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**DESIGN AND TECHNOLOGY**

**0445/42**

Paper 4 Systems and Control

**May/June 2017**

**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 **19** printed pages and **1** blank page.

**Section A**

Answer **all** questions in this section.

1 Rigid PVC is a plastic often used for the manufacture of door and window frames.

(a) Give **two** advantages of using rigid PVC as a structural material when compared to wood.

1 .....

.....

2 .....

.....

[2]

(b) Give **two** advantages of using wood as a structural material when compared to plastics.

1 .....

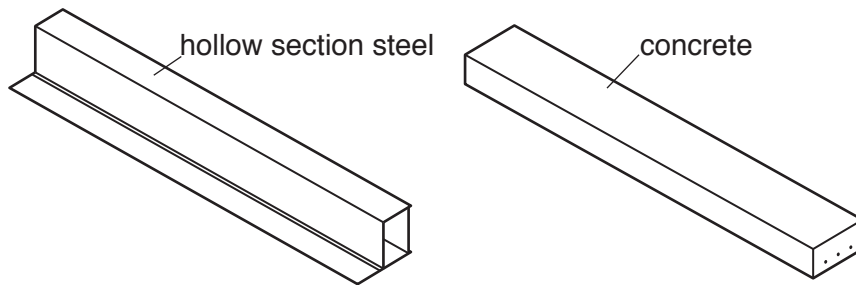
.....

2 .....

.....

[2]

2 Fig. 1 shows two different types of structural beam used to span an opening in a building.



**Fig. 1**

(a) Give **two** reasons for hollow section steel beams often being used in preference to solid concrete beams.

1 .....

.....

2 .....

.....

[2]

(b) Use sketches and notes to show what is meant by a 'laminated wooden beam'.

[2]

(c) Give **one** reason for choosing a laminated wooden beam rather than concrete or hollow section steel.

.....  
.....[1]

3 Explain, using an example, what is meant by 'mechanical advantage'.

.....  
.....  
.....  
.....[3]

4 (a) State **one** reason for using bearings in a machine.

.....[1]

(b) Bearings will normally require lubrication.  
Describe the type of lubrication most suitable for the following purposes.

Plain bearings in a car engine .....  
Ball bearings in a cycle wheel ..... [2]

(c) Nylon is often used as a material for plain bearings.  
Give **two** properties required of nylon when it is used as a bearing material.

1 .....  
2 ..... [2]

5 Printed circuit board (PCB) manufacture can involve the use of hazardous chemicals. Give **two** ways of controlling these hazards in a school workshop.

1 .....

2 .....

[2]

6 Fig. 2 shows two input transducers with their circuit symbols.

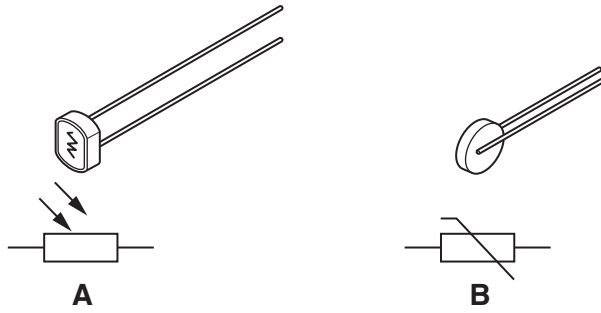


Fig. 2

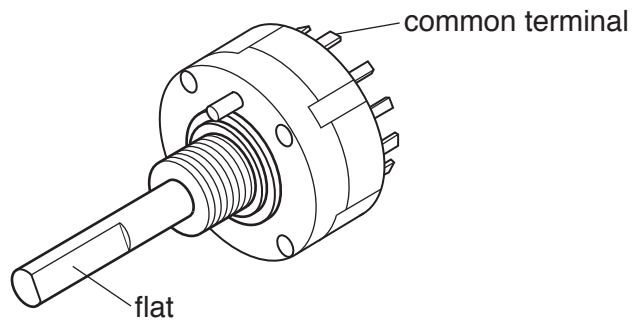
(a) State the physical property that will change in value in both transducers when they are in use.

.....[1]

(b) Explain why transducer **A** will react to changing conditions faster than transducer **B**.

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

7 Fig. 3 shows a 12-way rotary switch.



**Fig. 3**

(a) Describe the operation of a 12-way rotary switch.

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

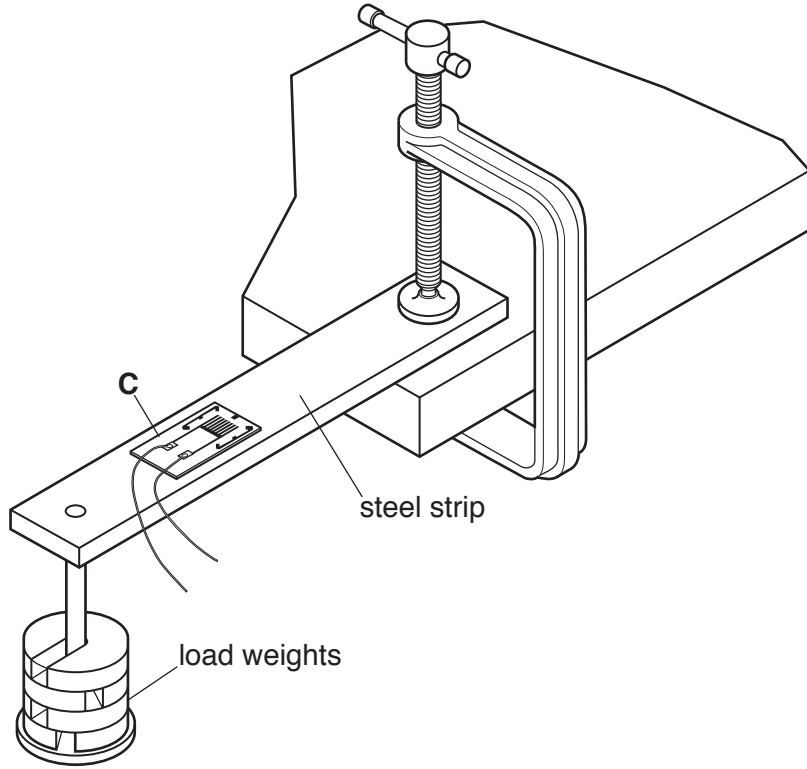
(b) State the purpose of the flat on the spindle of the rotary switch.

..... [1]

**Section B**

Answer **one** question from this section.

8 (a) Fig. 4 shows a steel strip in a test rig.



**Fig. 4**

(i) Give the name of electronic component **C**.

.....[1]

(ii) State the physical property that will change in component **C** when the load is increased.

.....[1]

(iii) Component **C** could be attached to either the top or bottom face of the steel strip. State the force being measured according to which face of the steel strip is used.

top face .....

.....

bottom face .....

.....

[2]

- (iv) Use sketches and notes to show how a non-electronic method could be used to test the amount of movement in the steel strip when a load is applied.

[3]

- (b) Fig. 5 shows packaging for a delicate electronic device. The moulded inner packaging fits inside the assembled outer. When the box is assembled no glue is used.

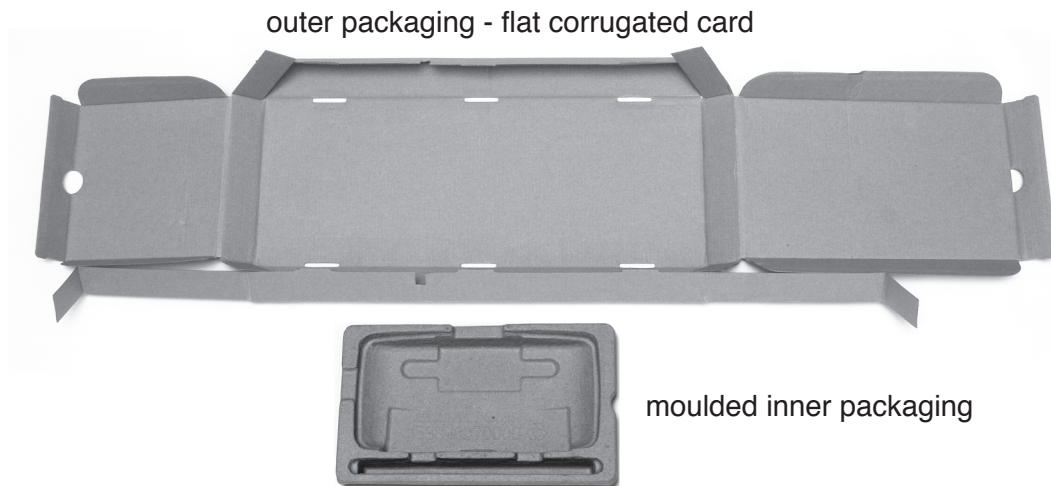


Fig. 5

- (i) Give **two** reasons why the assembled packaging provides protection to the contents when it is being transported.

1 .....

2 .....

[2]

- (ii) The card used in the construction of the outer packaging is corrugated, a shape that can also be applied to plastic or metal sheet.  
Use sketches and notes to show what is meant by the term 'corrugated'.

[2]

- (iii) Fig. 6 shows a frame for a carport. The roof is to be covered using six uncut corrugated plastic sheets  $2600\text{ mm} \times 800\text{ mm}$ .

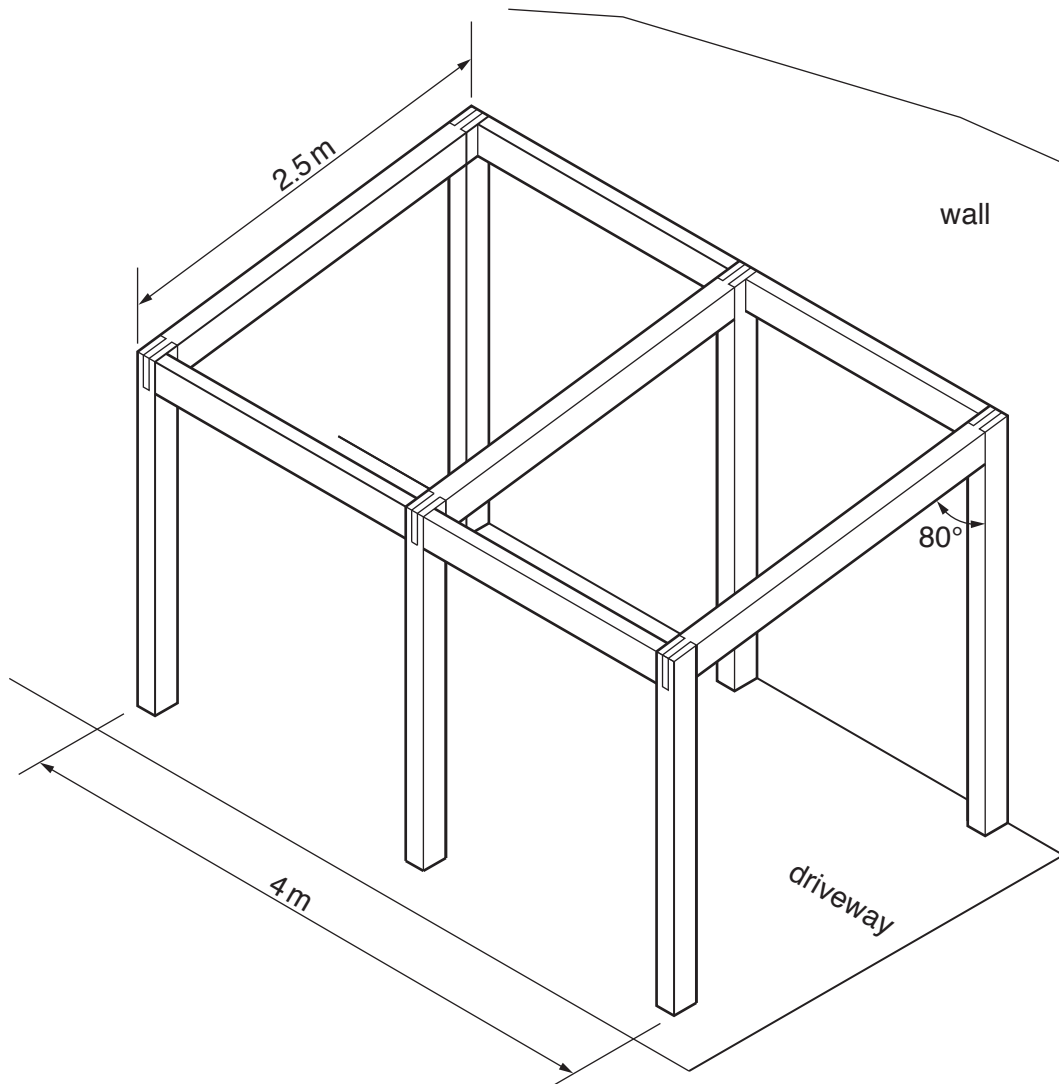


Fig. 6

Draw on Fig. 6 to show **two** of the corrugated plastic sheets correctly positioned on the roof frame. [2]



- (c) (i) Fig. 7a and Fig. 7b show two views of a beam used to support a pulley for raising loads on a building site.

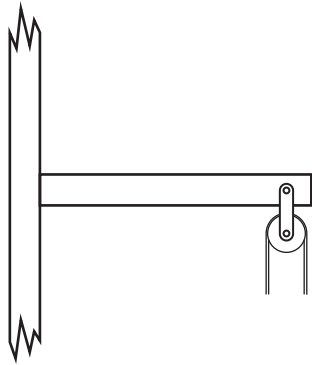


Fig. 7a

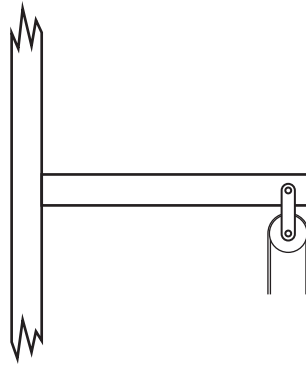


Fig. 7b

Draw the following methods of reinforcement:

- a gusset plate on Fig. 7a
- a brace on Fig. 7b

[3]

- (ii) Fig. 7c shows an alternative method of supporting the beam.

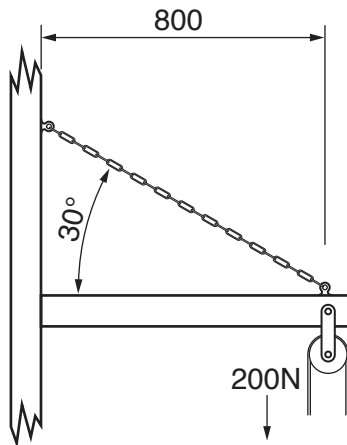
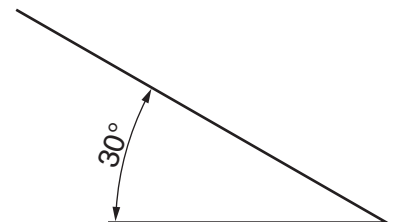


Fig. 7c

Draw a scaled force triangle in the space below to calculate the magnitude of the force acting on the chain in Fig. 7c.  
The diagram has been started for you.



Force acting on the chain ..... N

[3]

- (d) Tall garden plants will often need supporting. Use sketches and notes to show a structure supporting a plant that has reached a height of 1.5 m.

Give details of suitable materials for the structure and for any joints used.

[4]

- (e) Explain, using an example, what is meant by torsion in a structure.

.....

.....

.....

.....[2]

- 9 (a) Fig. 8 shows a cycle brake lever in the released and pulled position and the brake mechanism.

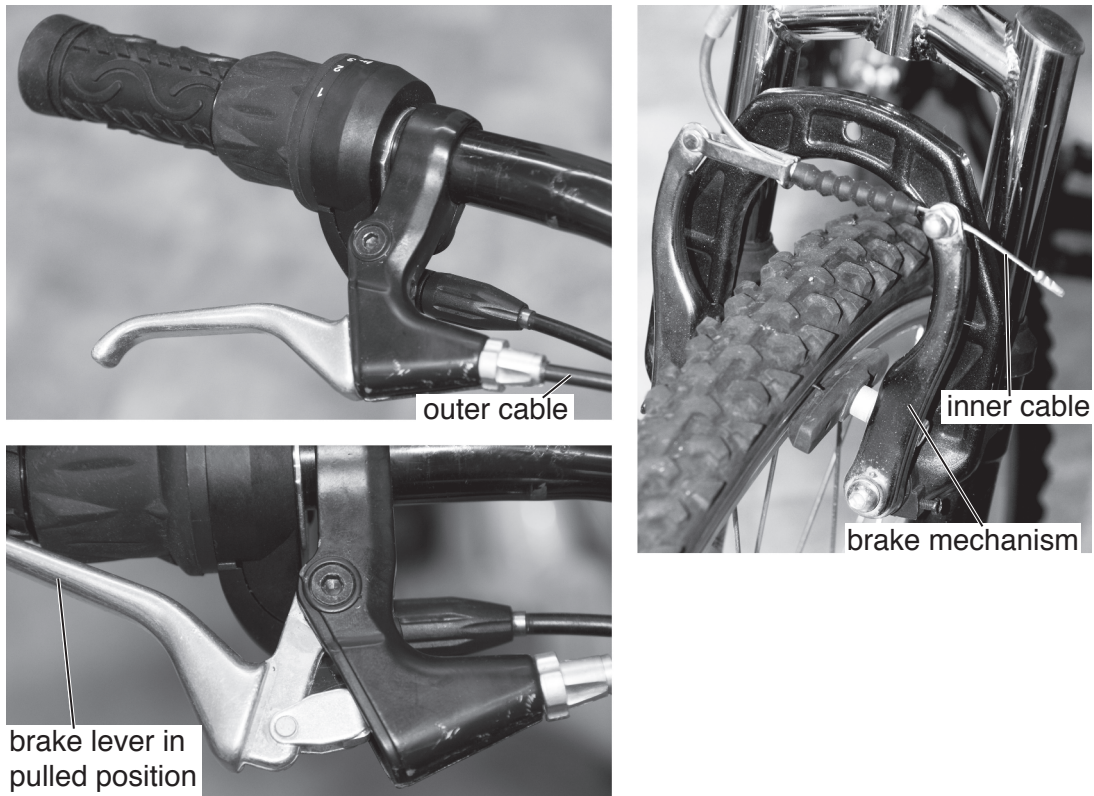


Fig. 8

- (i) State the order of lever used on the brake lever.  
.....[1]
- (ii) The brake lever and brake mechanism are connected by a cable.  
Give **two** benefits of a cable linkage.  
1 .....  
.....  
2 .....  
.....[2]
- (iii) Give **one** drawback of a cable linkage.  
.....  
.....[1]

(iv) Fig. 9 shows the dimensions of the brake lever and part of the mechanism.

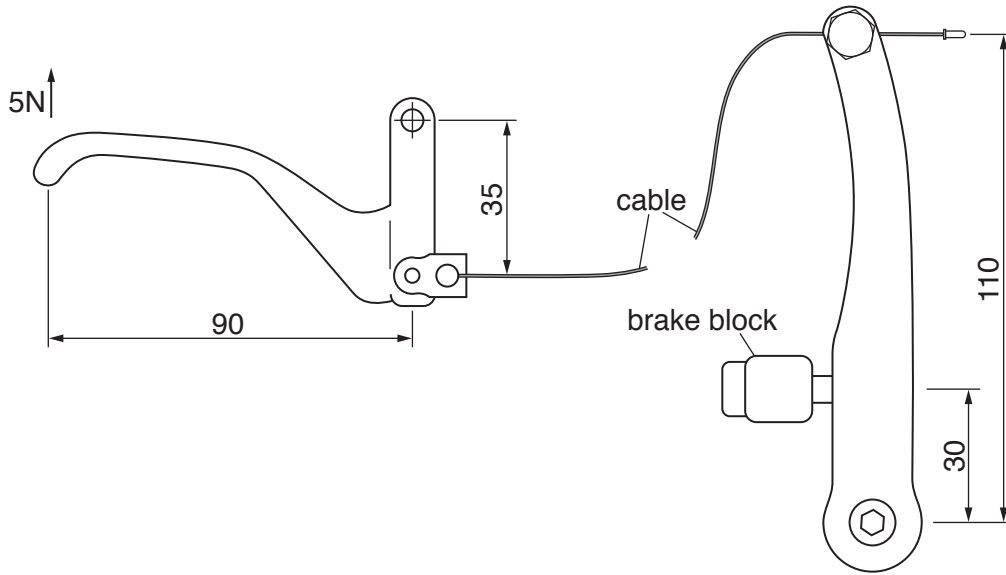


Fig. 9

Calculate the force generated at the brake block by a 5N pulling force at the end of the brake lever.

.....

.....

.....

.....

.....

.....[4]

(b) Mechanisms require energy to operate; it is often necessary to store the energy before it is used in a mechanism.

(i) Use the words below to complete the sentence about the energy conversion that takes place when a battery is used to power a mechanism.

- light      chemical      mechanical      heat      electrical      magnetic**

An electrical battery will convert stored ..... energy into  
 ..... energy which is converted by a motor into ..... energy. [3]

(ii) Give **two** examples of how energy, other than electrical energy, can be stored before it is used in a mechanism.

1 .....

2 .....

[2]

(iii) Explain, using an example, how designers can reduce the energy demand of a mechanism.

.....

.....

.....

.....

[3]

(c) (i) A ratchet and pawl mechanism will only rotate in one direction.  
Use sketches and notes to show how a ratchet and pawl mechanism works.

[3]

(ii) Name **one** other mechanism that will only rotate in one direction.

.....

[1]

(d) (i) Part of the cylinder head of an engine is shown in Fig. 10.

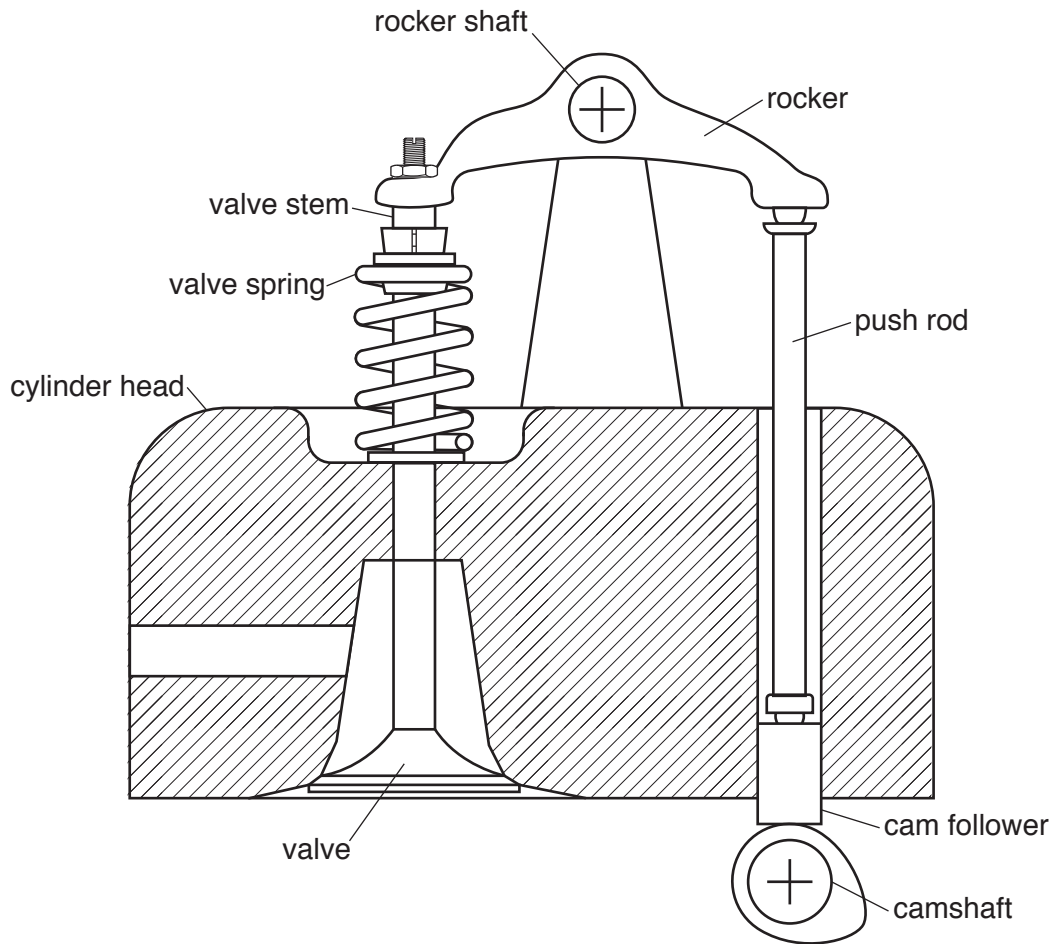


Fig. 10

The valve opens when the camshaft rotates and lifts the cam follower. Movement is transmitted through the push rod and rocker to the valve stem, opening the valve. The valve spring holds the valve closed until the cam lifts the push rod.

Give **two** ways that a designer could change the distance moved by the valve as it opens.

1 .....

.....

2 .....

.....

[2]

(ii) State the movement of the rocker as the camshaft rotates.

.....[1]

(e) Fig. 11 shows two screw threads with the same outside diameter.

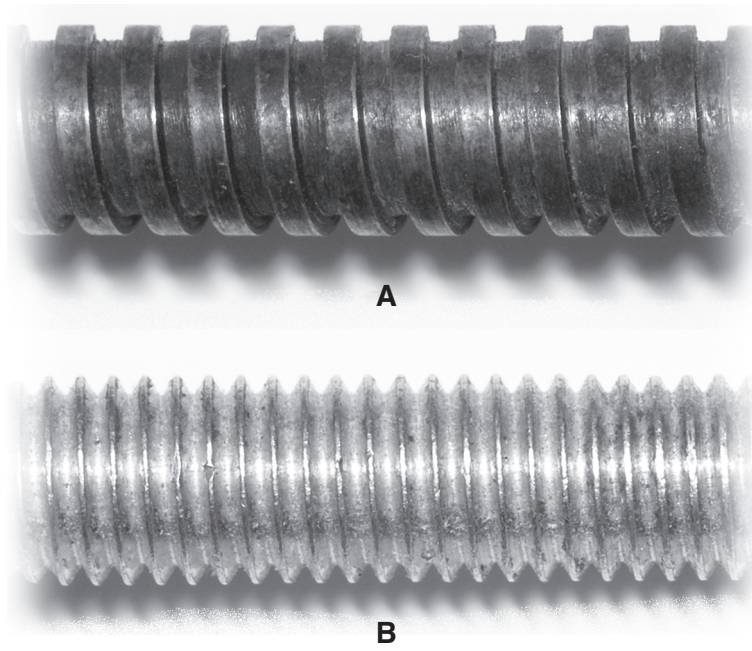


Fig. 11

(i) State **one** difference between the screw threads.

.....[1]

(ii) Give **one** effect that will be noticed when using thread **B** compared to thread **A**.

.....  
.....[1]

10 (a) Fig. 12 shows four different types of switch.

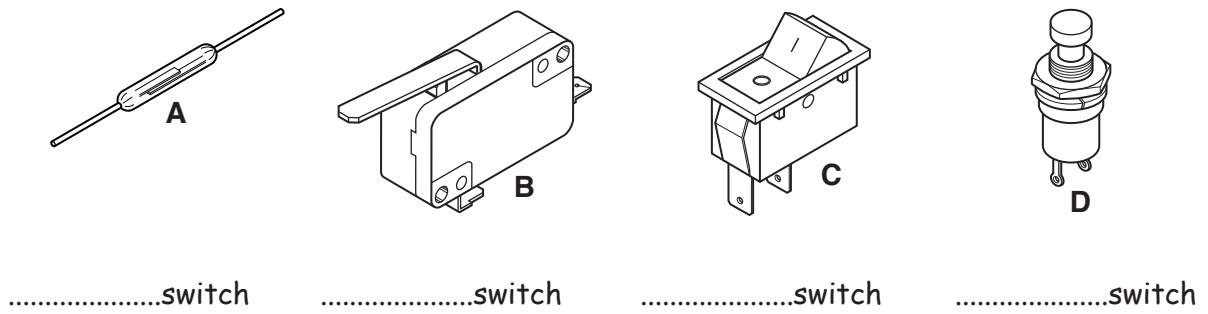


Fig. 12

(i) Complete the labels on Fig. 12 to identify the types of switch. [4]

(ii) Name the component that is used to operate switch A.

.....[1]

(iii) Fig. 13 shows a DPDT slide switch with information about the contacts.

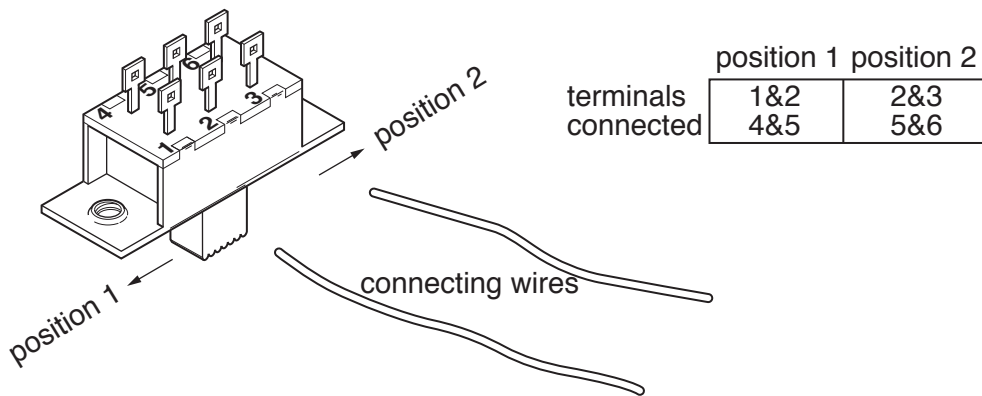


Fig. 13

Draw on Fig. 13 to show the connections that will allow the switch to operate as a single pole single throw (SPST) switch. [2]

(iv) State the numbers of the two common terminals.

.....[2]



(b) Fig. 14 shows a touch pad sensor circuit used to operate a motor.

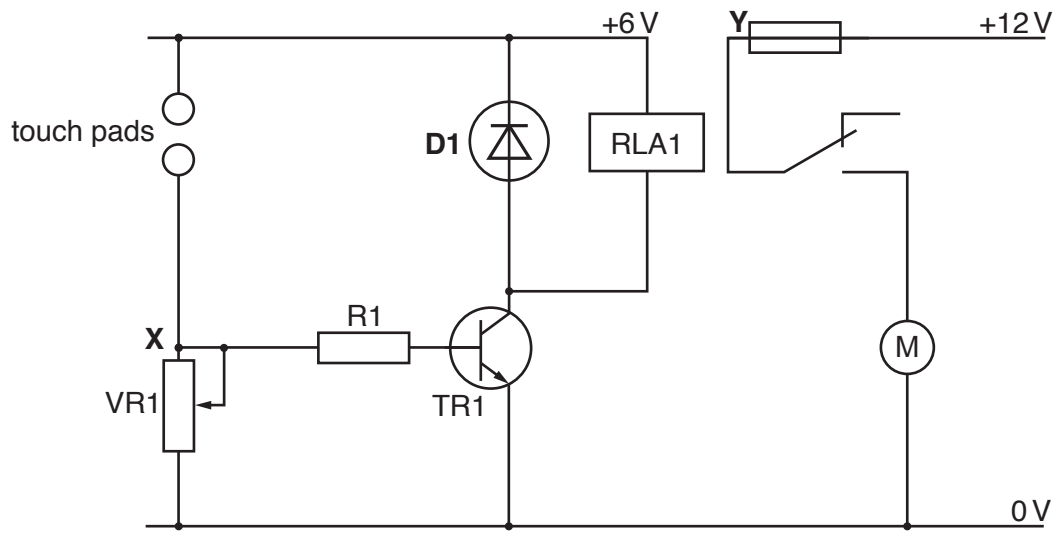


Fig. 14

(i) Give **two** reasons for using a relay to switch the motor on and off.

- 1 .....
- .....
- 2 .....
- .....

[2]

(ii) Fig. 15 shows component **D1**.

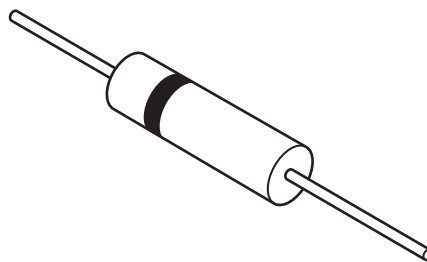


Fig. 15

Explain why component **D1** is included in the circuit.

- .....
- .....
- .....
- .....

[2]

- (iii) To operate the motor the voltage at point **X** must be at least +0.6 V.  
Explain how the transistor **TR1** will use that voltage to power the relay.

.....  
 .....  
 .....  
 ..... [3]

- (iv) The power rating of the motor is 100 W.  
Calculate the maximum current in the motor circuit.  
Use the formula  $P = V \times I$ .

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

- (v) Choose a suitable relay for the motor circuit from the table below.

|                     |                     |                      |                      |                       |
|---------------------|---------------------|----------------------|----------------------|-----------------------|
| SPDT 6A<br>6 V coil | DPDT 6A<br>6 V coil | DPDT 6A<br>12 V coil | SPDT 10A<br>6 V coil | DPDT 16A<br>12 V coil |
|---------------------|---------------------|----------------------|----------------------|-----------------------|

..... [1]

- (vi) Give the name of component **Y** in Fig. 14.

..... [1]

- (c) (i) Fig. 16 shows a circuit diagram and the start of a PCB layout for an LED lamp that uses two LEDs in series.

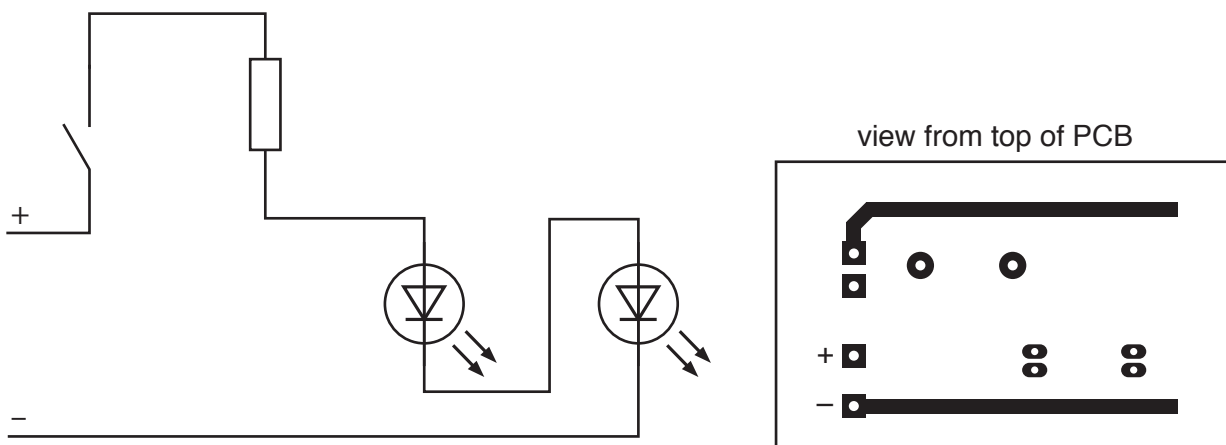


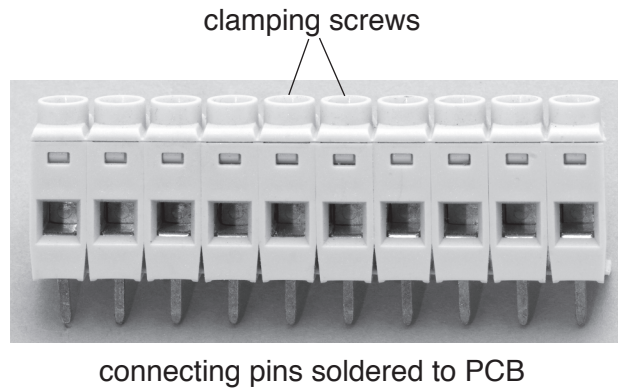
Fig. 16

Add the following to the PCB layout:

- Tracks for the LEDs and resistor
- Track for the on/off switch

[3]

- (ii) Fig. 17 shows a terminal block that could be used to connect the battery and switch to the PCB.



**Fig. 17**

Explain why a terminal block may be better than soldering direct to a circuit board.

.....

.....

.....[2]

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