New Specification

Rewarding Learning

Centre Number

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Technology and Design

Assessment Unit AS 1
assessing
Systems and Control or
Product Design

STE12

[STE12]

MONDAY 22 MAY, MORNING

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 in the spaces provided.

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.

Examiner Only	
Marks	Remark

1 **(a)** A circuit which consists of a power supply, capacitor, three switches and three fixed resistors is shown in **Fig. 1.**

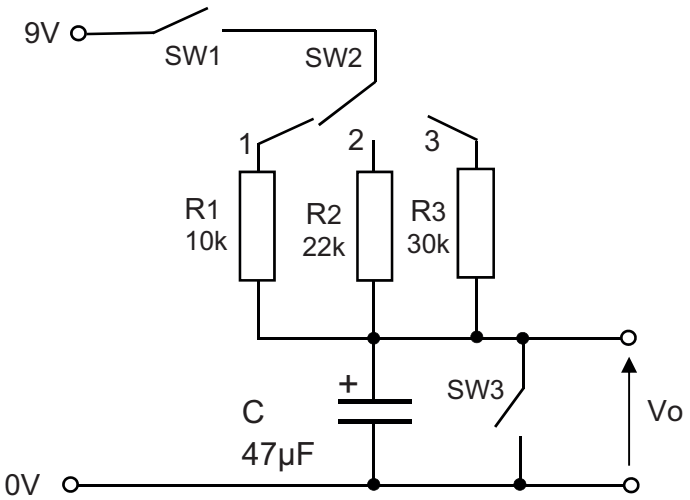


Fig. 1

(i) Name the type of switch labelled SW2 shown in **Fig. 1.**

_____ [1]

(ii) The capacitor shown in **Fig. 1** is an electrolytic type. State **two** general characteristics of electrolytic capacitors.

Characteristic 1 _____

_____

Characteristic 2 _____

_____ [2]

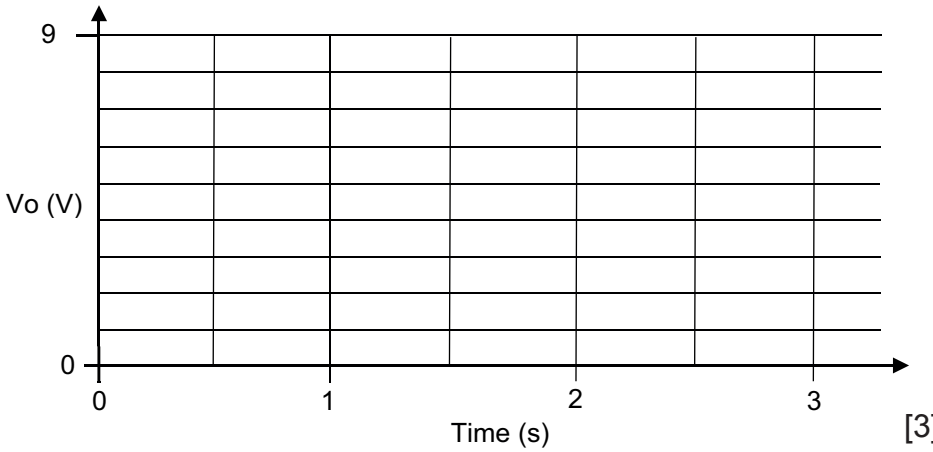
(iii) Calculate the time constant for the circuit shown in **Fig. 1** when the switch SW2 is in position 2.

[2]

(iv) Sketch a graph on the axes provided below to show Vo against time for the circuit shown in **Fig. 1** (assume the capacitor is initially discharged). The graph should show the following:

- What happens when switch SW1 is closed for 2 seconds (assume SW2 is in position 2 and switch SW3 is open); and
- After the 2 seconds switch SW3 is then closed immediately.

Mark the time constant on the graph.



[3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(b) The 555 timer based circuit shown in **Fig. 2** also utilises an electrolytic capacitor.

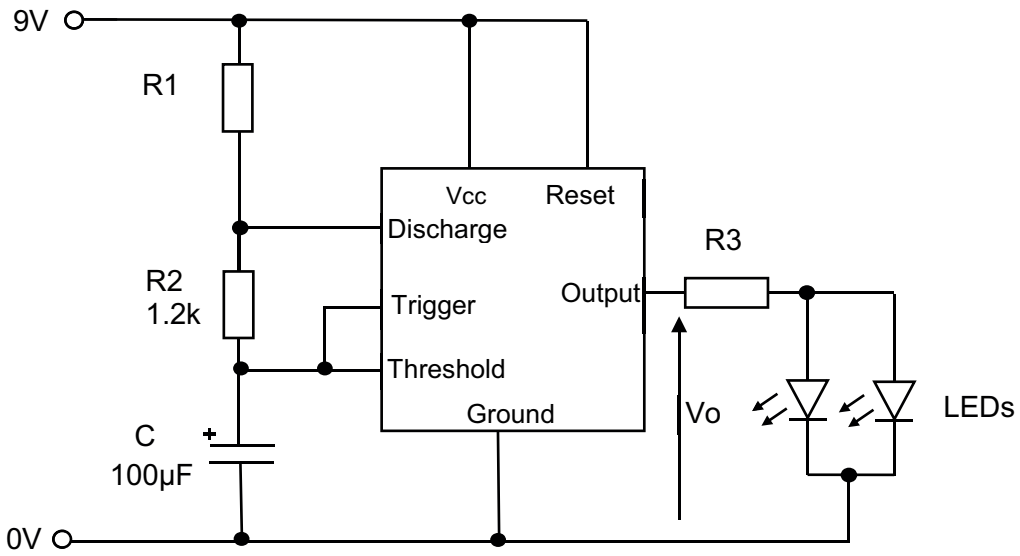


Fig. 2

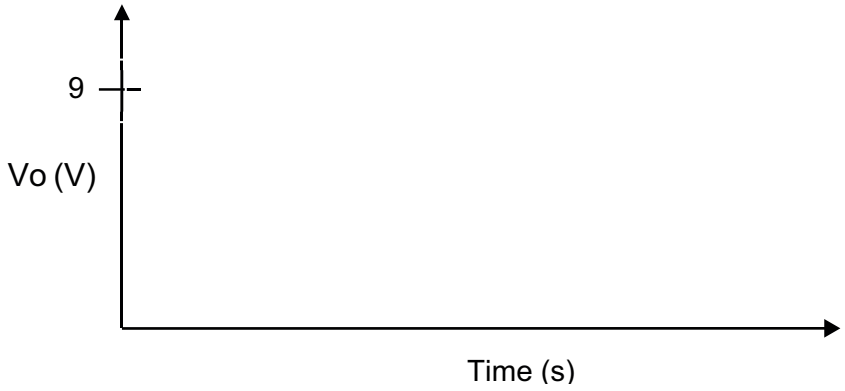
(i) Calculate the required value for the resistor R3 in **Fig. 2** to allow the LEDs to function safely with a forward voltage of 1.6V and a current of 12mA for each. (Assume the output of the 555 timer is 9 volts when on.)

[3]

(ii) If the LEDs in **Fig. 2** are required to flash at a frequency of 4 hertz, calculate the required value for the resistor R1. Show how you calculated this value.

[4]

(iii) The output from the circuit shown in **Fig. 2** has a mark space ratio of 2:1. Sketch the output waveform on the labelled axes below. Label the **mark** and the **time period** on your waveform.



[3]

(iv) The circuit shown in **Fig. 2** could be replaced with a PIC based circuit. State **one** advantage and **one** disadvantage of using a hardwired system such as a 555 timer over a PIC based system to control a flashing LED.

Advantage _____

_____

Disadvantage _____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

2 **(a)** A logic circuit is shown in **Fig. 3.**

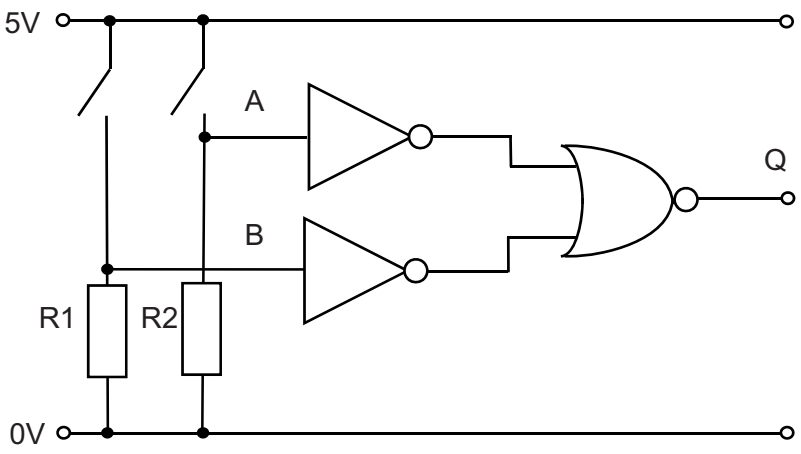


Fig. 3

(i) State the purpose of the resistors R1 and R2 in **Fig. 3.**

_____

_____ [1]

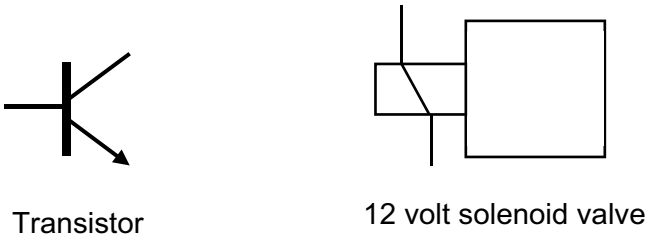
(ii) Complete the truth table below to show the output Q for the input combinations of A and B for the circuit in **Fig. 3**.

A	B	Q
0	0	
1	0	
0	1	
1	1	

[4]

Examiner Only	
Marks	Remark

(b) The output Q from the logic circuit shown in **Fig. 3** is to be used to control a 12 volt solenoid valve by means of a transistor which has an h_{fe} of 100 and a V_{be} of 0.6 volts. The symbols for the transistor and solenoid are shown in **Fig. 4**.



Transistor

12 volt solenoid valve

Fig. 4

(i) Explain the principle of operation of a solenoid valve.

_____

_____

_____

_____ [2]

(ii) The transistor shown in **Fig. 4** will require a base resistor when connected to the output of the logic circuit. Assuming that the high output from the logic circuit is 5 volts, and the resistance of the solenoid is 30 ohms, calculate the required value for the base resistor when the transistor is used to drive the solenoid.

[4]

(iii) With the aid of a circuit diagram show how the output from the logic circuit in **Fig. 3** can be used in conjunction with a transistor to drive the 12 volt solenoid in **Fig. 4**. Show any additional components required.

[3]

(c) An SR flip flop based on NAND gates is shown in **Fig. 5**. It will form the basis of an alarm system that will detect if a window has been opened and 'latch' a buzzer.

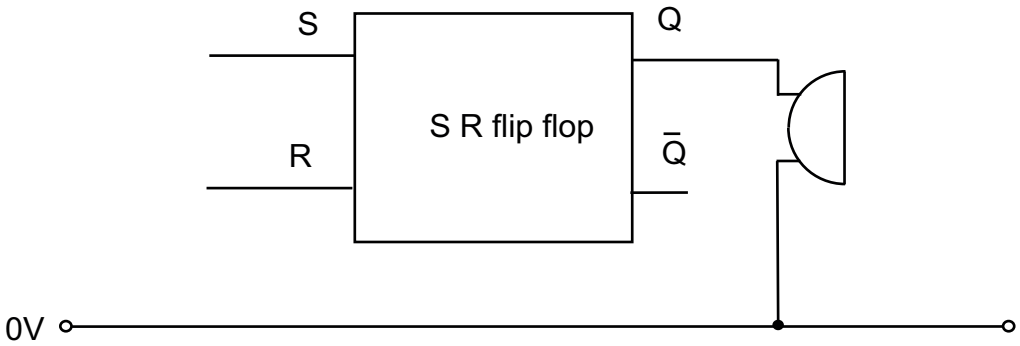
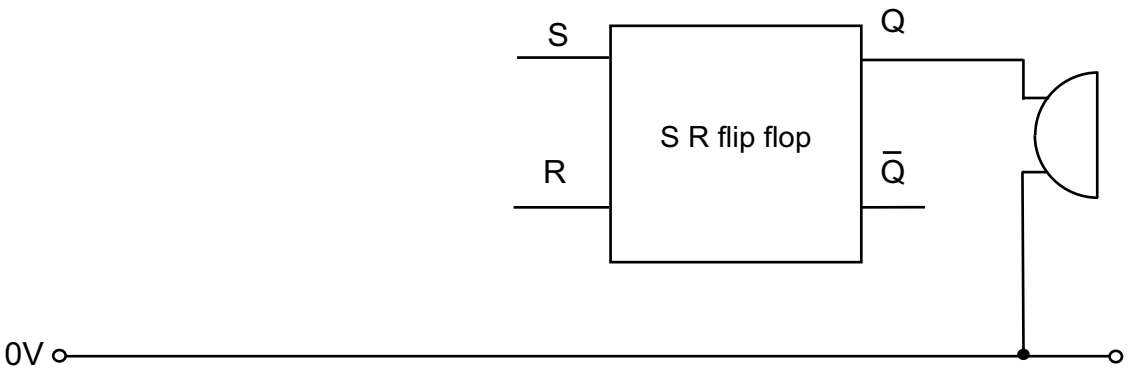


Fig. 5

(i) Draw the NAND gate arrangement required to provide the SR function.

[2]

(ii) The alarm is to be triggered by a SPST reed switch and magnet and reset by a SPST push to make switch. Complete the circuit diagram below showing how these two switches could be connected to the S and R inputs to ensure that the buzzer will latch on when the window is opened and reset when the push to make switch is operated. Describe how the position of the magnet relative to the reed switch determines the output state.



_____

_____

_____

_____ [4]

Examiner Only	
Marks	Remark

Section B

Mechanical and Pneumatic Control Systems

Answer **both** questions in this section.

3 **Fig. 6** shows an incomplete conveyor system which is to be used to move packages containing assorted toy building blocks from **Conveyor Belt R** to **Conveyor Belt S**.

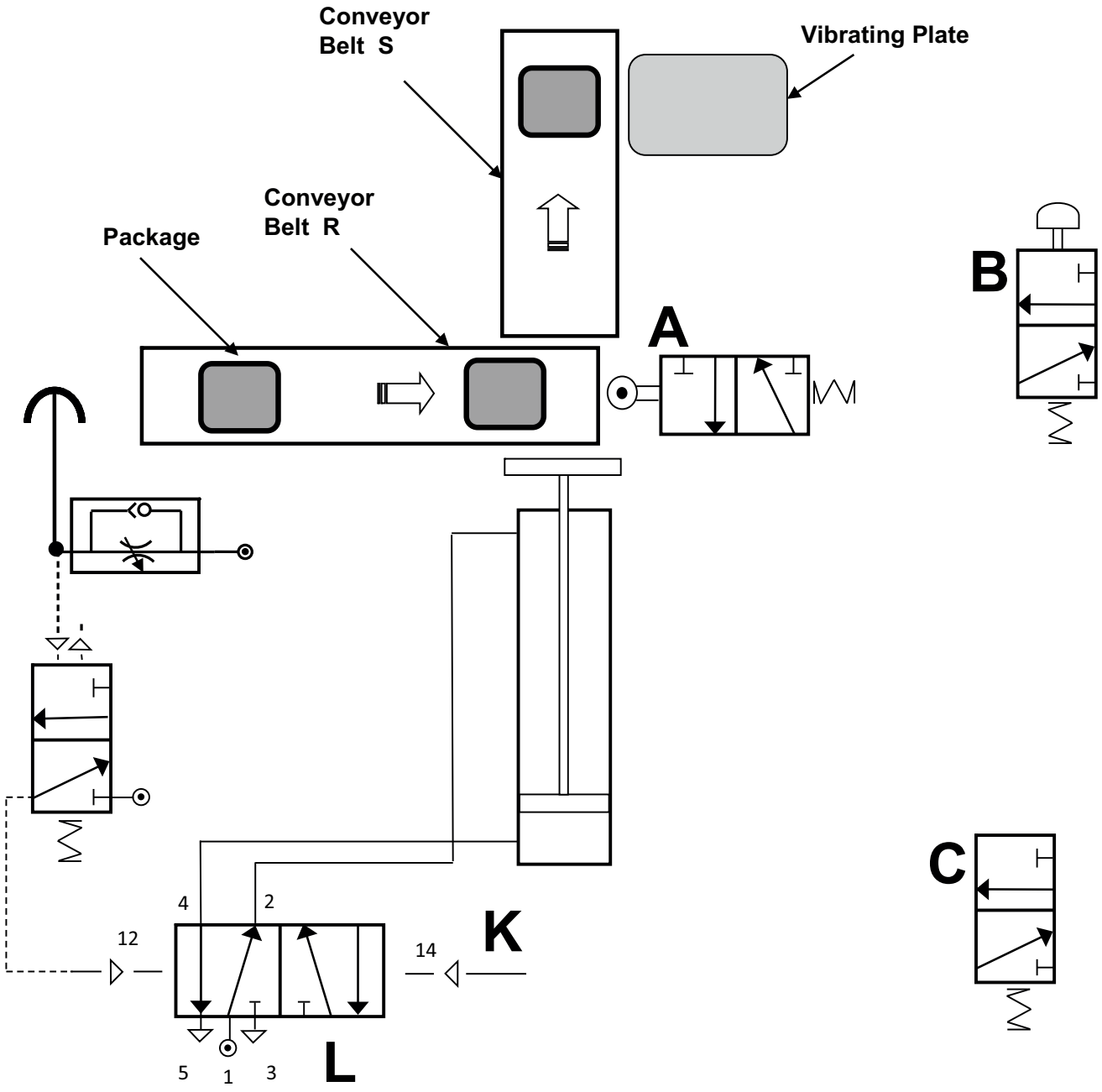


Fig. 6

(a) Name port **5** on component **L**.

_____ [1]

(b) Describe how the double acting cylinder shown on **Fig. 6** instrokes following an activation of the air bleed. Your explanation should include the names of the components used and reference to the flow of air.

_____

_____

_____

_____

_____ [3]

Examiner Only	
Marks	Remark

(c) The conveyor system includes a vibrating plate shown on **Fig. 6**, powered by an electric motor, which is used to ensure that the enclosed toy blocks are evenly distributed.
In the blank space below, using an annotated sketch with appropriate dimensions, draw a suitable mechanical system which would convert the rotary motion of the electric motor to provide the vibrating plate with a vertical reciprocating motion. The vibrating plate should move up and down by 2 cm in total. (Your drawing does not have to be to scale).

[5]

Examiner Only	
Marks	Remark

(d) The conveyor belt system has an overall velocity ratio of 5 and a mechanical advantage of 4.5. Calculate the efficiency of the system and clearly show your working out.

Efficiency = _____ [2]

(e) During testing, the double acting cylinder produces a force of 100 N through the outstroke and is supplied with an air pressure of 0.5 N/mm^2. During the instroke it produces a force of 74.88 N. Calculate the piston rod radius. Please assume π = 3.14 and clearly show your working out.

Piston rod radius = _____ [4]

Examiner Only	
Marks	Remark

(f) Complete the circuit shown on **Fig. 7** to enable activations at **A or B** to signal **C** for activation which in turn activates the five port valve at **K** after a time delay. [5]

Examiner Only	
Marks	Remark

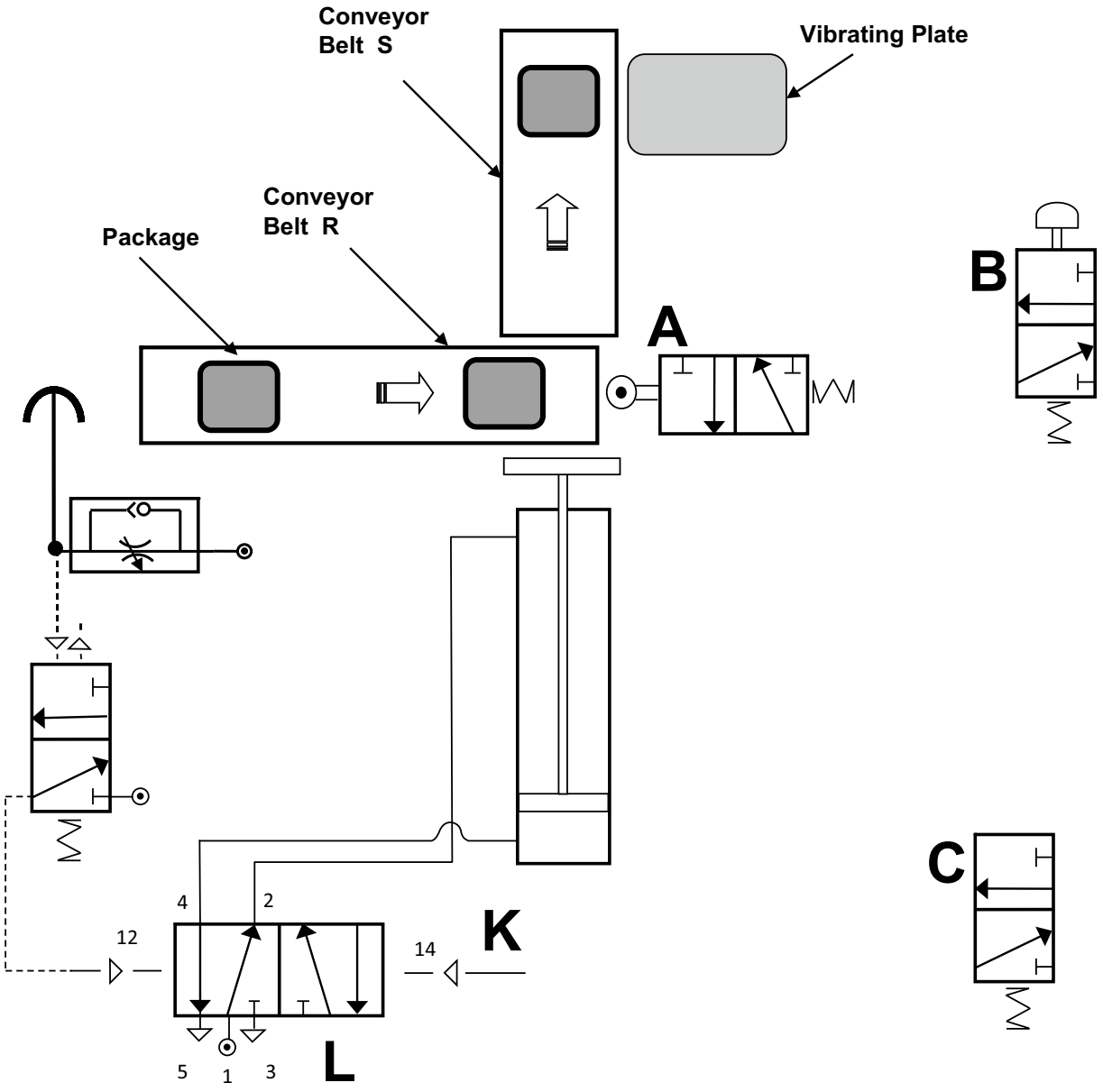


Fig. 7

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

4 **Fig. 8** shows a mechanical system used to provide rotary motion through three output shafts to various parts of a prototype funfair display.

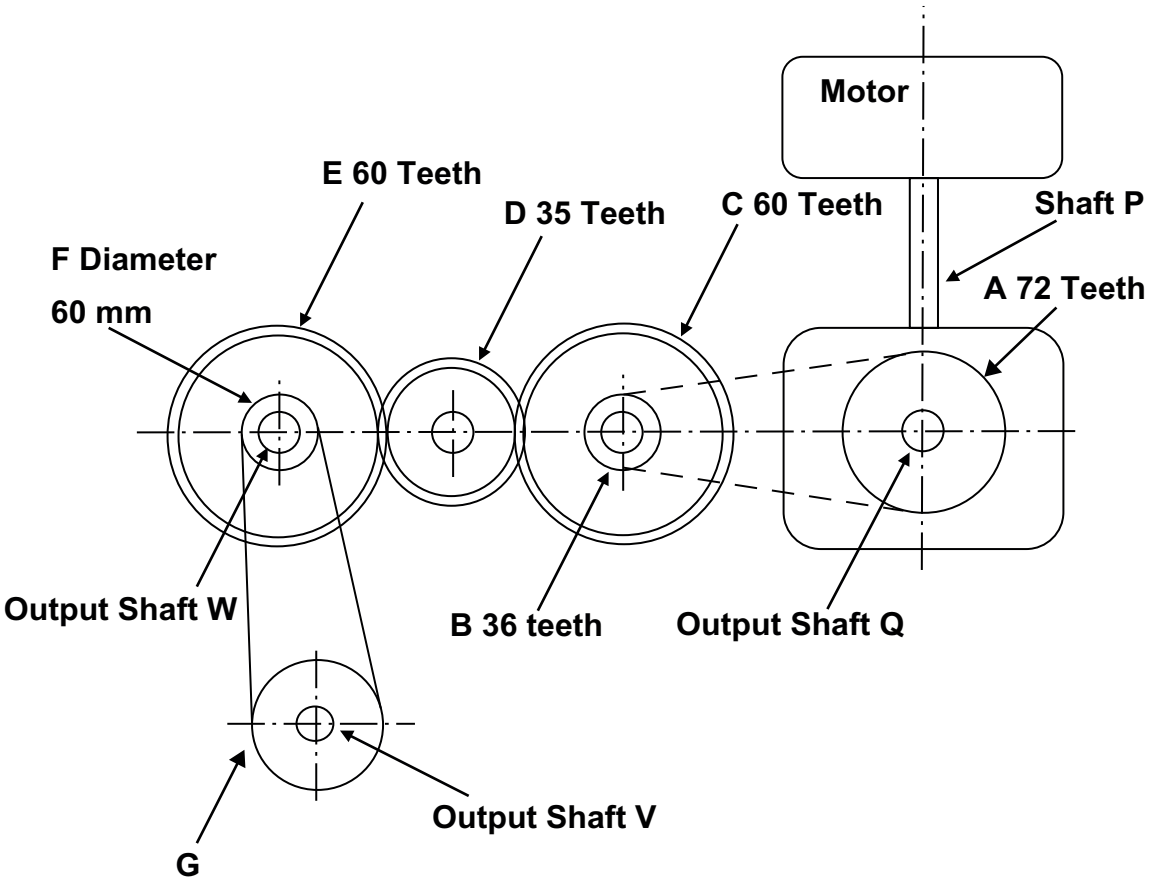


Fig. 8

(a) **(i)** State the direction of rotation at output shaft **W** if output shaft **Q** is rotating in a clockwise direction. Please note that both shafts are observed from the same point.

_____ [1]

(ii) Name and draw a suitable mechanism which could link the motor shaft **P** and output shaft **Q** maintaining the same velocity ratio.

[3]

(iii) Calculate the diameter of pulley **G** which is necessary to produce a velocity ratio of 3 between gear **C** and output shaft **V**. Clearly show your working out.

Diameter of pulley **G** = _____ [3]

(iv) Calculate the speed of output shaft **W** if output shaft **Q** rotates at 100 rev/min. Clearly show your working out.

Speed of output shaft **W** = _____ [4]

(b) Outline **three** main safety issues associated with mechanical systems.

1. _____

_____

2. _____

_____

3. _____

_____ [3]

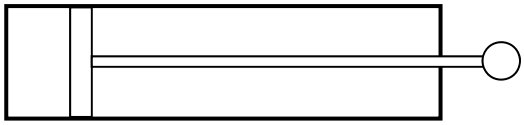
Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(c) The mechanical system shown in **Fig. 8** is to be enhanced to include a pneumatic system capable of pushing **Output Shaft V** from side to side. The shaft is located on a moveable housing which requires reciprocating motion to be provided by a double acting cylinder (DAC). **Fig. 9** shows an incomplete pneumatic circuit incorporating a double acting cylinder (DAC) and a 5PV.

Complete the circuit to enable:

- the double acting cylinder to repeatedly outstroke and instroke slowly without time delays. [4]
- both the instroke and outstroke movement of the DAC to be stopped and restarted at any time as a safety feature. [2]



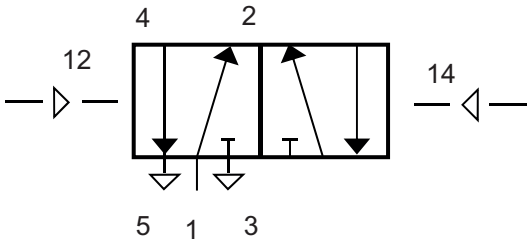


Fig. 9

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(Questions continue overleaf)

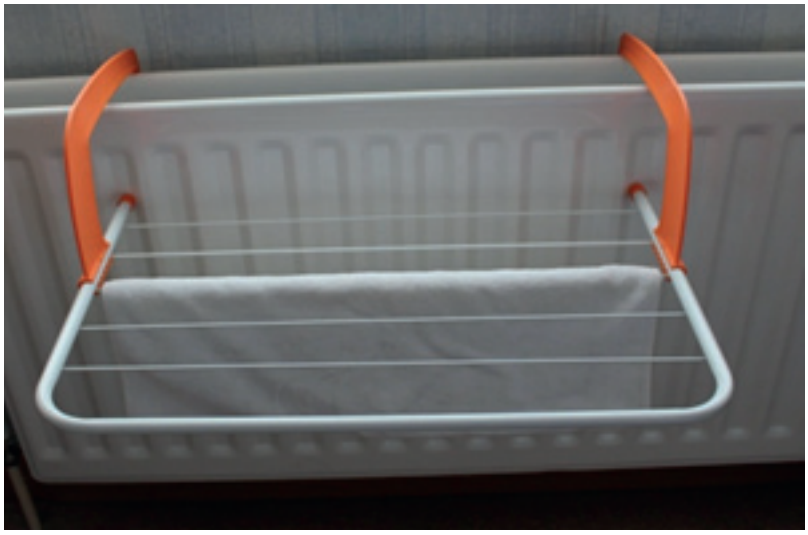
Section C

Product Design

Answer **both** questions in this section.

Examiner Only	
Marks	Remark

5 The radiator dryer shown in **Fig. 10** is a space saving product often used for drying smaller laundry items.



Source: Principal Examiner

Fig. 10

(a) When generating ideas for the radiator dryer the company manufacturing this product used the technique of **SCAMPER**. With reference to the words **combine** and **reverse** in the acronym **SCAMPER** explain how the meaning of each word could help generate ideas for the radiator dryer.

Combine _____

_____

_____

_____ [2]

Reverse _____

_____

_____

_____ [2]

(b) Before beginning production of the radiator dryer the company applied for a patent.
Explain **one** specific characteristic associated with a patent.

_____

_____

_____

_____ [2]

(c) The production process for the radiator dryer required that the company comply with the control of substances hazardous to health regulations (**COSHH**).
Explain **one** specific characteristic associated with the (**COSHH**) regulations.

_____

_____

_____

_____ [2]

(d) The company designs and manufactures an extensive range of dryers utilising a JIT approach and adopts the view of 'right first time'.

(i) State **two** main characteristics associated with the JIT approach.

1. _____

_____

2. _____

_____ [2]

(ii) State **two** main ways that the company may benefit as a result of adopting the approach of 'right first time'.

1. _____

_____

2. _____

_____ [2]

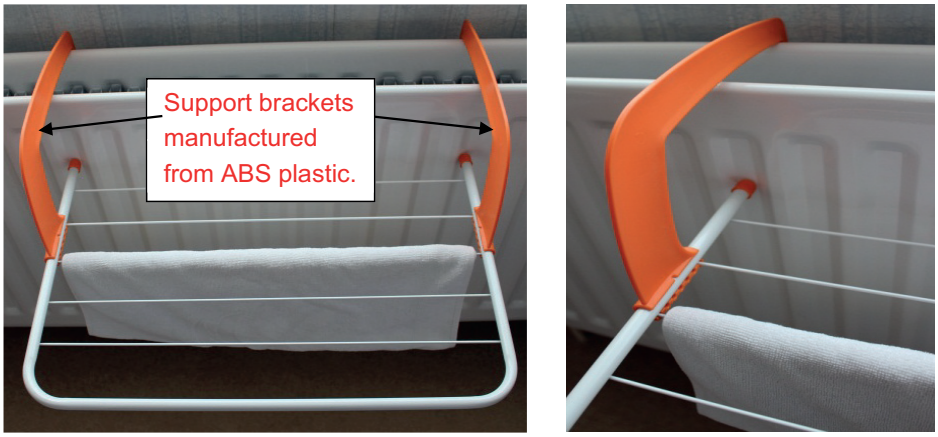
Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(e) With the aid of detailed annotated sketches using the blank pages provided (answer number **5(e)(i) and 5(e)(ii)**) complete each of the following:

(i) An appropriate design that will connect the two support brackets in **Fig. 11** to give the product more rigidity. Your design will need to be easily assembled by the consumer and suitable for flat pack assembly. [4]

(ii) An appropriate design of a tray which could be quickly and easily attached to the radiator dryer to catch any possible water droplets from small wet laundry items. Your design must minimise the use of materials. [4]



Source: Principal Examiner

Fig. 11

Answer page (answer number **5(e)(i)**)

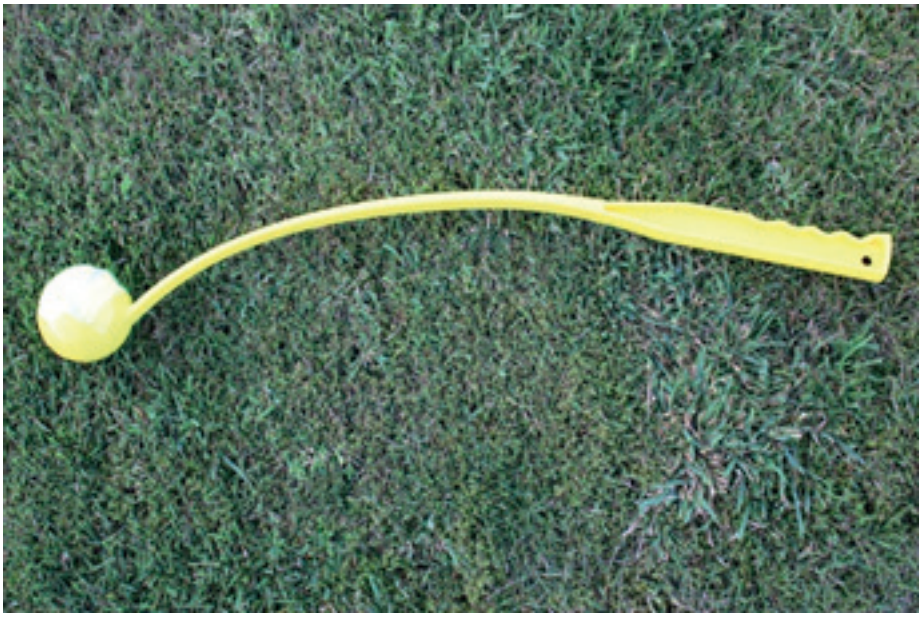
Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

Answer page (answer number **5(e)(ii)**)

Examiner Only	
Marks	Remark

6 The ball thrower shown in **Fig. 12** is a lightweight, easy to use product that can provide maximum exercise for your dog with little effort by the operator.



Source: Principal Examiner

Fig. 12

(a) Secondary research played a key role in the early stage of the design of the ball thrower.

(i) Outline **two** main sources associated with secondary research.

1. _____

_____

2. _____

_____ [2]

(ii) For any **one** of the main sources identified in **(a)(i)** explain the type of information that might have been obtained in order for it to be used in the early stages of the design of the ball thrower.

_____

_____

_____

_____ [2]

(b) The 3D printing process was used at the modelling stage in order to develop the design of the product.

Explain the process of 3D printing making specific reference to the drawing file and how the machine creates a three dimensional product.

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(c) For the company manufacturing the ball thrower, batch production was considered the most appropriate scale of production.

State **two** main characteristics associated with batch production.

1. _____

_____

2. _____

_____ [2]

(d) To plan for the manufacture of the product a Gantt chart was used. State **two** main characteristics associated with a Gantt chart.

1. _____

_____

2. _____

_____ [2]

Examiner Only	
Marks	Remark

(e) In order to check the quality of the product being manufactured statistical testing methods were used by the company.

With reference to the production of the ball thrower explain what is meant by statistical testing methods.

_____

_____

_____

_____ [2]

(f) This company has been awarded the ISO 9001 standard.

Explain what is meant by the ISO 9001 standard.

_____

_____

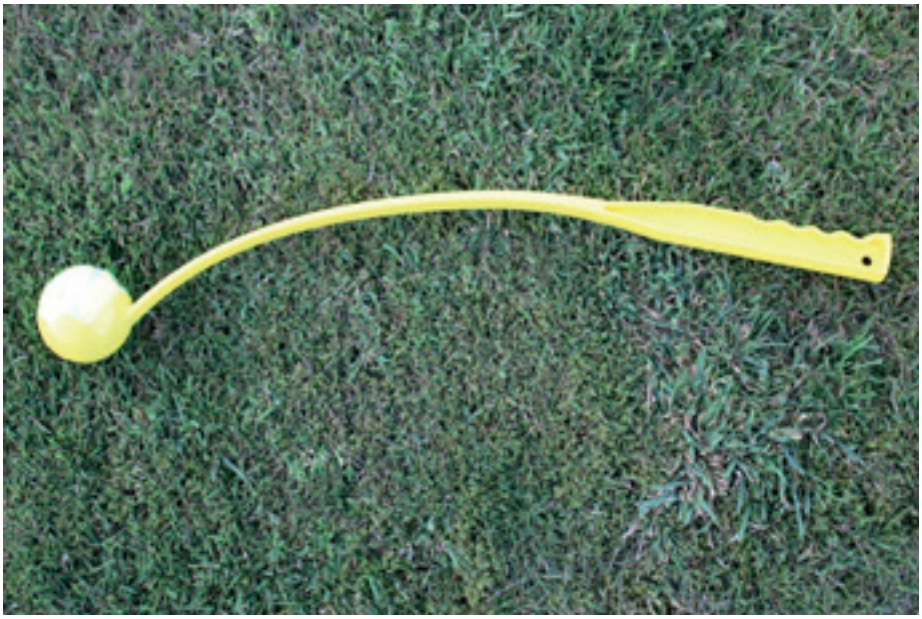
_____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(g) With reference to **Fig. 13** below and on the blank A4 page (answer number **6(g)**) use a detailed annotated sketch to produce **one** possible solution for the following:



Source: Principal Examiner

Fig. 13

An appropriate design for the handle of the ball thrower that will enable the user to quickly secure the thrower to their wrist in order to minimise the risk of damage if it were to slip out of their hand during use. [4]

Answer page (answer number **6(g)**)

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER