Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8477739809

DESIGN & TECHNOLOGY **0445/43**

Paper 4 Systems & Control **October/November 2023**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **one** question.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Answer in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].
- All dimensions are in millimetres unless otherwise stated.

This document has **20** pages. Any blank pages are indicated.

DC (AP) 331732

Section A

Answer **all** questions in this section.

1 Fig. 1.1 shows part of the steel frame structure of an industrial building.

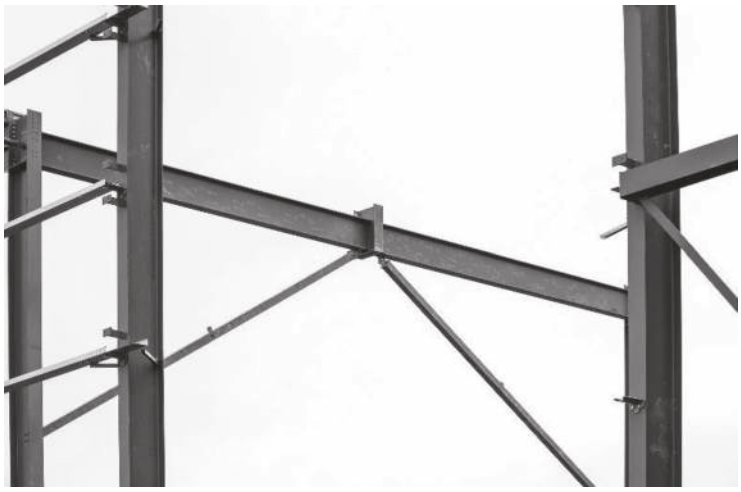


Fig. 1.1

(a) State **one** reason for using triangulation in the steel frame structure.

..... [1]

(b) The individual parts of the steel frame structure are all fabricated off-site before being assembled at the site.
Give **two** benefits of using this method for the frame structure of a building.

1 .....

.....

2 .....

.....
[2]

(c) Give **one** drawback of using concrete for the framework of this type of structure.

..... [1]

2 Give **two** items of Personal Protective Equipment (PPE) that should be used on the building site.

1 .....

.....

2 .....

.....
[2]

3 Describe, using an example, the meaning of static load in a structure.

.....

.....

..... [2]

4 Sketch and name **one** example of a third order lever.

[2]

5 Fig. 5.1 shows a linkage used on a front loader truck.

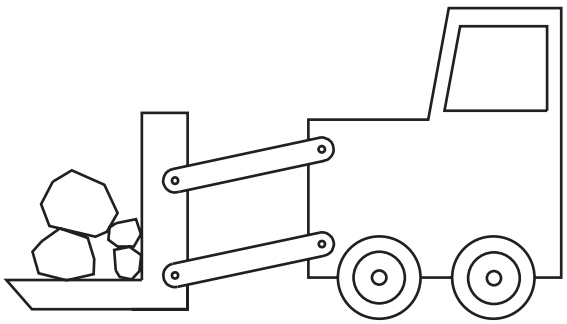


Fig. 5.1

(a) Name the type of linkage shown in Fig. 5.1.

..... [1]

(b) Explain why this type of linkage has been chosen to connect the bucket to the truck.

.....

.....

..... [2]

(c) Use sketches and notes to show a different type of linkage.

[2]

6 Fig. 6.1 shows a simplified line drawing of a small internal combustion (IC) engine.

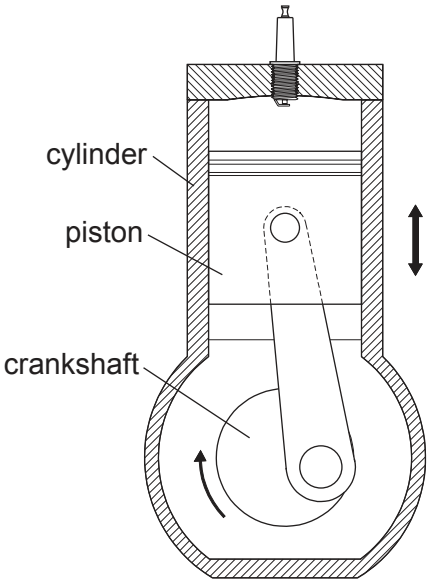


Fig. 6.1

State the conversion of motion that takes place in the IC engine when the crankshaft is driven by the piston.

..... to ..... [2]

7 Fig. 7.1 shows part of an electronic circuit.

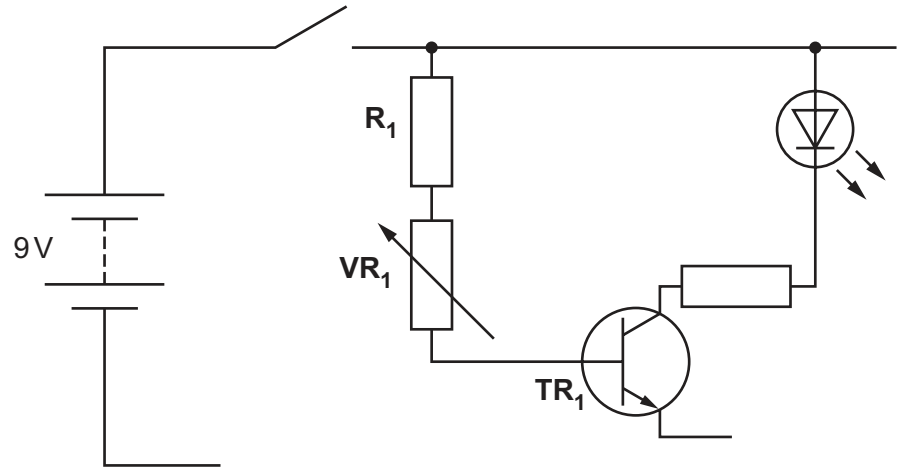


Fig. 7.1

(a) State the name of the components R_1, VR_1 and TR_1 in the circuit.

R_1 .....

VR_1 .....

TR_1 .....

[3]

(b) Multiple and sub-multiple units used in electronics contain letters to indicate their value. Give the meaning of the following letters used in unit values.

M .....

n .....

μ .....

[3]

8 Use sketches and notes to describe how a reed switch is operated.

[2]

Section B

Answer **one** question from this section.

9 Fig. 9.1 shows part of a model of a roof truss. Joints at **X** and **Y** have been glued together.

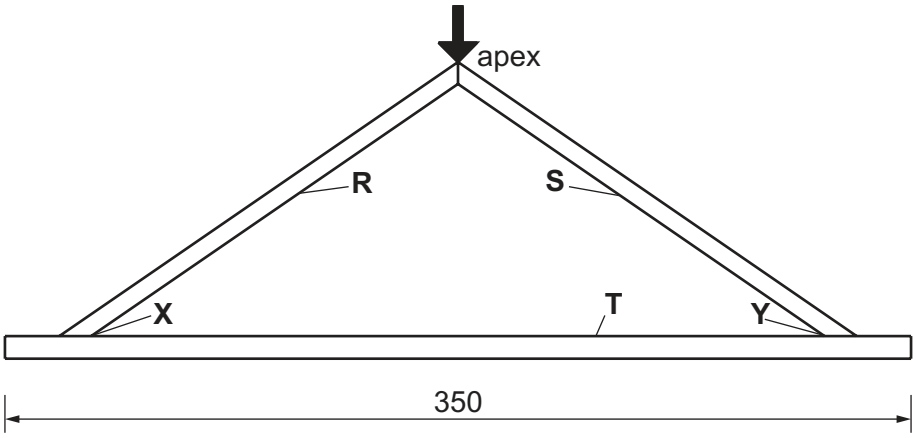


Fig. 9.1

(a) (i) Name the force that will act on beam **T** when a load is placed at the apex of the truss.

..... [1]

(ii) Describe the likely effect on the glued joints **X** and **Y** with the load in place.

.....

.....

..... [2]

(iii) Use sketches and notes to show **one** method of strengthening joints **X** and **Y** without adding any extra materials or components to the joints.

[3]

(iv) Fig. 9.2 shows weights that will be used to test the completed model.

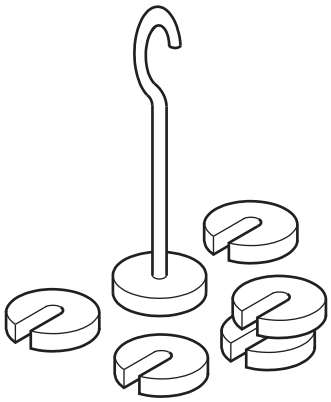


Fig. 9.2

To test the completed model the weights will be suspended from the apex where the rafters **R** and **S** meet allowing gradual, measured increase in the load.
Sketch a design for a simple test rig that will allow the weights to be applied gradually.

[3]

(v) Name **one** static and **one** moving load that a full-size roof truss must withstand.

static load .....

moving load .....

[2]

(b) Fig. 9.3 shows two structures used to access a building under construction.
Both structures use linkages to achieve vertical movement.

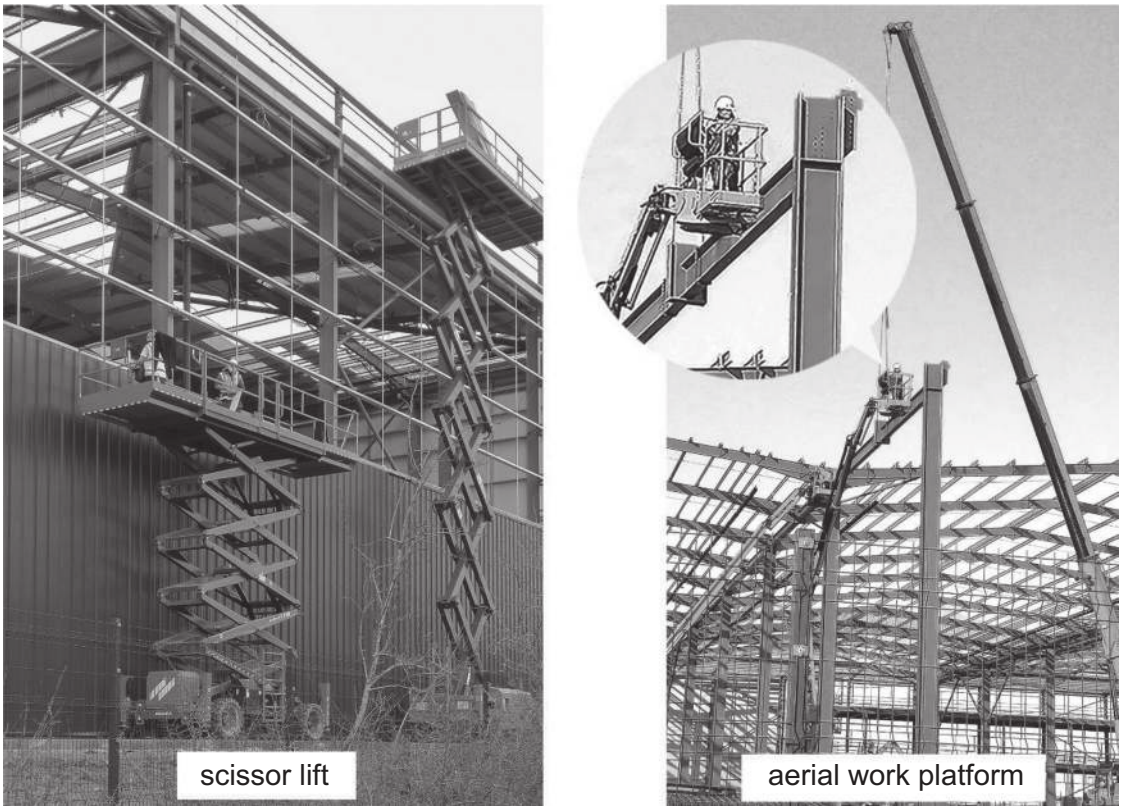


Fig. 9.3

(i) Give **two** advantages of using the scissor lift rather than an aerial work platform.

1 .....

.....

2 .....

.....
[2]

(ii) State **one** disadvantage of using the scissor lift rather than an aerial work platform.

.....

..... [1]

(iii) Both types of lifting equipment will require Factor of Safety to be considered.
State who will be responsible for identifying the safety considerations in any lifting equipment used.

..... [1]

(iv) Describe three features of the equipment in use that will have been considered when deciding on the Factor of Safety.

.....

.....

.....

..... [3]

(c) Fig. 9.4 shows a beam that is loaded on both sides of a central support.

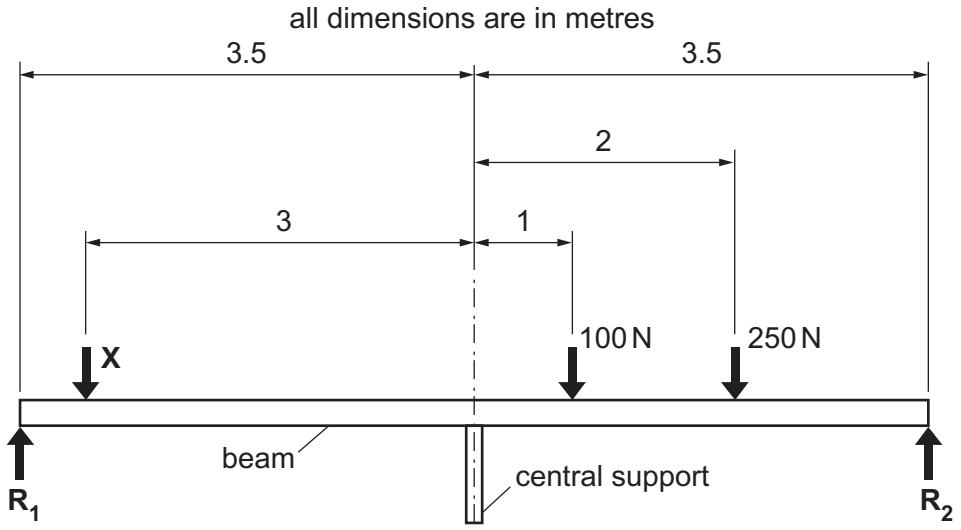


Fig. 9.4

(i) Calculate the clockwise moment on the right-hand side of the beam.

.....

.....

.....

..... [3]

(ii) Calculate the load that must be placed at **X** to keep the beam in equilibrium.

.....

.....

.....

..... [2]

(iii) State the reaction at $\mathbf{R_1}$ and $\mathbf{R_2}$ when the beam is in equilibrium.

..... [2]

10 **(a)** Fig. 10.1 shows a cam and follower mechanism.

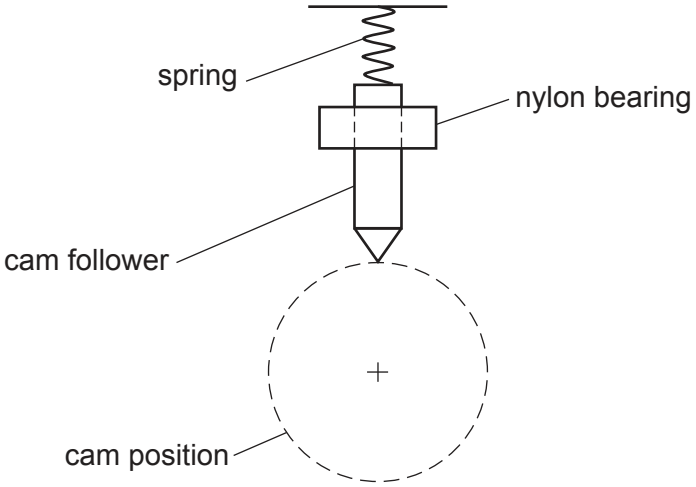


Fig. 10.1

(i) Draw a cam on the position shown in Fig. 10.1 to operate the cam follower 4 times for each revolution of the cam. [2]

(ii) State the purpose of the spring.

..... [1]

(iii) The bearing supporting the follower is made from nylon.
Give **two** properties of nylon that make it a suitable material for the bearing.

1 .....

.....

2 .....

.....
[2]

(b) Fig. 10.2 shows a toy gyroscope used to demonstrate how a spinning rotor can be used to stabilise motion.
The rotor is made to spin by pulling on a string that is wrapped around the axle.

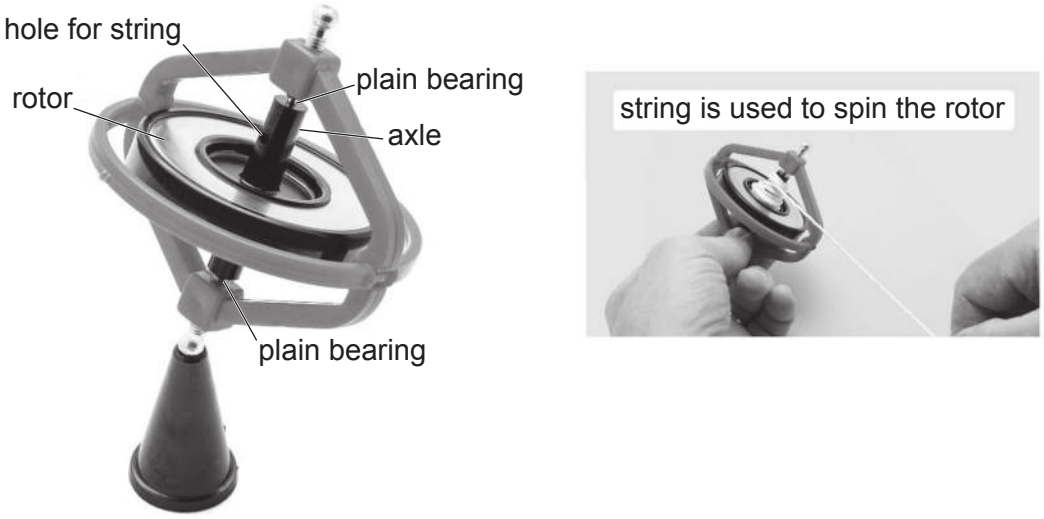


Fig. 10.2

(i) State the conversion of motion that takes place when the string is pulled.

..... to ..... [2]

(ii) The axle is supported at each end by plain bearings.
Explain what is meant by a plain bearing.

.....

.....

.....

..... [2]

(iii) State **two** factors that will affect the length of time that the rotor will spin.

1 .....

.....

2 .....

.....
[2]

(c) Fig. 10.3 shows details of a vee belt and a flat belt that can drive a pulley in either direction.

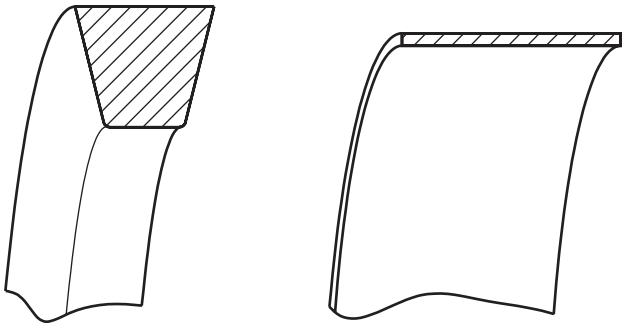


Fig. 10.3

(i) Give **two** advantages that the vee belt has when being used to drive a pulley on a machine.

1 .....

.....

2 .....

.....

[2]

(ii) Sketch the arrangement of the flat belt that will change the direction of the driven pulley.

[1]

(iii) Explain why the vee belt cannot change the direction of the driven pulley.

.....

.....

.....

..... [2]

(iv) Use sketches and notes to show a method of tensioning a vee belt without changing the position of the pulleys.

[3]

(d) Fig. 10.4 shows a section through a car jack.

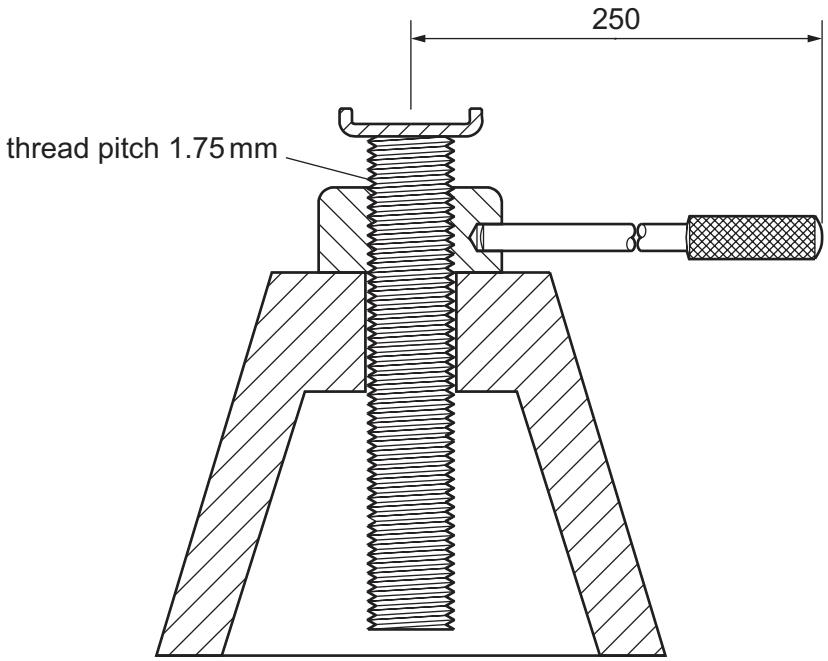


Fig. 10.4

(i) Calculate the velocity ratio (VR) of the car jack.

.....

.....

.....

..... [2]

(ii) The car jack is 30% efficient.
Give **one** reason for the loss of efficiency in the car jack.

.....

..... [1]

(iii) Calculate the effort needed to lift a load of 5 kN, ignoring the loss of efficiency.

.....

.....

.....

..... [3]

11 **(a)** Fig. 11.1 shows an incomplete circuit for a transistor amplifier.

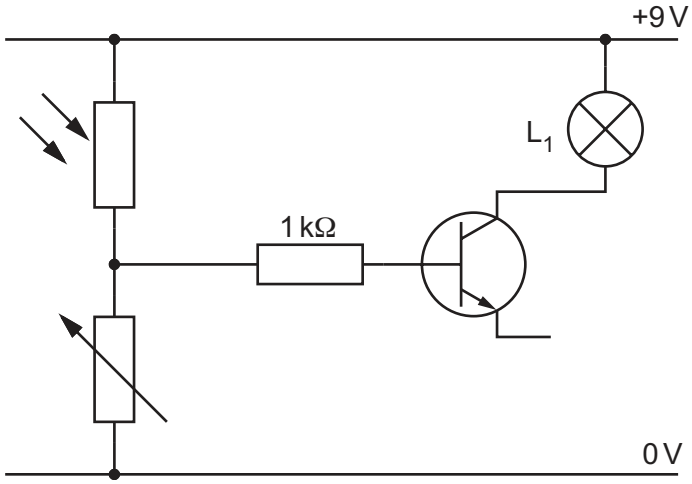


Fig. 11.1

(i) Add the missing connection to Fig. 11.1. [1]

(ii) Describe the purpose of the transistor amplifier in Fig. 11.1.

.....

.....

.....

..... [2]

(iii) Fig. 11.2 shows a pin diagram for a transistor.
Label the drawing of the transistor to identify each pin.

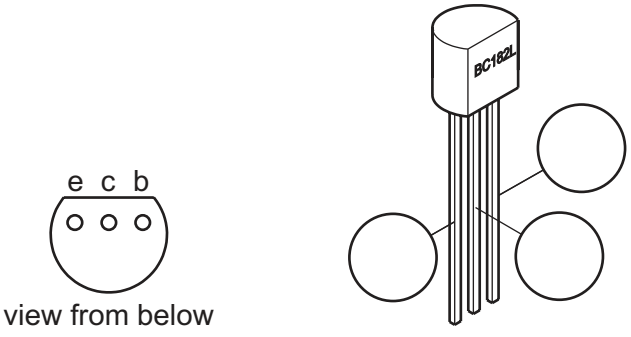


Fig. 11.2

[2]

(b) Fig. 11.3 shows a circuit for the brake lights on a car.
The brake light circuit uses 21 W filament lamps.
The lights come on when the brake pedal is pressed, operating a PTM switch.

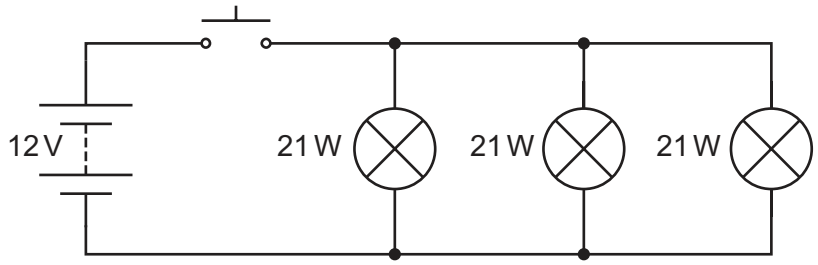


Fig. 11.3

(i) State **one** reason for using a parallel connection for the filament lamps rather than a series connection.

.....

..... [1]

(ii) Calculate the resistance in a single 21 W lamp in the circuit.

Use the formula $\frac{P}{V} = \frac{V}{R}$

.....

.....

.....

..... [3]

(iii) A SPDT relay will be used to switch the lights on.
State the meaning of SPDT.

..... [1]

(iv) Give **two** benefits of using a relay to switch on electrical items.

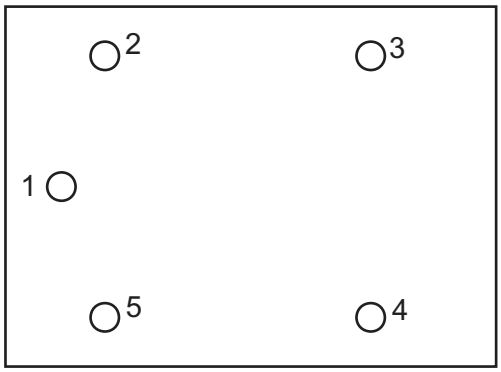
1 .....

.....

2 .....

.....
[2]

(v) Fig. 11.4 shows the relay outline and a table of test results.
The tests were carried out using a multimeter on a resistor setting, to identify each connection on the relay.
When a 12 V supply is connected across pins 2 and 5 there is 0.001 Ω resistance between pins 1 and 3.



view from below

pins	multimeter measurement
1 – 2	OL or 1
1 – 3	OL or 1
1 – 4	0.001 Ω
1 – 5	OL or 1
2 – 5	400 Ω
OL or 1 = no connection	

Fig. 11.4

Add symbols to the relay outline to show the following connections:

coil connections

common (C)

normally open (NO)

normally closed (NC). [3]

(vi) Give **one** reason why filament lamps are being replaced by LEDs in many cars.

.....

..... [1]

(c) Fig. 11.5 shows the circuit symbol for an operational amplifier (OP AMP) that will be used to compare two voltages in a circuit.

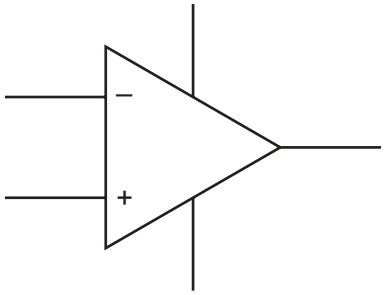


Fig. 11.5

(i) Explain how the output of the OP AMP is decided when it is used to compare two voltages.

.....

.....

.....

.....

..... [3]

(ii) Fig. 11.6 shows the outline of an OP AMP IC that will be used in a comparator circuit.

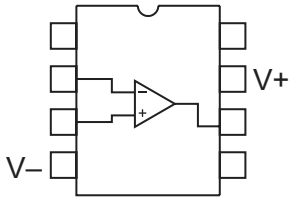


Fig. 11.6

State the pin numbers that are **not** used in the comparator circuit.

..... [3]

(d) (i) Name **one** component that can cause back emf in a circuit.

..... [1]

(ii) Use sketches and notes to show how a diode can be used in a circuit to protect against back emf.

[2]

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