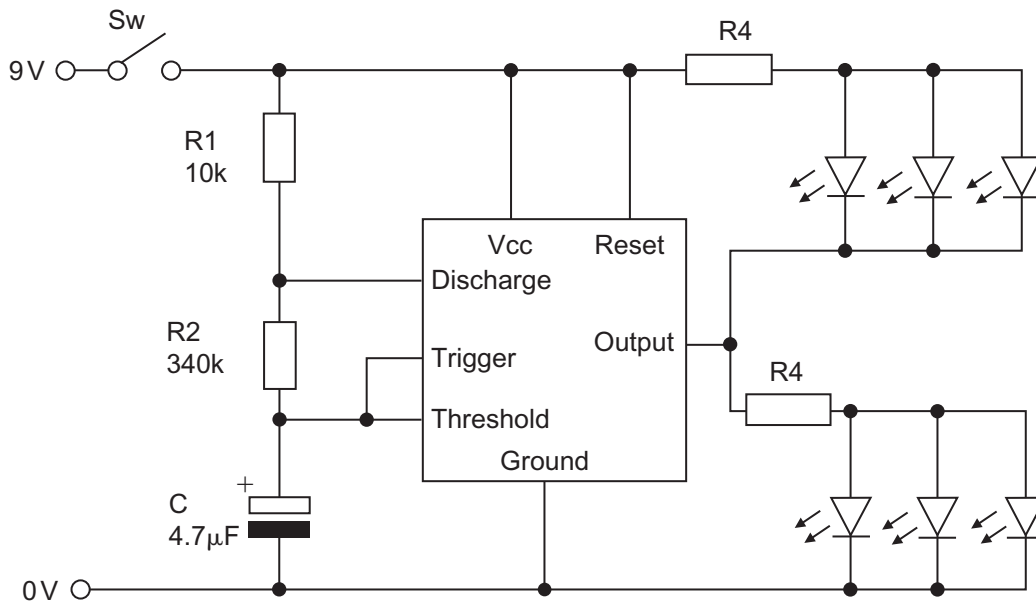
- 9 (a) A series resistor/capacitor (RC) circuit is shown in **Fig. 9(a)**.



**Fig. 9(a)**

- (i) The resistor R shown in **Fig. 9(a)** has a specified tolerance. Explain what is meant by tolerance when referring to resistors. [1]
- (ii) State the formula for the time constant in a series resistor/capacitor circuit and calculate the value of the resistor R in **Fig. 9(a)** to provide a time constant of 5 seconds. [2]
- (iii) Sketch and label a V/T (voltage/time) graph showing how the capacitor in **Fig. 9(a)** charges from zero, having been initially discharged. Mark and label the time constant on the graph. [2]

(b) An astable circuit based on a 555 timer shown in **Fig. 9(b)** is to be used for a warning light.



**Fig. 9(b)**

- (i) Calculate the output frequency of the circuit shown in **Fig. 9(b)** given that the time period  $T = C (R1+2R2) / 1.44$ . [2]
- (ii) Using the value from answer **9(b)(i)** above, sketch and label the output waveform for the circuit in **Fig. 9(b)**, indicating the **mark**, **space** and **period** on the waveform. [4]
- (iii) Explain, in detail, the operation of the warning light circuit shown in **Fig. 9(b)**. [4]
- Quality of written communication [1]
- (iv) Calculate the required value for the resistor R4 in **Fig. 9(b)** if the LEDs shown are each designed to work at a forward voltage of 1.4 V and a current of 12mA. [2]
- (v) Using the answer from **9(b)(iv)** above, choose a practical value for the resistor R4 from the E12 series 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and justify your choice. [2]

10 (a) An arrangement of logic gates is shown in Fig. 10(a).

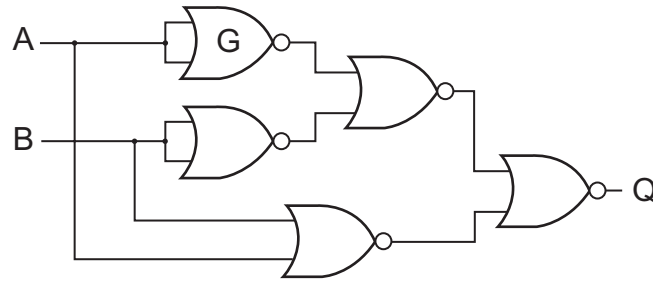


Fig. 10(a)

- (i) Name the logic gate labelled **G** shown in Fig. 10(a). [1]
- (ii) Draw a logic truth table showing all input combinations of **A** and **B** and the corresponding output **Q** for the arrangement of logic gates shown in Fig. 10(a). [3]
- (iii) Name and draw one logic gate that could be used to replace all 5 logic gates shown in Fig. 10(a). [2]

(b) The output from the logic circuit in Fig. 10(a) is to be used to activate a transistor based 24volt alarm circuit as shown in Fig. 10(b).

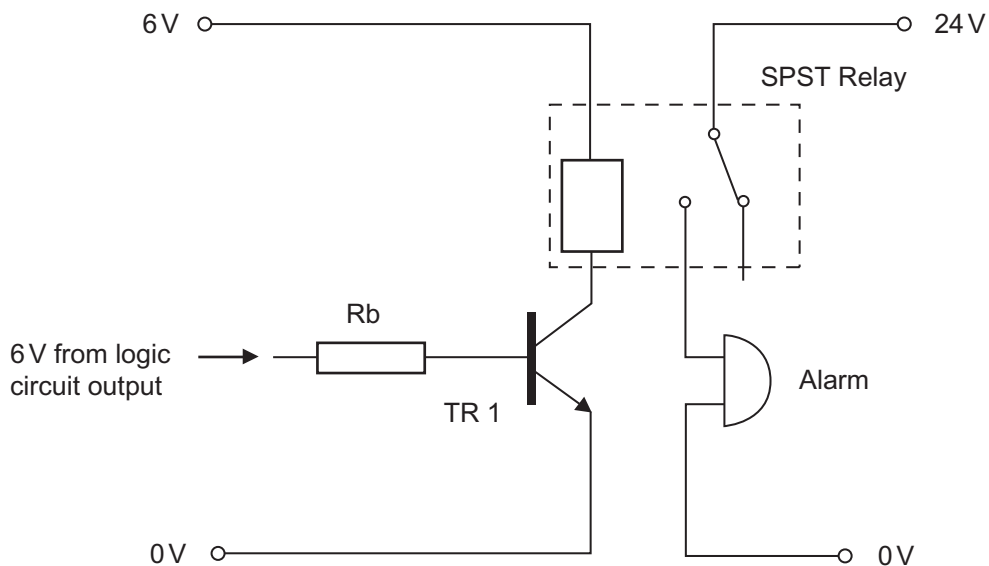


Fig. 10(b)

- (i) State the formula for the current gain ( $h_{FE}$ ) of a transistor. [1]
- (ii) The transistor shown in Fig. 10(b) has a current gain ( $h_{FE}$ ) of 80 and a base/emitter voltage ( $V_{be}$ ) of 0.6V. If the resistance of the relay coil is 30 Ohms, calculate the required resistor value for Rb. [4]

(iii) Name a component that should be added to the circuit in **Fig. 10(b)** in order to provide circuit protection. Briefly explain how this component functions to provide circuit protection. [2]

(iv) The circuit shown in **Fig. 10(b)** is to be altered to utilise a Double Pole Double Throw (DPDT) relay in order to achieve a latching action.

Draw the altered circuit showing how this latching action can be achieved. [4]

(c) Describe **two** main safety issues that should be considered when working with electronic systems. [2]

Quality of written communication [1]

## Section C

### Mechanical and Pneumatic Control Systems

Answer both questions in this Section **or** both questions in Section B **or** both questions in Section D.

You are advised to spend approximately **1 hour** on this Section.

- 11 (a) Fig. 11(a)** shows part of a prototype lifting system used to move mechanical components during assembly. The lifting system has adjustable mechanical advantage settings.
- (i)** Lifting systems commonly use pulleys. Name a type of pulley which prevents slippage. [1]
  - (ii)** Calculate the effort required if the load is 48 N and the mechanical advantage is 1.2. [2]
  - (iii)** The velocity ratio is 2 and the effort moves 0.8 m. Calculate the distance moved by the load. [2]
  - (iv)** Calculate the efficiency of the lifting system if the mechanical advantage is changed to 1.8 and the velocity ratio is 2. [2]

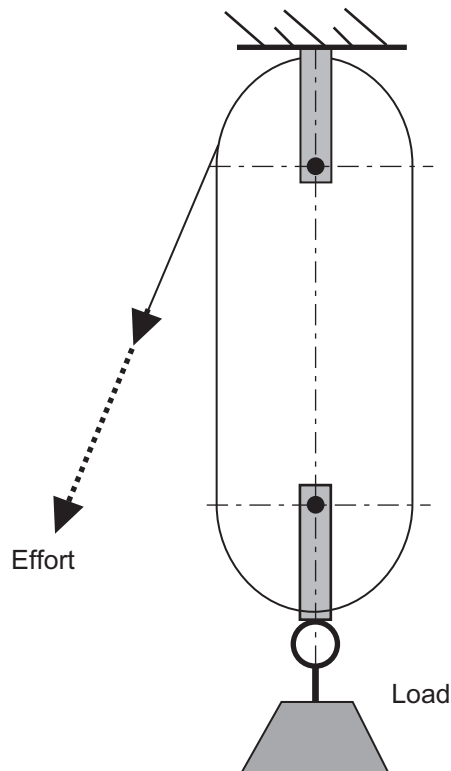


Fig. 11(a)



(b) Fig. 11(b) shows a gear, pulley and sprocket train.

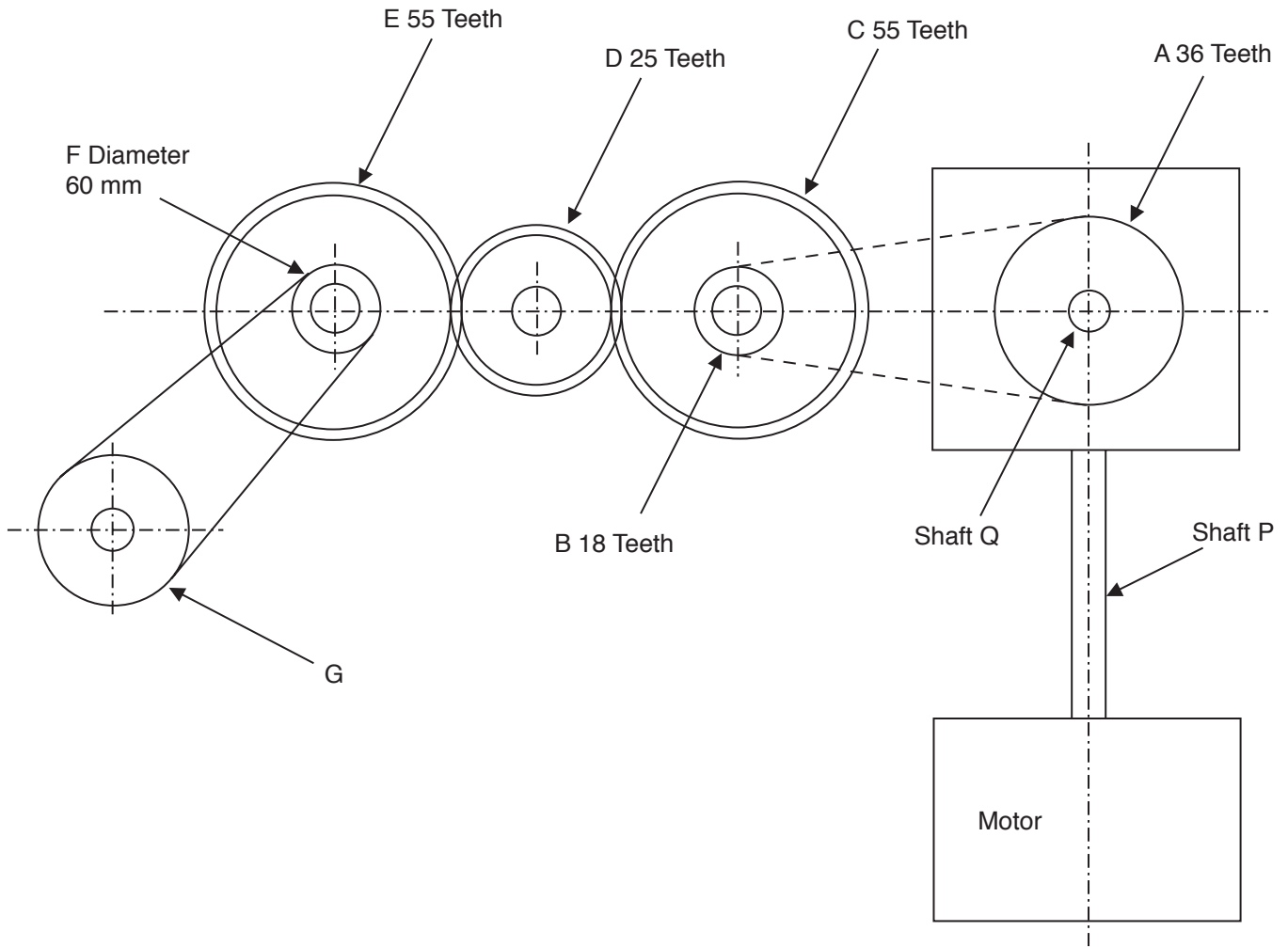


Fig. 11(b)

- (i) State the direction of rotation at gear **E** if sprocket **A** rotates in an anticlockwise direction. [1]
  - (ii) Calculate the velocity ratio between sprocket **A** and pulley **F**. [3]
  - (iii) Calculate the diameter of pulley **G** required to produce a velocity ratio of 3 between gear **C** and pulley **G**. [3]
  - (iv) In your answer booklet name and draw a suitable system that will link the motor shaft **P** and shaft **Q**. [3]
  - (v) Describe **two** safety issues that should be considered when working with mechanical systems. [2]
- Quality of written communication [1]

12 Fig. 12 shows part of an incomplete pneumatic locking system. The double acting cylinder is attached to the locking rod.

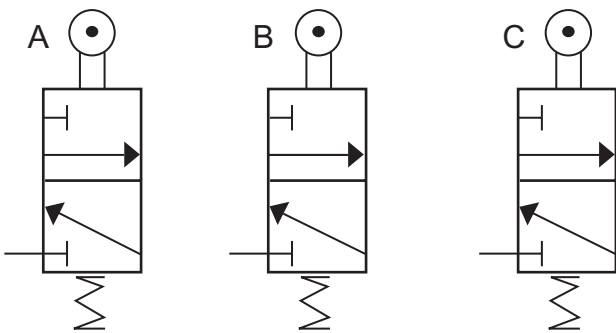
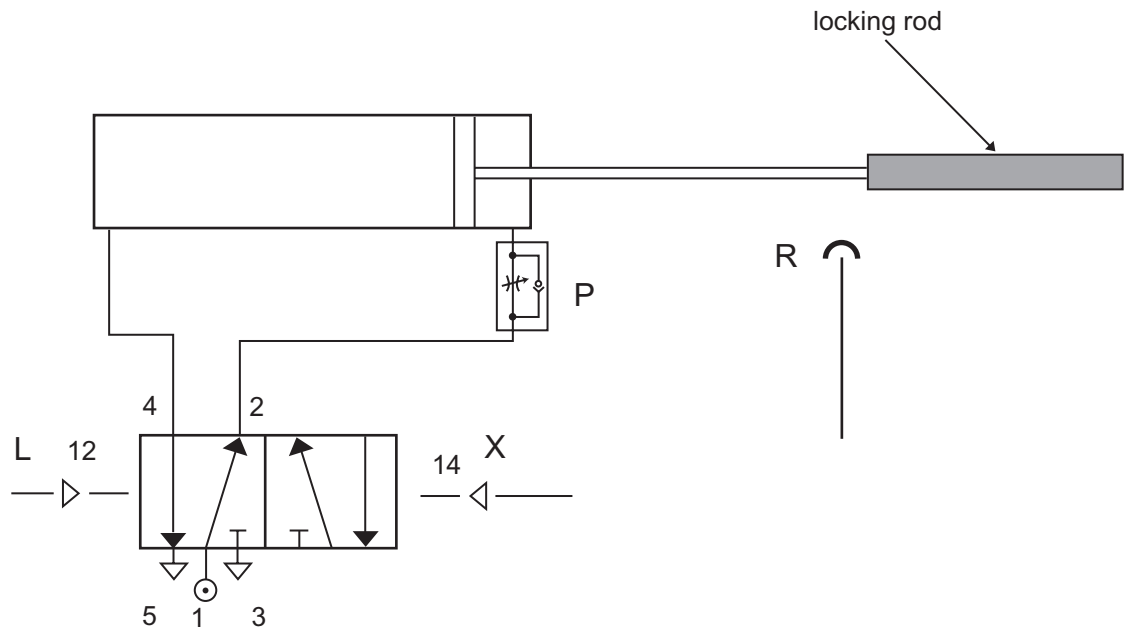


Fig. 12

(a) (i) Name the activation method at A. [1]

(ii) Name the activation method at X. [1]

(b) Describe the operation of the following units in a typical compressor installation:

(i) Lubricator unit. [1]

(ii) Regulator unit. [1]

(iii) Filter unit. [1]

(c) On the pro forma provided (answer number **12(c)** and **(d)**) develop the circuit enabling a combined activation at **A and B or C** to signal the five port valve at **L** to instroke. [4]

(d) On the pro forma provided (answer number **12(c)** and **(d)**) complete the circuit including the air bleed to enable the double acting cylinder to outstroke automatically once the air bleed connection at **R** is activated. [5]

(e) Describe the function component **P** would have in the circuit and explain why positioning it the wrong way round would not produce the desired outcome. [2]

Quality of written communication [1]

(f) The double acting cylinder is supplied with an air pressure of  $0.5 \text{ N/mm}^2$ , has a piston diameter of 80mm and a piston rod diameter of 8mm. Calculate the difference in forces produced by the cylinder during the instroke in comparison with the outstroke. Please assume  $\pi = 3.14$ . [3]

## Section D

### Product Design

Answer **both** questions in this Section **or** both questions in Section B **or** both questions in Section C.

You are advised to spend approximately **1 hour** on this Section.

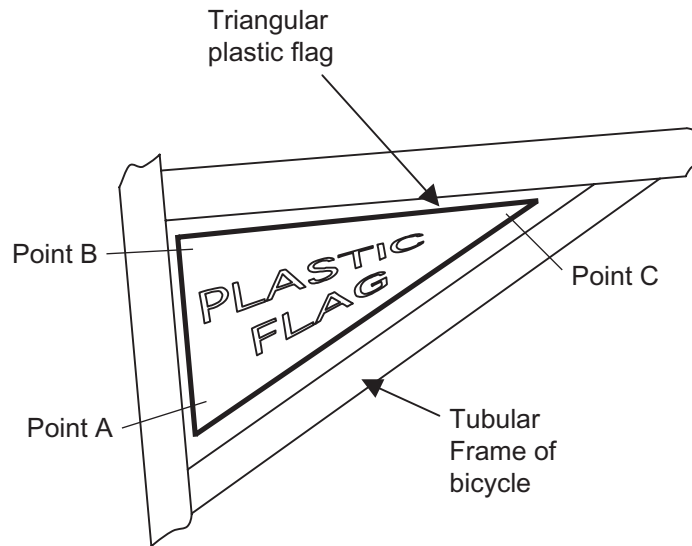
- 13 (a)** With reference to **Fig. 13(a), (b), (c) and (d)** on the insert sheet:
- (i)** Outline the target audience that this product has been designed for. [2]  
Quality of written communication [1]
  - (ii)** Briefly explain **two** ways in which the designer has incorporated aesthetic appeal into the design of the bicycle shown in **Fig. 13(a) to (d)** [2]
  - (iii)** Briefly outline **two** different feasible and specific changes which the manufacturer of the product shown in **Fig. 13(a) to (d)** could make in order to reduce the cost of producing this product. [2]
  - (iv)** Briefly outline **two** main characteristics of natural rubber which make it suitable for the tyres of the bicycle shown in **Fig. 13(a) to (d)**. [2]
  - (v)** Briefly outline **one** main environmental issue associated with the use of natural rubber for the tyres. [1]
  - (vi)** For some bicycle frames the tubular steel has been replaced with glass reinforced plastic (GRP). Briefly outline **two** main properties of GRP which make it suitable for bicycle frames. [2]

(b) With reference to **Fig. 13(c) and (d)** on the insert sheet, produce detailed annotated sketches, using the blank A3 pro forma answer page (answer number **13(b)**), for each of the following:

- (i) A design which will enable the user to quickly secure and remove the triangular plastic flag to the tubular frame of the bicycle at point **A**, point **B** and point **C**. (see **Fig. 13(b)(i)**).

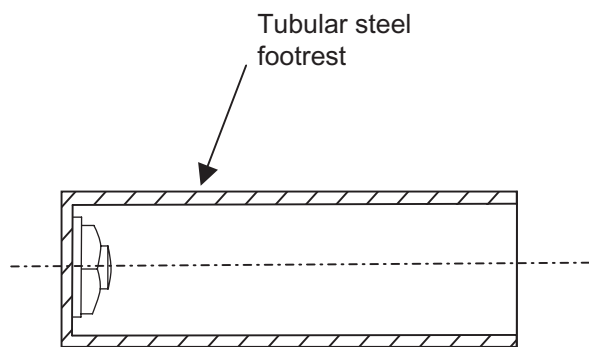
Your proposed design should ensure that when in position the triangular flag is firmly secured.

[4]



**Fig. 13(b)(i)**

- (ii) A design for the footrest which will improve the foot grip and prevent the foot from slipping off when attempting tricks. (see **Fig. 13(b)(ii)**). [4]



Sectional View of the footrest

**Fig. 13(b)(ii)**

**14** The child's cup shown in **Fig. 14** in the insert is manufactured using thermochromic materials.

**(a)** Briefly explain **one** main characteristic associated with thermochromic materials. [1]

**(b)** A design and manufacturing specification has played an important role throughout the design stage of the product shown in **Fig. 14**.

Distinguish between a design specification and a manufacturing specification for this product. [2]

Quality of written communication [1]

**(c)** Before developing the product the designer applied for a patent.

Outline the main benefits to the designer of having a patent on this product. [2]

**(d)** The thermochromic cup is to be partly packaged using solid white board.

**(i)** Briefly outline **two** main characteristics associated with solid white board which make it suitable for packaging. [2]

**(ii)** With the use of an annotated sketch explain the process of die cutting which could be used to cut out the profile for the packaging of the thermochromic cup. [4]

**(e)** As a designer you have been asked to consider the problem of designing a suitable package for the thermochromic cup shown in **Fig. 14**. Suggest using annotated sketches, on the blank A3 pro forma answer page (answer number **14 (e)**) **one** possible solution to the problem. Your answer must include the following:

- Sketches showing the shape of the packaging that will provide protection for the cup while minimizing the use of materials. [4]

- An explanation of how you have considered environmental issues; [2]  
and

- An explanation of how the safety of the user has been considered. [2]

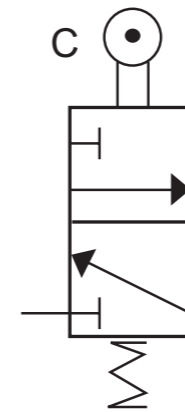
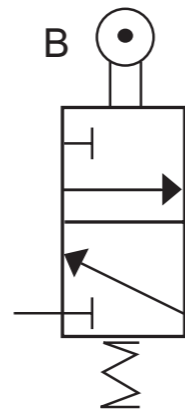
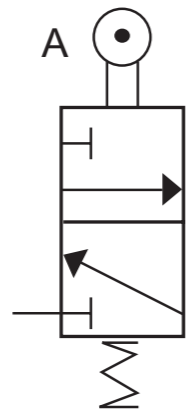
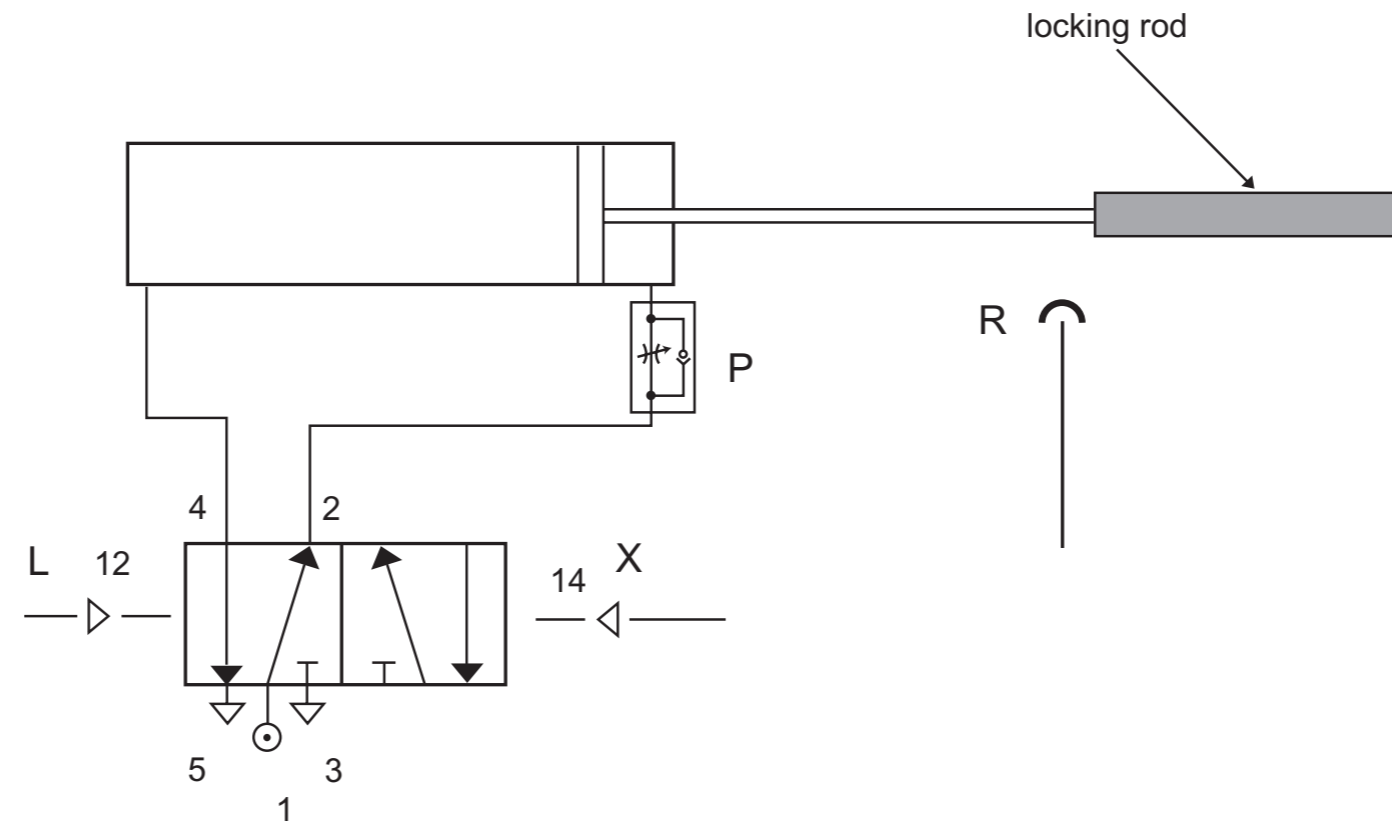
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**THIS IS THE END OF THE QUESTION PAPER**

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Pro forma answer page  
 (answer numbers 12(c) and (d))

(i) A design which will enable the user to quickly secure and remove the triangular plastic flag to the tubular frame of the bicycle at point A, point B and point C. (Your proposed design should ensure that when in position the triangular flag is firmly secured.) [4]

(ii) A design for the foothold which will improve the foot grip and prevent the foot from slipping off when attempting tricks. [4]

**Pro forma answer page  
(answer numbers 13(b)(i) and (ii))**

Question No. 14(e)

ADVANCED SUBSIDIARY (AS) TECHNOLOGY AND DESIGN  
Assessment Unit AS 1      Unit 1  
January 2012

Centre Number

71

Candidate Number

**Pro forma answer page  
(answer number 14(e))**

GCE Advanced Subsidiary (AS) Technology and Design  
Assessment Unit AS 1 January 2012

(for use with Question 13)

Do not write your answers on this insert



Fig. 13(a)



Fig. 13(b)



Fig. 13(c)



Fig. 13(d)



**GCE Advanced Subsidiary (AS) Technology and Design  
Assessment Unit AS 1 January 2012**

**(for use with Question 14)**

**Do not write your answers on this insert**



**Fig. 14**