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Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2012

Technology and Design

Assessment Unit AS 1
assessing
Product Design and
Systems and Control

[AV111]

AV111

TUESDAY 17 JANUARY, MORNING

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.

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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.

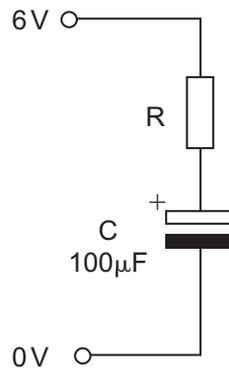**9** **(a)** A series resistor/capacitor (RC) circuit is shown in **Fig. 9(a)**.

6 V

R

+

C
100μF

0 V

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]

4

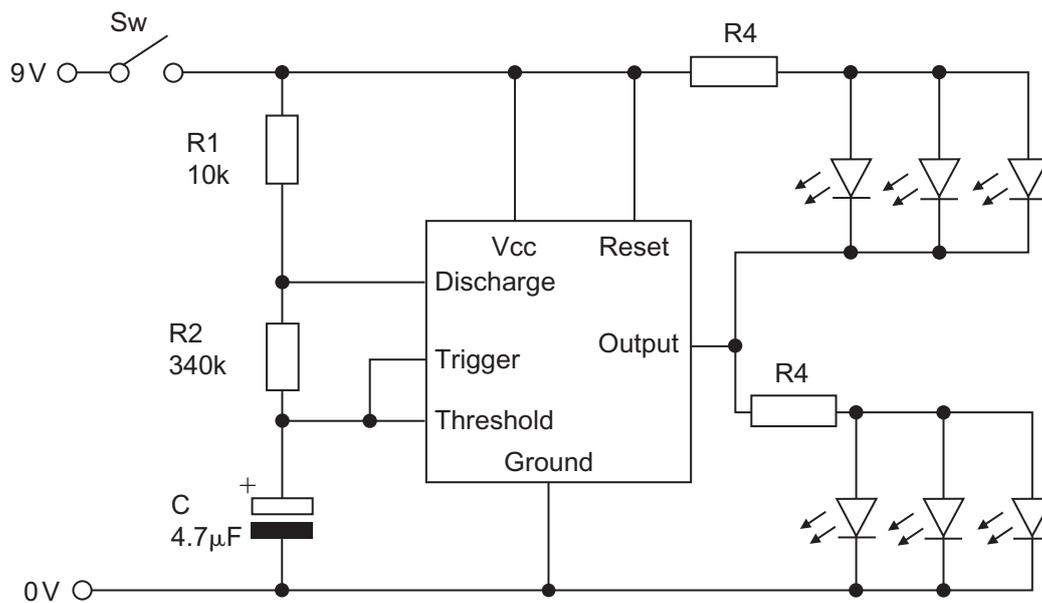**(b)** An astable circuit based on a 555 timer shown in **Fig. 9(b)** is to be used for a warning light.

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]

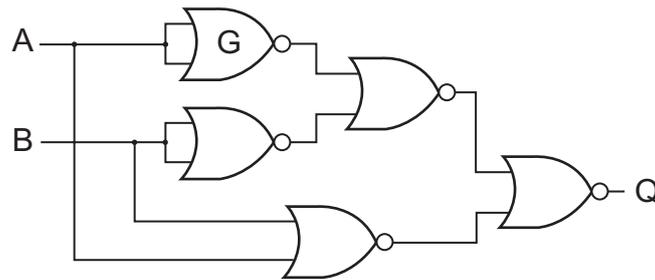**10 (a)** An arrangement of logic gates is shown in **Fig. 10(a)**.

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)**.
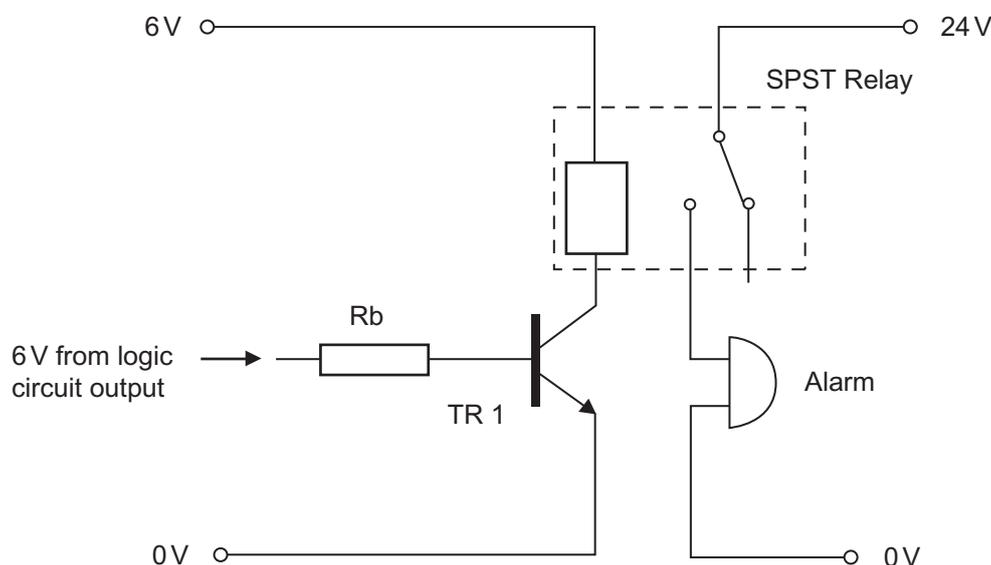

Fig. 10(b)

(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 (Vbe) of 0.6V. If the resistance of the relay coil is 30 Ohms, calculate the required resistor value for Rb. [4]

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(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]
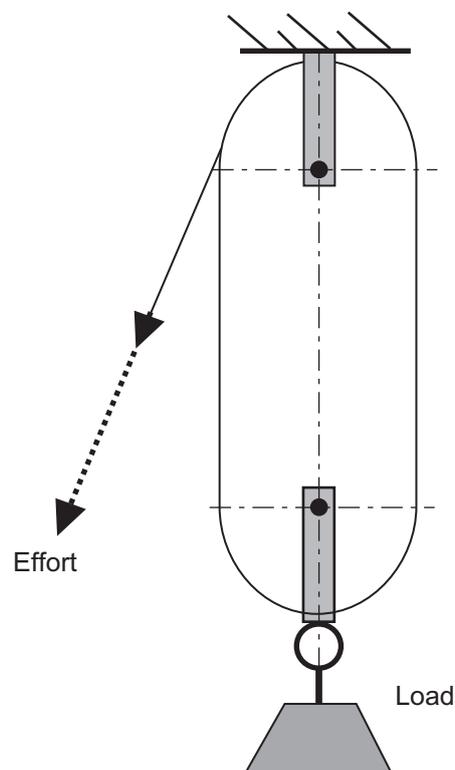

Fig. 11(a)

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

E 55 Teeth

D 25 Teeth

C 55 Teeth

A 36 Teeth

F Diameter 60 mm
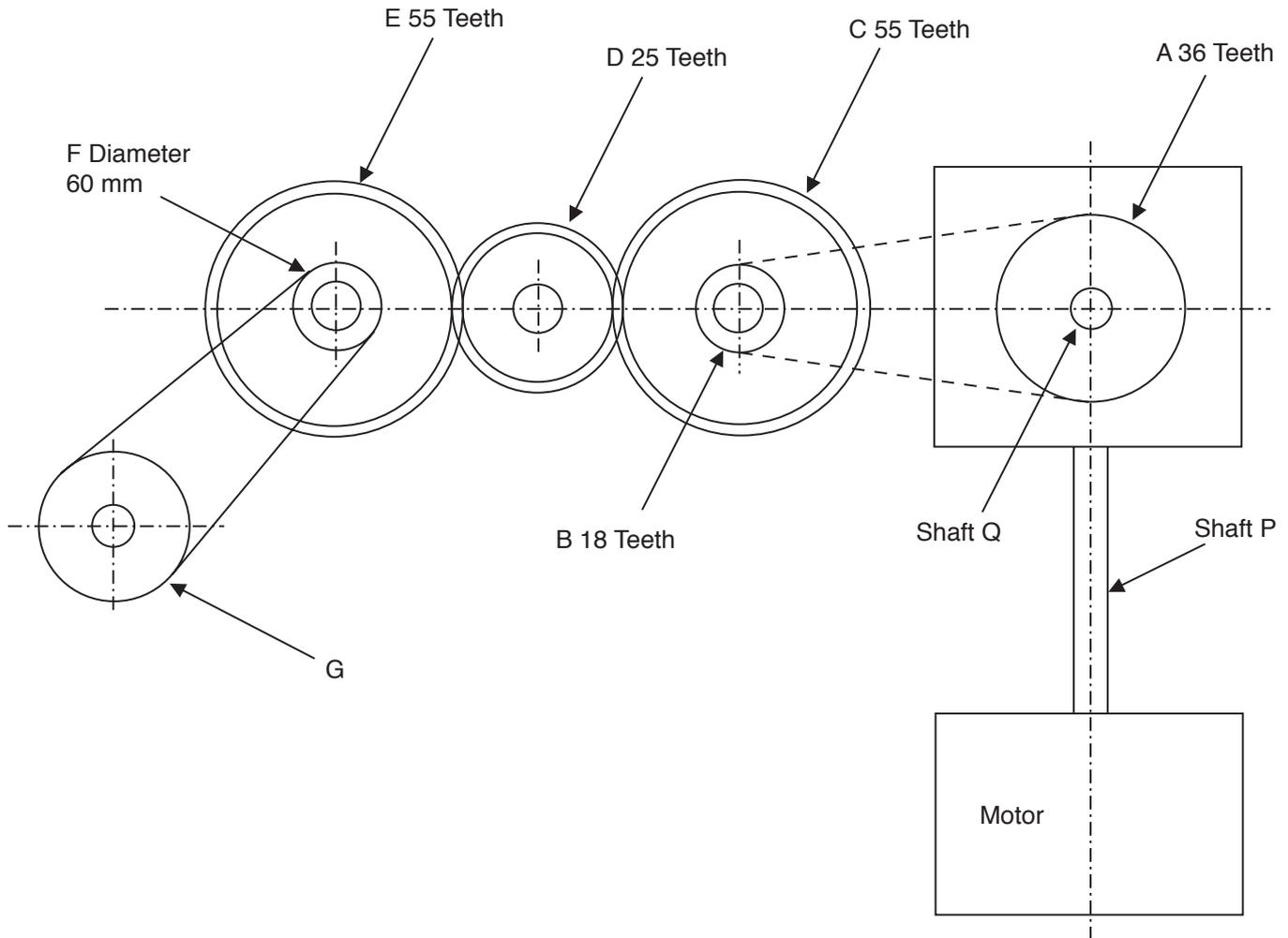
B 18 Teeth

Shaft Q

Shaft P

G

Motor

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.
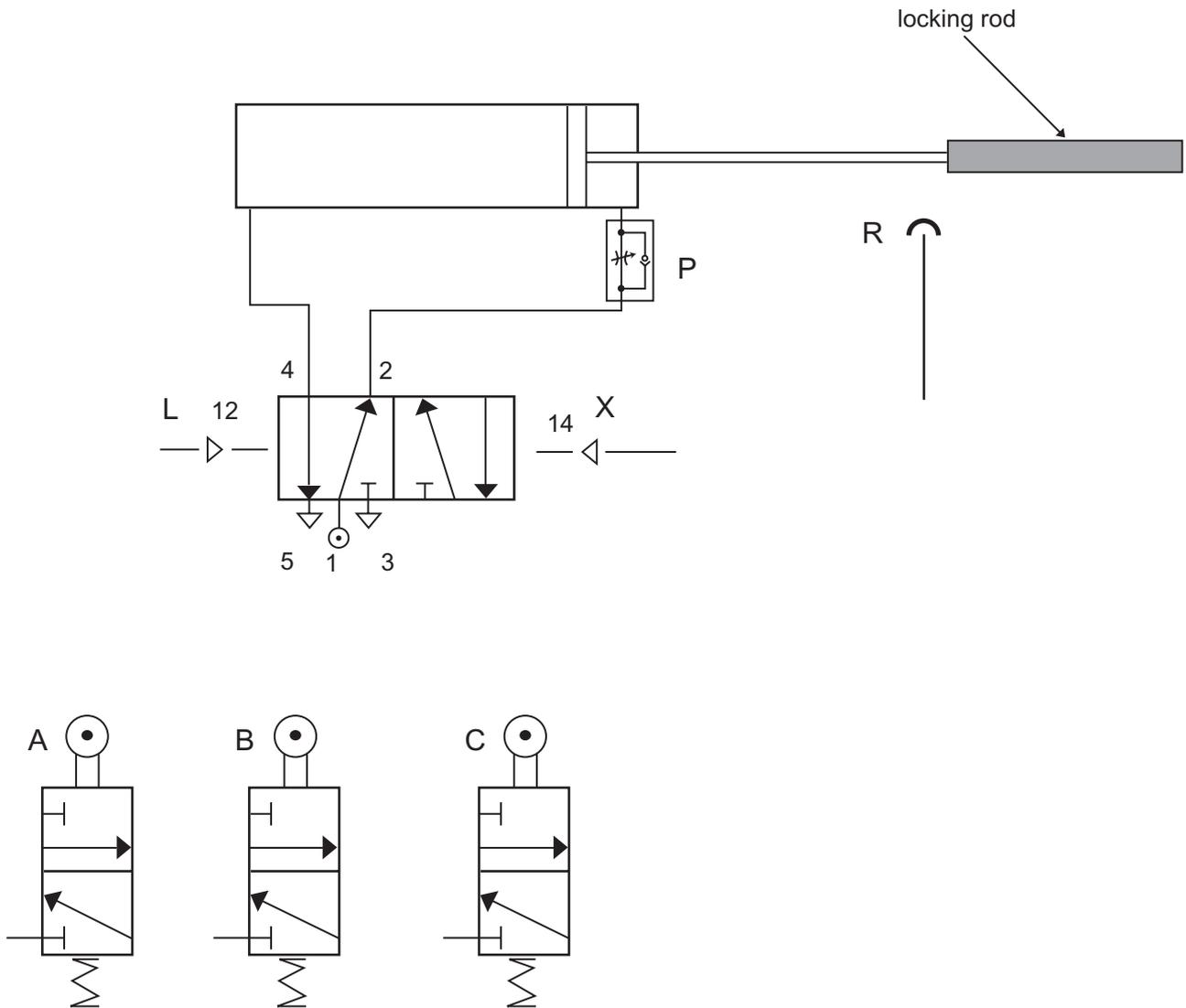

Fig. 12

(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 N/mm^2, has a piston diameter of 80 mm and a piston rod diameter of 8 mm. 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)**).

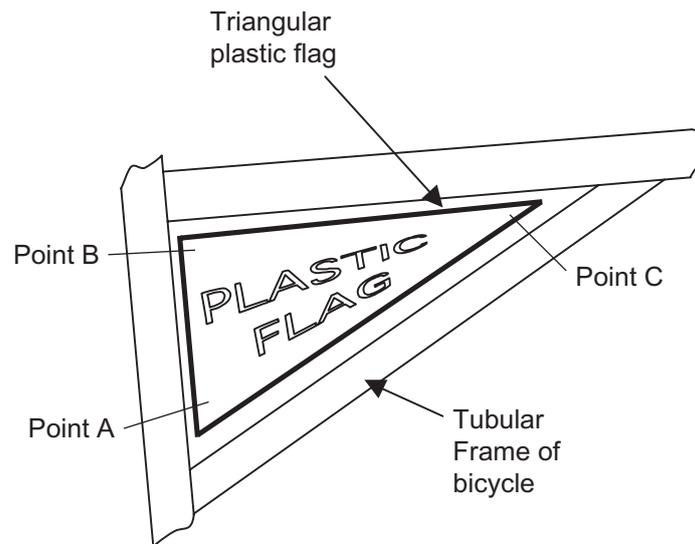Your proposed design should ensure that when in position the triangular flag is firmly secured. [4]
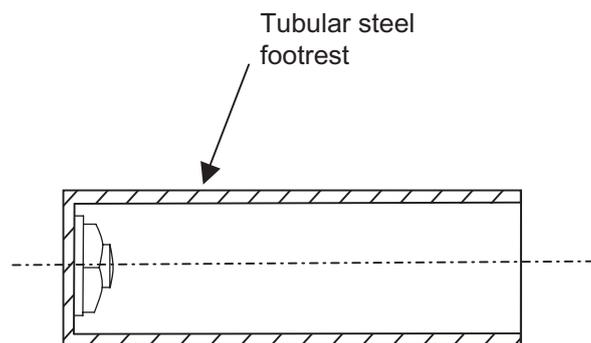

Fig. 13(b)(i)

(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)

13

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:
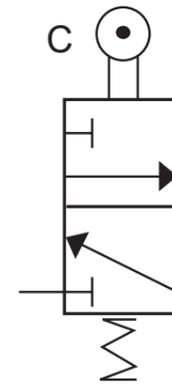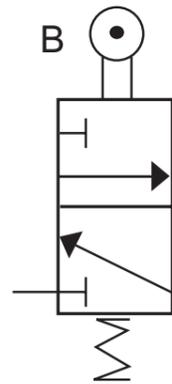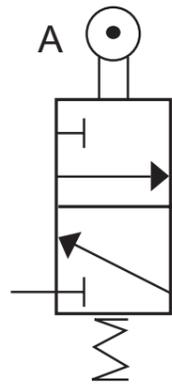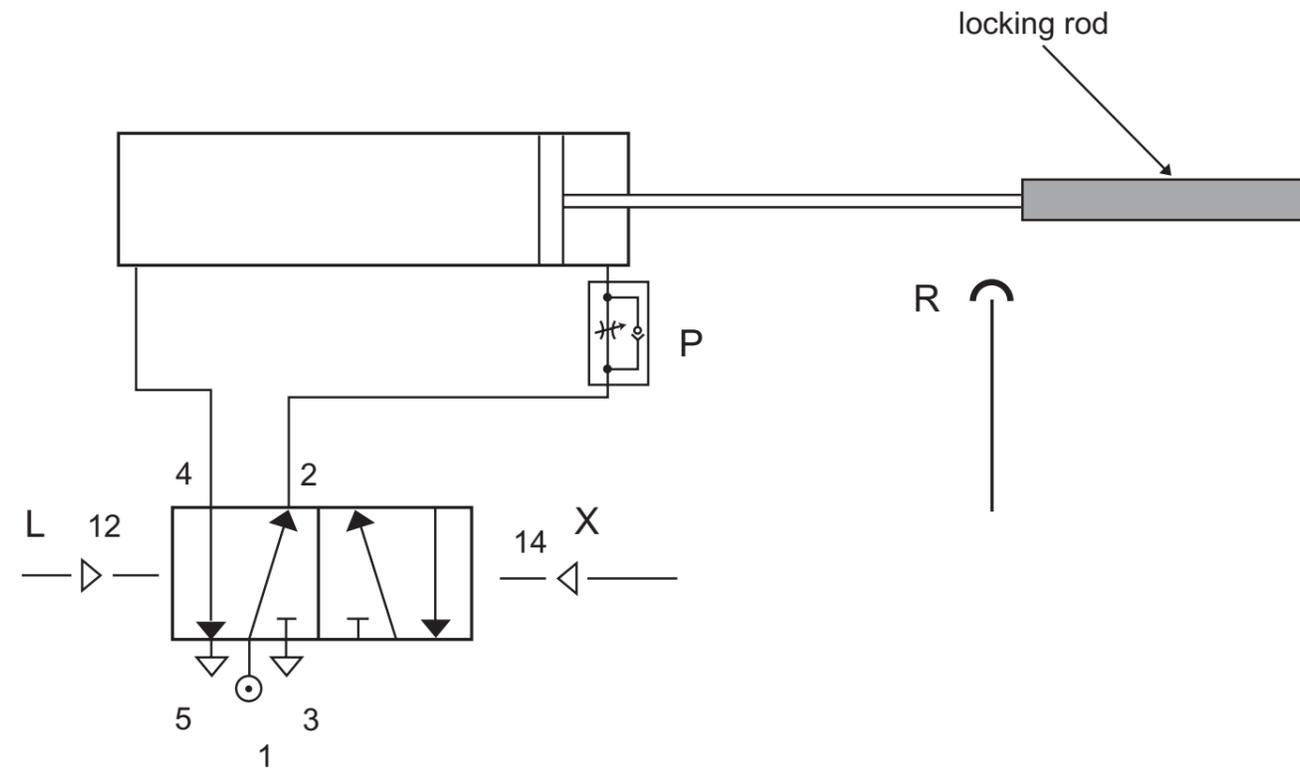
- Sketches showing the shape of the packaging that will provide protection for the cup while minimizing the use of materials.   [4]
- An explanation of how you have considered environmental issues; and   [2]
- An explanation of how the safety of the user has been considered.   [2]

THIS IS THE END OF THE QUESTION PAPER

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Question No. 12(c) and (d)

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

Centre Number

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Candidate Number

locking rod

P

R

4   2

L   12

14   X

5   3

1

A

B

C

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

Question No. 13(b)(i) and (ii)

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

Centre Number

71

Candidate Number

(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))

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

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

Tubular steel frame

Fig. 13(a)

Natural rubber

Fig. 13(b)

Footrest

Fig. 13(c)

Fig. 13(d)

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Assessment Unit AS 1 January 2012

(for use with Question 14)

Do not write your answers on this insert

Fig. 14

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