Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6266073748

DESIGN AND TECHNOLOGY **0445/43**

Paper 4 Systems and Control **October/November 2015**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions in this section.

Section B
Answer **one** question in this section.

You may use a calculator.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 50.

This document consists of **17** printed pages and **3** blank pages.

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Section A

Answer **all** questions in this section.

1 Plastic fibre reinforcement can be added to concrete at the mixing stage.

(a) Give **one** reason for adding reinforcement to concrete.

.....

.....[1]

(b) Give **one** benefit of using plastic as the reinforcing material.

.....

.....[1]

2 Fig. 1 shows a brick wall with a crack in it.

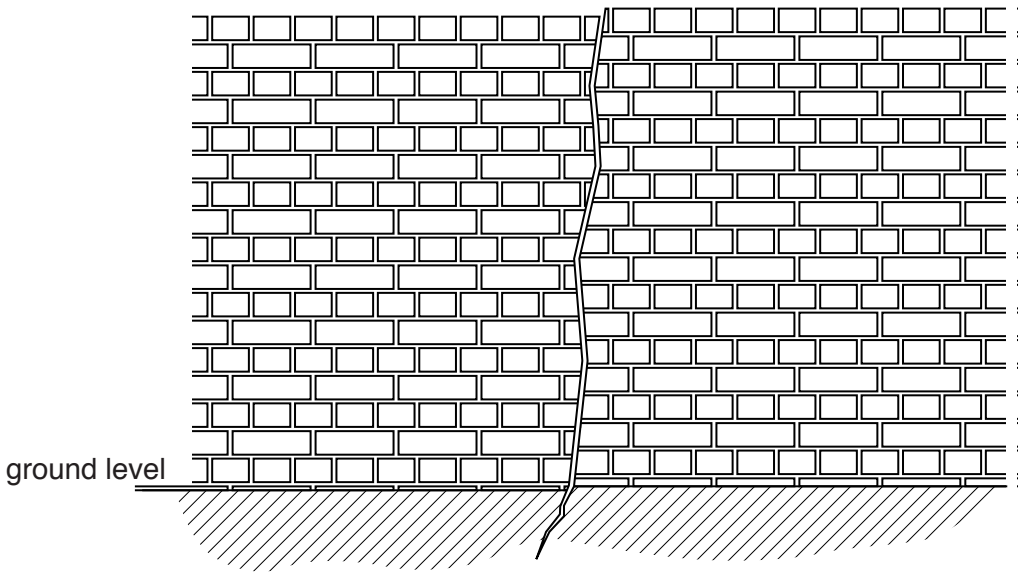

Fig. 1

(a) State the force that has caused the crack.

.....[1]

(b) Give **one** possible reason why the crack has occurred.

.....

.....[1]

3 Struts and ties are used in structures.
Use sketches and notes to show the difference between a strut and a tie.

[4]

4 **(a)** Friction is not normally wanted in a mechanism.
Give **two** types of energy that are the result of unwanted friction in a mechanism.

1 .....

2 .....[2]

(b) Give **two** examples of a mechanism in which friction **is** needed.

1 .....

2 .....[2]

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[Turn over

5 Fig. 2 shows a salad spinner which uses a gear system to spin a basket to remove water from washed salad.

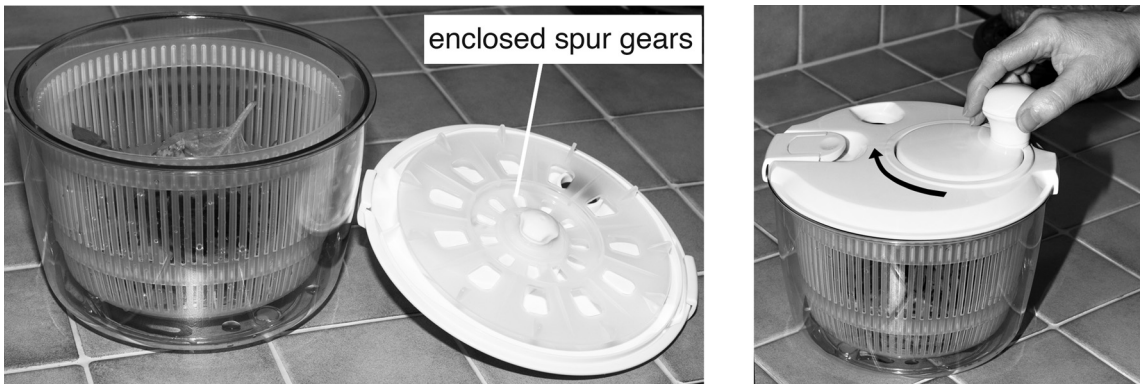

Fig. 2

(a) State the name of the hand operated mechanism that is used to drive the salad spinner.

.....[1]

(b) Two spur gears are used to increase the speed of the salad spinner giving a velocity ratio of 5:1.
From the list below choose two gears that will give a 5:1 velocity ratio.

24t **8t** **18t** **40t** **46t**

driver gear ..... driven gear ..... [3]

6 Name the electronic symbols shown in Fig. 3.

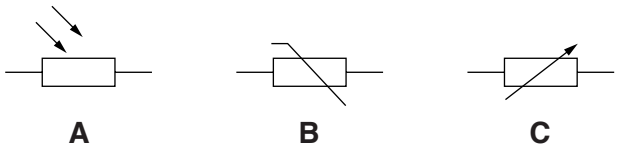

Fig. 3

A .....

B .....

C .....[3]

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7 An electrolytic capacitor is shown in Fig. 4.

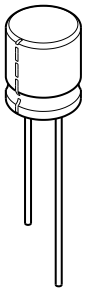

Fig. 4

Describe how this type of capacitor should be correctly fitted in a circuit board.

.....

.....

.....[2]

8 A high intensity LED is designed to have an operating current of 50 mA when used with a 9 V supply.

(a) (i) Calculate the power through the current limiting resistor used in the circuit. The forward voltage of the LED is 2 V.

Use the formula **P = V × I**

.....

.....

.....[2]

(ii) (Circle) on the list below the appropriate power rating for the resistor.

0.125W **0.25W** **0.4W** **0.5W** **1W** [1]

(b) State the result of using a resistor with a power rating that is too low.

.....

.....[1]

Section B

Answer **one** question in this section.

9 Fig. 5 shows part of a ladder made from hollow aluminium sections.

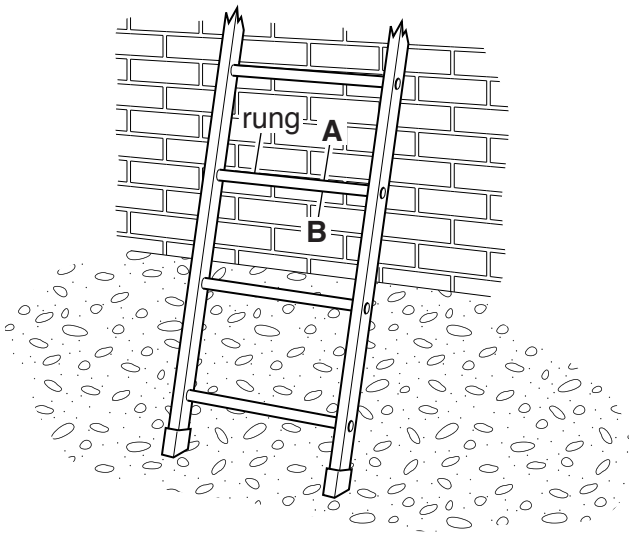

Fig. 5

(a) (i) Give **two** advantages of using aluminium rather than wood for the construction of a ladder.

1 .....

2 .....[2]

(ii) Name the forces acting at the positions **A** and **B** shown in Fig. 5 when a person stands on the rung of the ladder.

Force acting at **A** .....

Force acting at **B** .....[2]

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(iii) Fig. 6 shows the position of the foot of a user on a rung of the ladder.

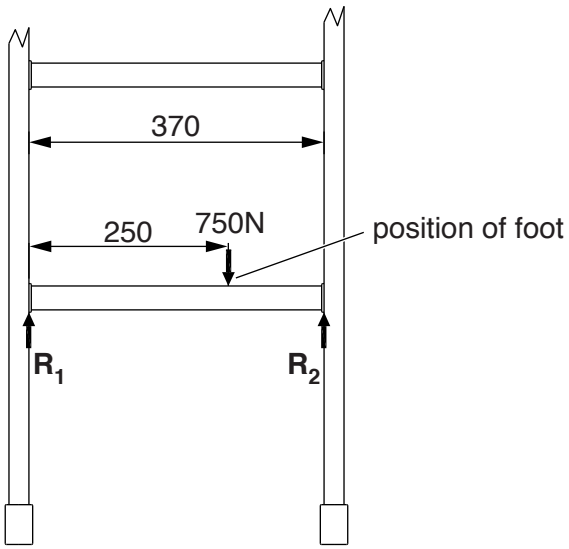


Fig. 6

Calculate the reactions $\mathbf{R_1}$ and $\mathbf{R_2}$.

.....

.....

.....

.....[3]

(iv) Use sketches and notes to show how the deflection caused by a person standing on the rung could be accurately measured.

[3]

(v) Explain why a Factor of Safety should be considered when designing a ladder.

.....

.....

.....[2]

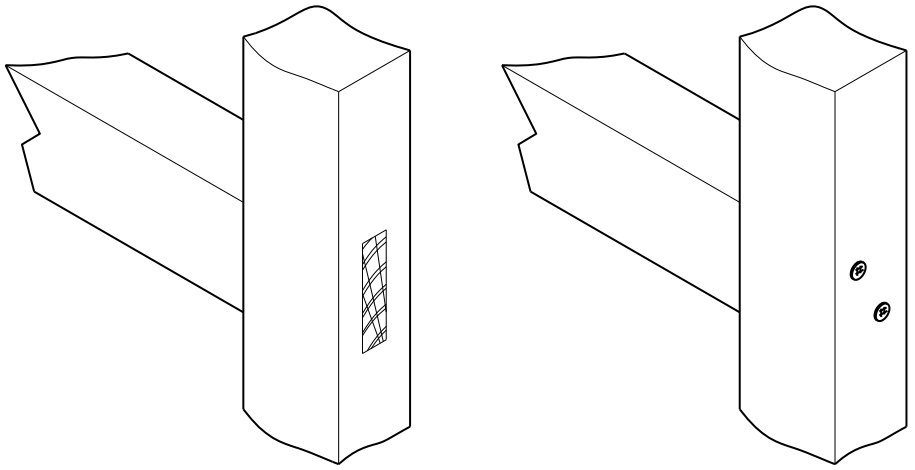
(vi) Describe how the manufacturer can ensure that any user of the ladder will be aware of Factors of Safety that have been considered.

.....

.....

.....[2]

(b) Fig. 7 shows a glued mortise and tenon joint and a nailed butt joint.



glued mortise and tenon joint nailed butt joint

Fig. 7

(i) Give **two** advantages of using a glued mortise and tenon joint rather than a nailed butt joint.

1 .....

2 .....[2]

(ii) Use sketches and notes to show **one** method to strengthen the glued mortise and tenon joint.

[3]

(iii) Give **two** temporary methods of joining wood in addition to nails.

1 .....

2 .....[2]

(c) Fig. 8 shows laminated beams used in the construction of a swimming pool roof.
The laminated beams are constructed from thin strips of wood glued together.

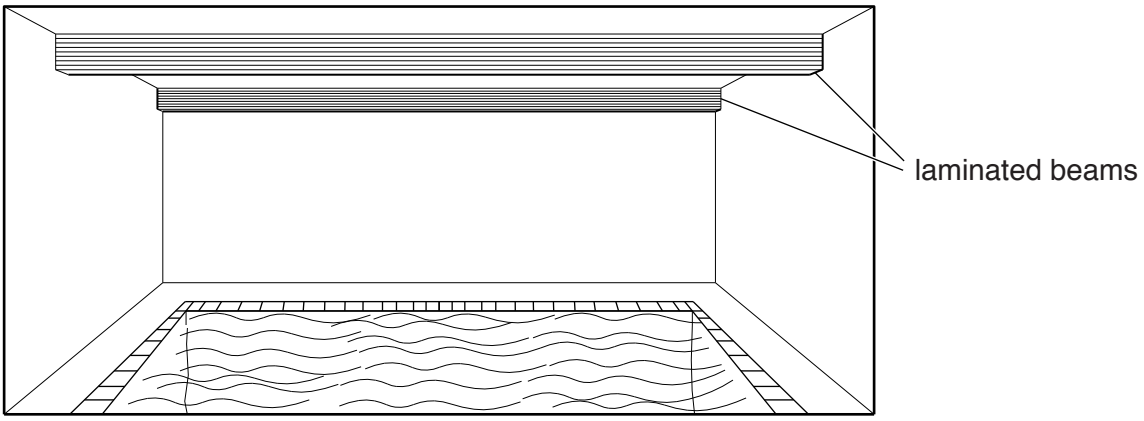


Fig. 8

Explain why laminated beams, rather than solid wood or steel, are frequently used in new swimming pools and other large public buildings.

.....

.....

.....

.....

.....

.....[4]

10 Fig. 9 shows a garden lawnmower and details of the drive mechanism for the rear roller and blade axle.

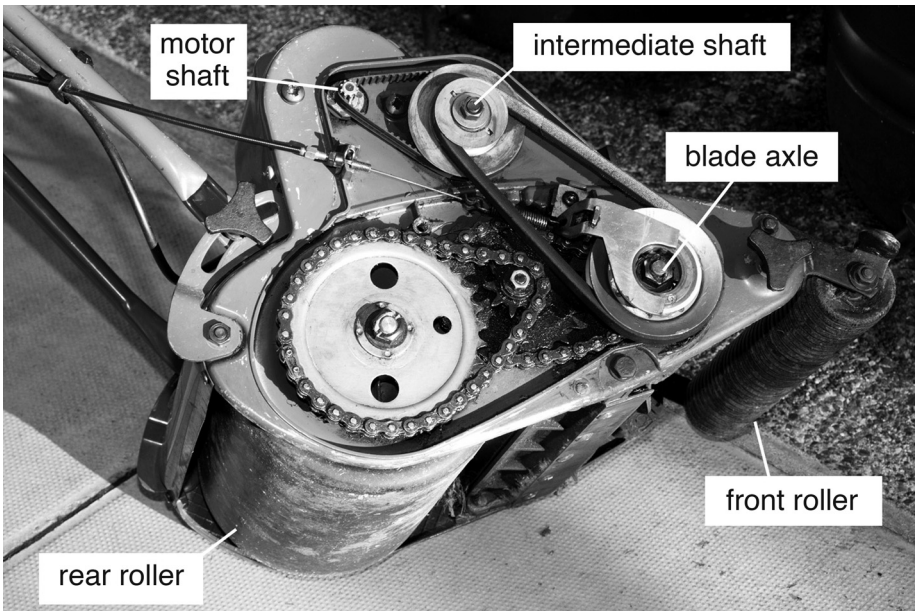


Fig. 9

(a) (i) Name the **three** types of drive system used on the lawnmower.

1 .....

2 .....

3 .....[3]

(ii) Explain why the type of drive system from the intermediate shaft to the blade axle has been chosen.

.....

.....

.....[2]

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(b) Fig. 10 shows details of the pulleys used to connect the motor shaft to the blade axle.

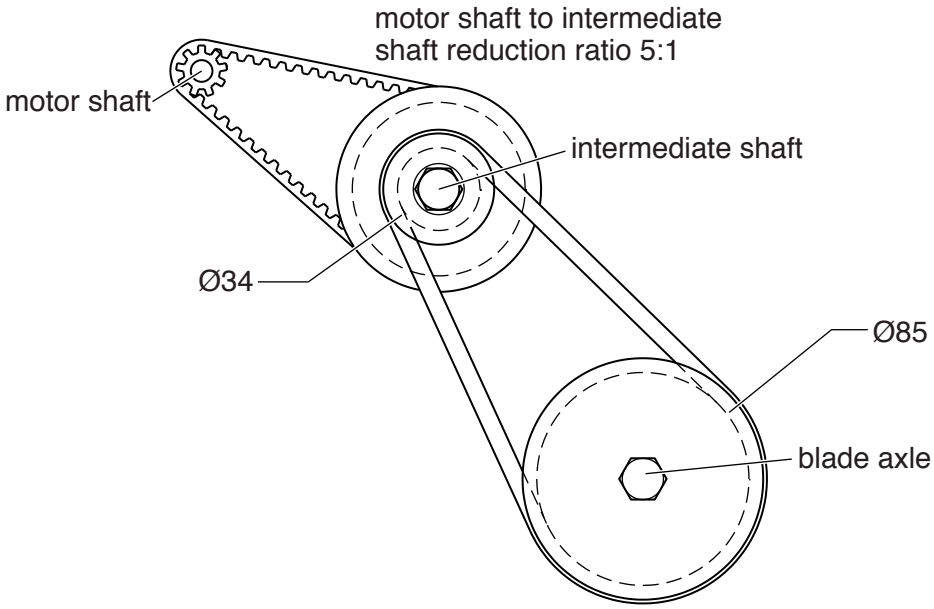

Fig. 10

Calculate the speed of the blade axle when the motor speed is 4000 rpm.

.....

.....

.....[3]

(c) When a downward force is applied to the handle, the lower part of the lawnmower will pivot on the rear roller, lifting the blades and front roller as shown in Fig. 11. This allows the lawnmower to be lifted easily over obstacles.

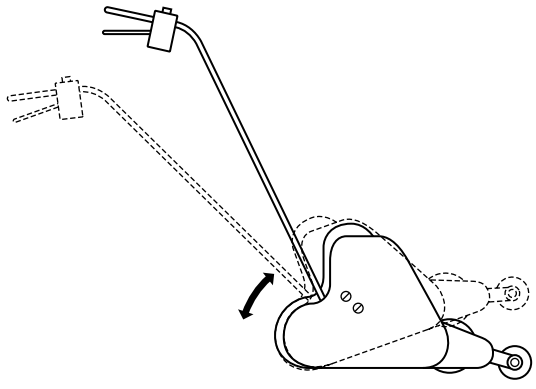

Fig. 11

(i) State the order of lever that is used to do this.

.....[1]

(ii) Mark the position of the load (L), effort (E) and fulcrum (F) on Fig. 11. [3]

(d) Fig. 12 shows the adjuster used to tighten the operating cable for the rear roller.
State the conversion of motion that takes place when this adjuster is turned.

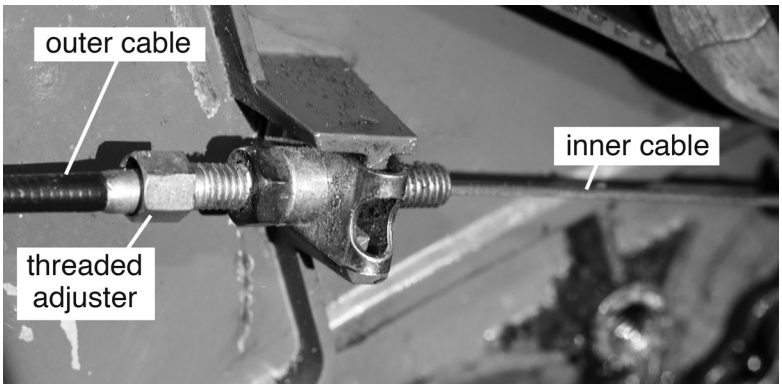

Fig. 12

From ..... motion to ..... motion [2]

(e) Fig. 13 shows the winding mechanism for a lift or elevator.

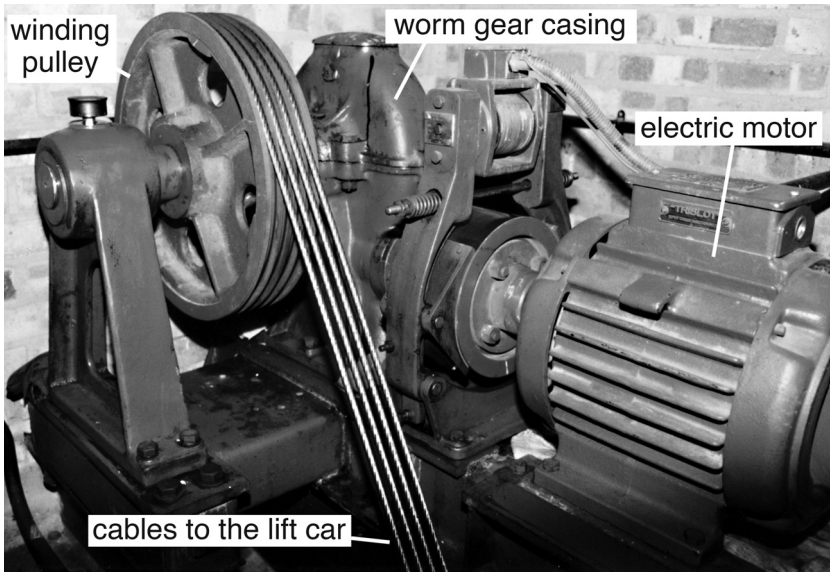

Fig. 13

(i) The motor is connected to the winding pulley by a worm gear.
Explain why a worm gear is suitable for this application.

.....

.....

.....

.....[3]

(ii) The winding pulley uses four cables connected to the lift car.
Give **two** reasons for using more than one cable.

1 .....

2 .....[2]

(iii) A hydraulic system could be used to operate the lift instead of an electric powered winding system.
Describe the principle of a hydraulic system for lifting a heavy load.

.....

.....

.....[2]

(f) Fig. 14 shows three cams.

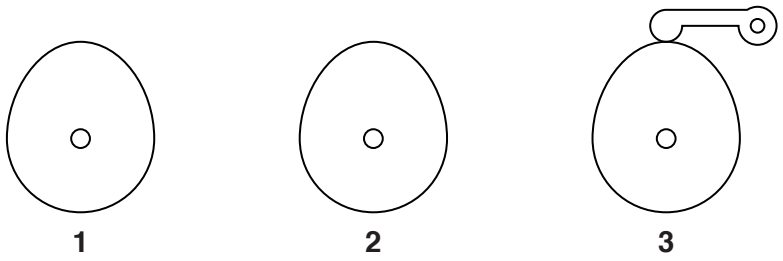

Fig. 14

Draw on Fig. 14 to show:

- a roller follower on cam **1**;
- a flat follower on cam **2**;
- an extension to the edge follower on cam **3** to amplify the movement.

[4]

11 **(a)** State the meaning of the circuit symbols shown in Fig. 15.

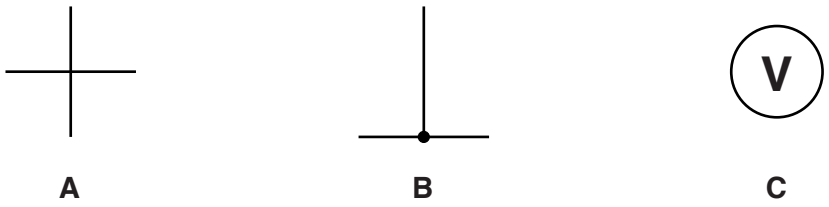

Fig. 15

A .....

B .....

C .....[3]

(b) A greenhouse sensor uses conductive probes to detect moisture in the soil.
When the soil is too dry a watering system is activated.
The sensing circuit and conductive probes are shown in Fig. 16.

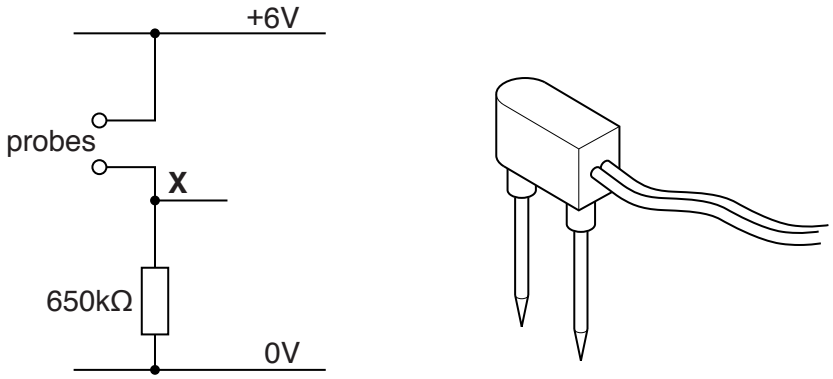

Fig. 16

(i) Calculate the voltage at **X** when the resistance in the soil is 1.2 MΩ.

Use the formula $\mathbf{V_{out} = \frac{R_2}{R_1 + R_2} \times V_{in}}$

.....

.....

.....[3]

(ii) To change the sensitivity of the sensor circuit a variable resistor could be used to replace the 650 kΩ fixed resistor.
Circle on the list below a suitable value for the variable resistor.

100 kΩ **220 kΩ** **470 kΩ** **1 MΩ** **10 MΩ** [1]

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(iii) Three conductive probes could be used with their outputs combined using logic.
Connect the logic gates in Fig. 17 so that the combined output will produce a high signal when at least one high signal is present at the inputs.

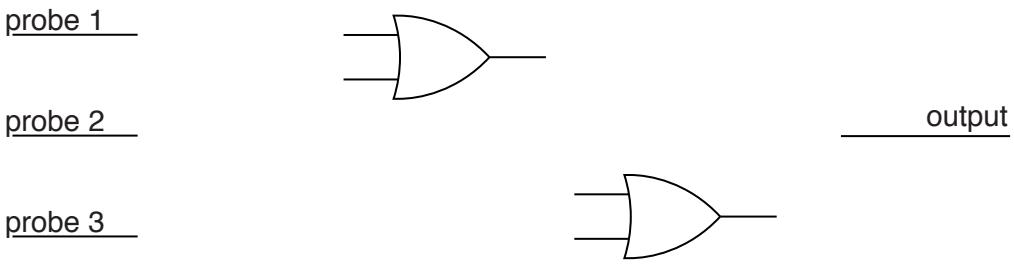

Fig. 17 [2]

(c) Fig. 18 shows an operational amplifier symbol and the pin diagram of the IC that will be used to switch the watering system on when needed.
The circuit will operate on a 6 V single rail supply.

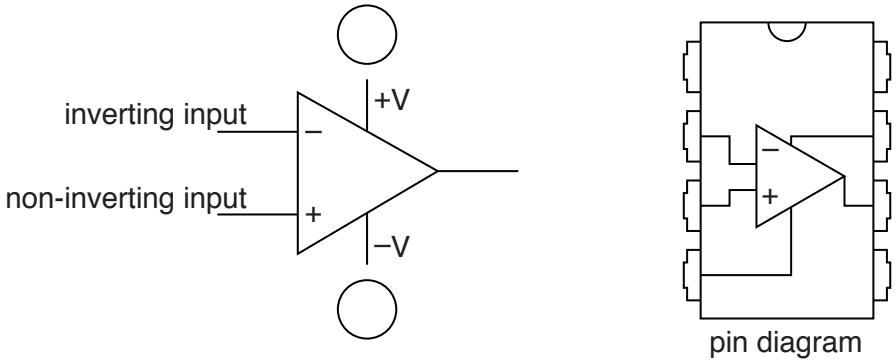

Fig. 18

(i) Use information from the IC pin diagram to add pin numbers to the power connections on the operational amplifier symbol. [2]

(ii) Complete the table below to show the approximate output voltage of the operational amplifier for the given conditions.

input condition	**approximate output voltage**
inverting input > non-inverting input	
non-inverting input > inverting input	

[2]

(iii) Fig. 19 shows the sensing circuit and start of the PCB layout.

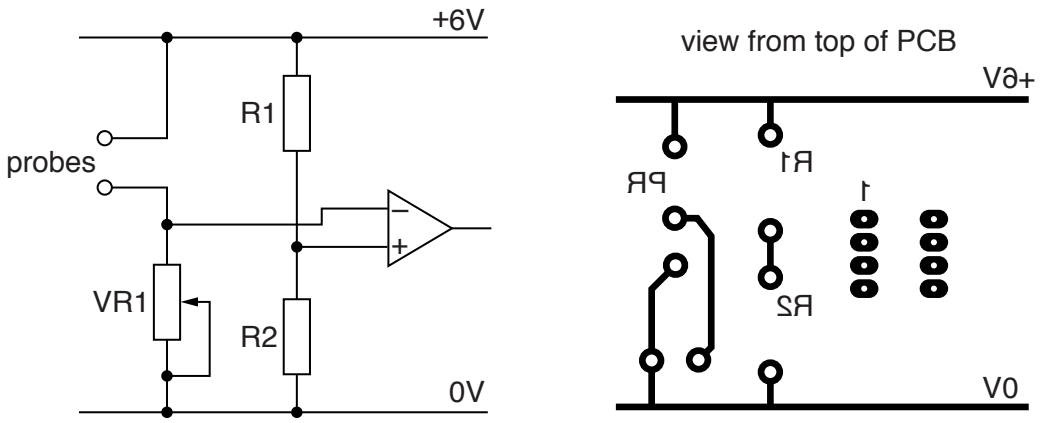

Fig. 19

Add the following connections to the layout:
- Probes / VR1 junction to pin 2
- R1 / R2 junction to pin 3. [2]

(iv) Give the reason for the information on the PCB layout being reversed.

.....

.....[1]

(d) The output to the watering system is a 12V DC electric pump which is connected to the sensing circuit through a relay. Fig. 20 shows part of the circuit diagram.

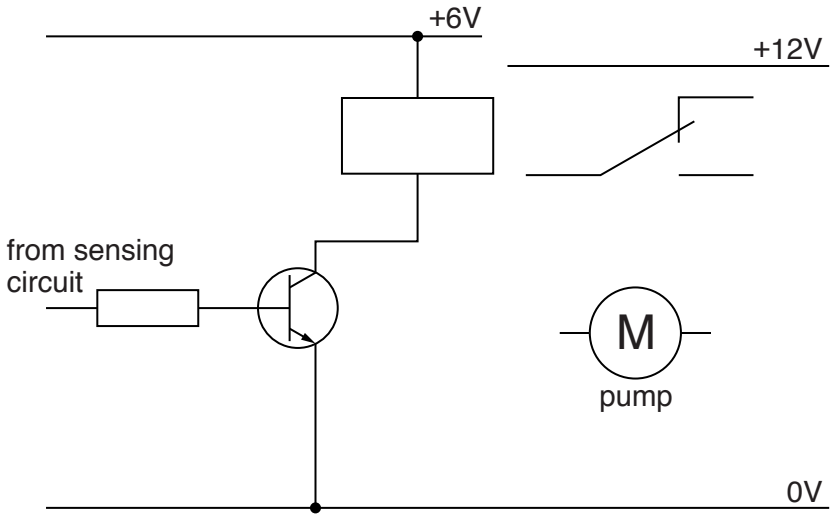

Fig. 20

(i) Add the following connections to Fig. 20:
- +12V to the relay common (C)
- Normally Open (NO) contact on the relay to the pump motor
- Pump motor to 0V. [3]

(ii) Add a diode to the circuit in Fig. 20 to protect the transistor from back emf. [2]

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(iii) Use sketches and notes to show how the cathode (negative end) of the diode would be identified on the component.

[2]

(e) To allow water to pass into the soil the pump must be switched on for a minimum period of time.
The time delay between the electric pump switching on and switching off could be controlled either by a 555 timer IC or by a programmable IC.
Give **two** benefits of using a programmable IC to provide a time delay.

1 .....

.....

2 .....

.....[2]

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