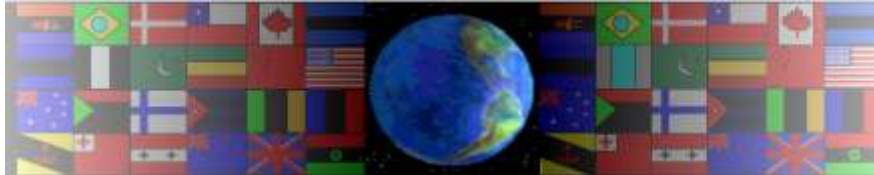


SYSTEMS AND CONTROL REVISION

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On behalf of The World Association of Technology Teachers

W.A.T.T.



World Association of Technology Teachers

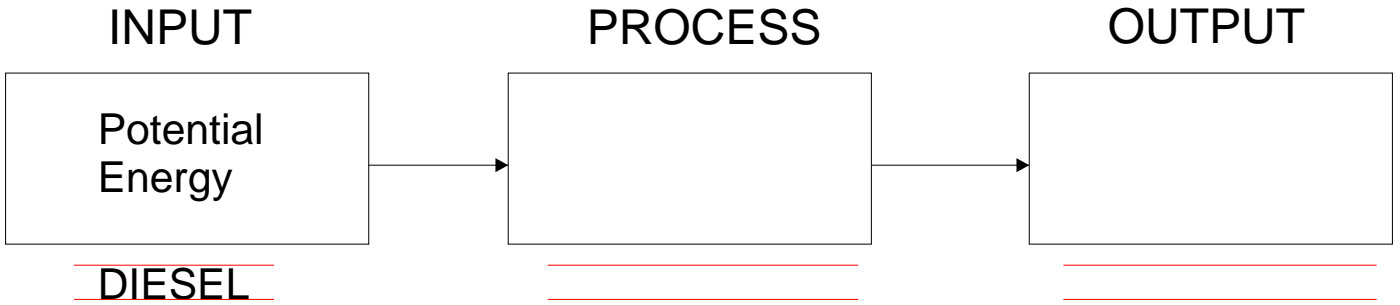
This exercise can be printed and used by teachers and students. It is recommended that you view the website (www.technologystudent.com) before attempting the design sheet .

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SYSTEMS PREPARATION 2007 - QUESTIONS

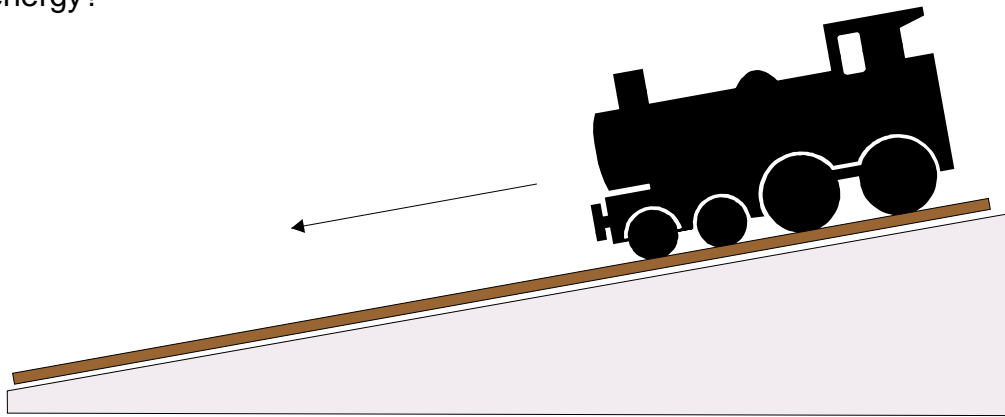
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1. Diesel trains are used throughout the country. They use diesel as a fuel for engines which drive the train forwards at high speed, creating movement. Complete the systems diagram below to show the main energy changes.



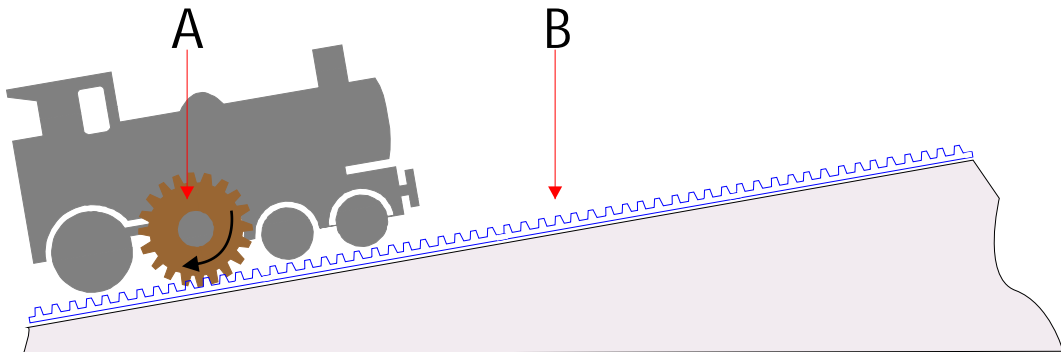
2. What is Kinetic Energy ?

3. The train seen below is at the top of an incline. At any point it could roll downwards, gathering speed. What is potential energy?



Potential energy is: _____

4. The train at the bottom of the steep incline has a special gear system. On the diagram the gear system is marked A and B. What are the correct names for parts A and B ?



PART A: _____

PART B: _____

SYSTEMS PREPARATION 2007 - QUESTIONS

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5. Explain why the gear system shown above is used where there are speed inclines.

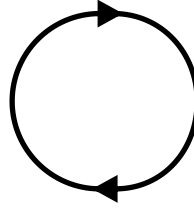
6. Motion involves movement of some kind. Four types of movement are listed below. Label the diagrams that represent motion with the correct name.

LINEAR

ROTARY

OSCILLATING

RECIPROCATING



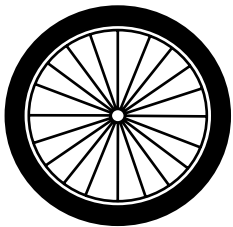
7. The items listed below all involve movement. Label each diagram with the correct type of movement

A.

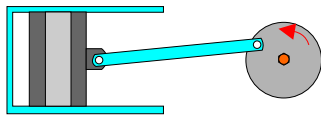
B.

C.

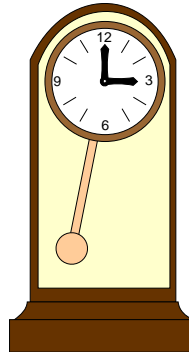
D.



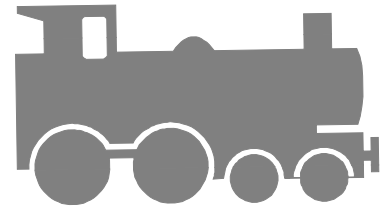
BICYCLE WHEEL



PISTON

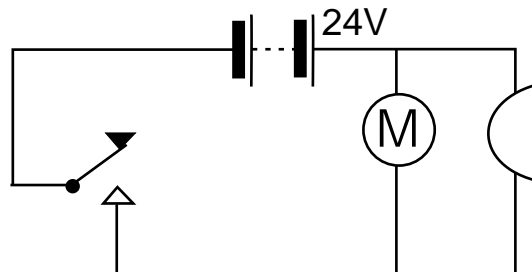
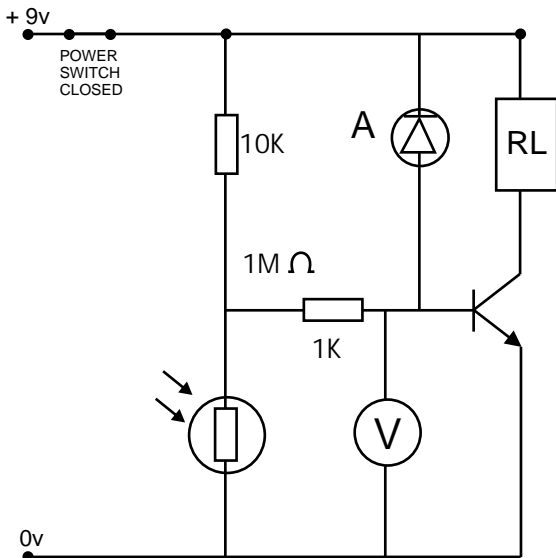


PENDULUM CLOCK



LOCOMOTIVE

8. The sensor circuit seen below is used to sense the movement of model trains. It is normally positioned before a model railway station. When a train is arriving the sensor detects a drop in the light level and a motor changes the signal and sounds a buzzer



A. Why has the circuits designer used a relay ?

SYSTEMS PREPARATION 2007 - QUESTIONS

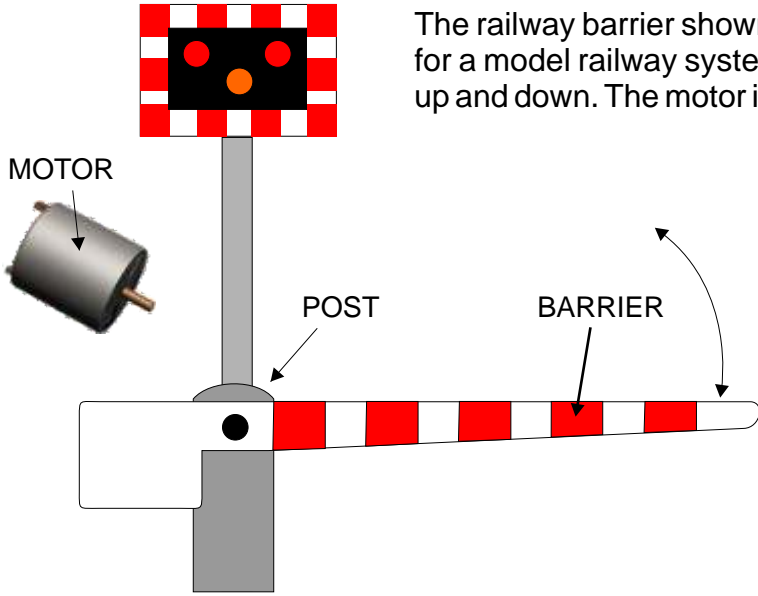
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8b. Name the component labelled 'A' and explain why its function.

NAME: _____

FUNCTION: _____

8c. What happens to reading on the voltmeter when a train passes the sensor ?



The railway barrier shown below has been designed and manufactured for a model railway system. The motor inside the post drives the barrier up and down. The motor is the output to a 555 timer circuit.

There are two types of 555 timer. What is the name of the 555 circuit shown below?

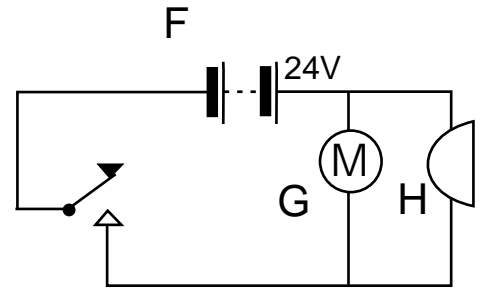
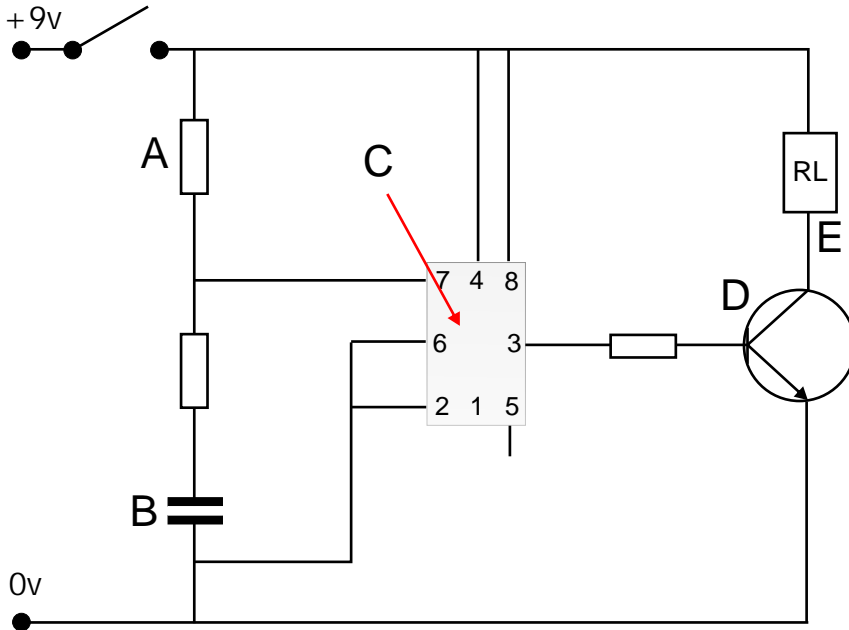
CIRCUIT NAME: _____

Label the components on the circuit diagram below (A TO G).

A: _____ B: _____ C: _____

D: _____ E: _____ F: _____

G: _____ H: _____

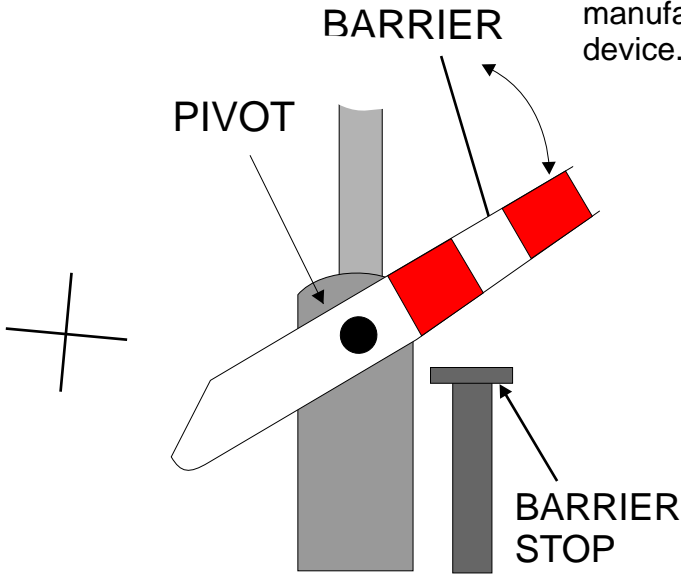


The relay is causing major problems because an important component is missing. Name the component and draw its symbol in the correct position on the circuit diagram above.

COMPONENT NAME: _____

What is the function of the component ?

A second version of the railway barrier has been manufactured. This is mechanically operated by a rotating device.



What is the function of the pivot ?

Draw the mechanical device on the diagram opposite.

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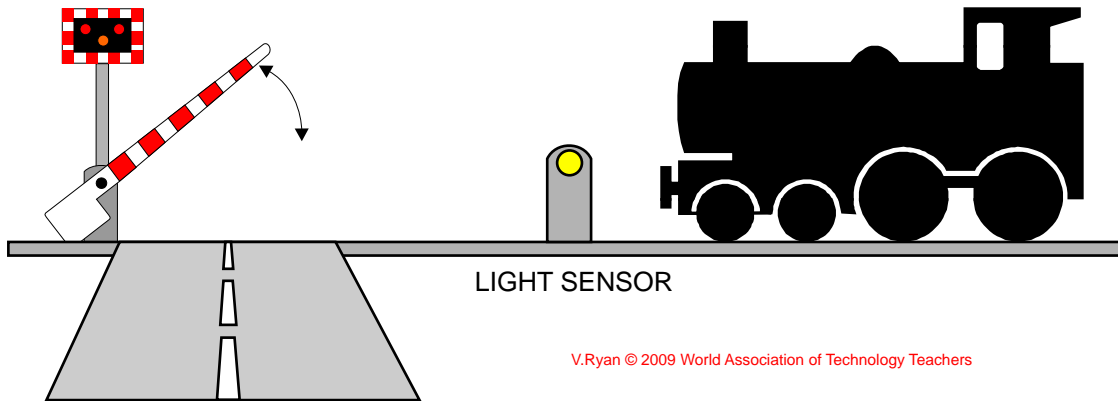
Name the device and explain how it works.

NAME: _____

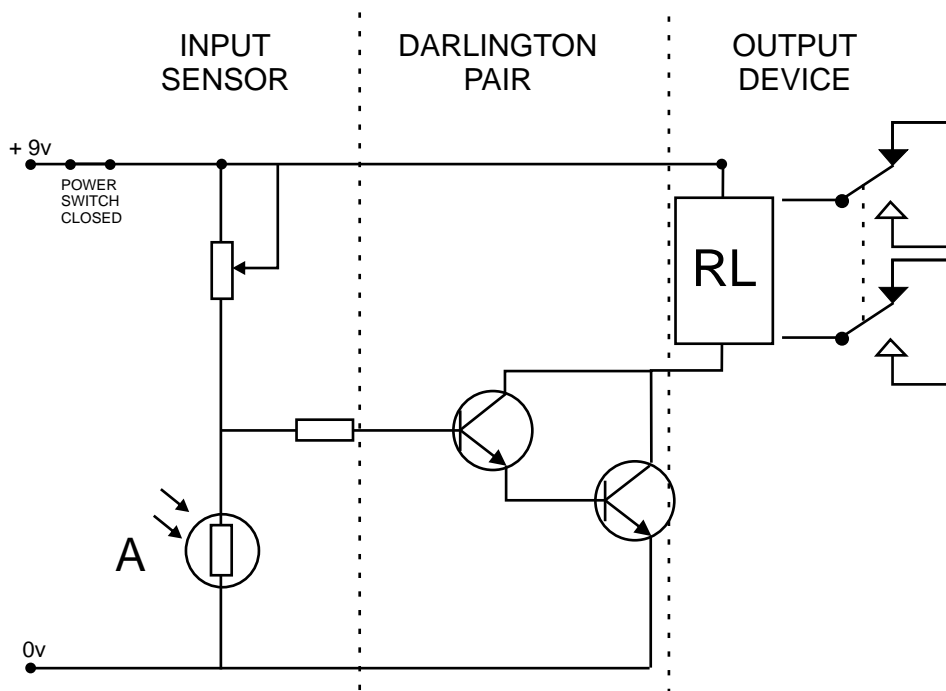
HOW IT WORKS: _____

What is the function of the barrier stop ?

As part of a GCSE project a student has designed a barrier system for a crossing. The specification drawn up by the student says - As a train approaches the crossing it breaks a light beam and the barrier is lowered, stopping cars and pedestrians. When the train has passed, the barrier should lift allowing cars and pedestrians to cross the railway line safely.



The student's prototype control circuit can be seen below.



Name component 'A'.

Give one reason why the circuit shown above will not meet the specification.

Write a modification that would solve the problem with the specification

Why is a darlington pair positioned between the sensor and the relay?

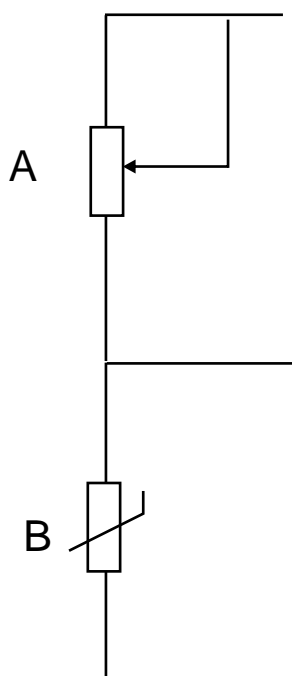
A railway track has sets of points that allow trains to transfer from one track to another. This allows them to change direction. However, in winter points can freeze and this is extremely dangerous as a train can be easily derailed.

The block / systems diagram shows how a heating system works. This warms up points in freezing weather ensuring that they operate safely.



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The ice sensing part of the circuit is shown below.

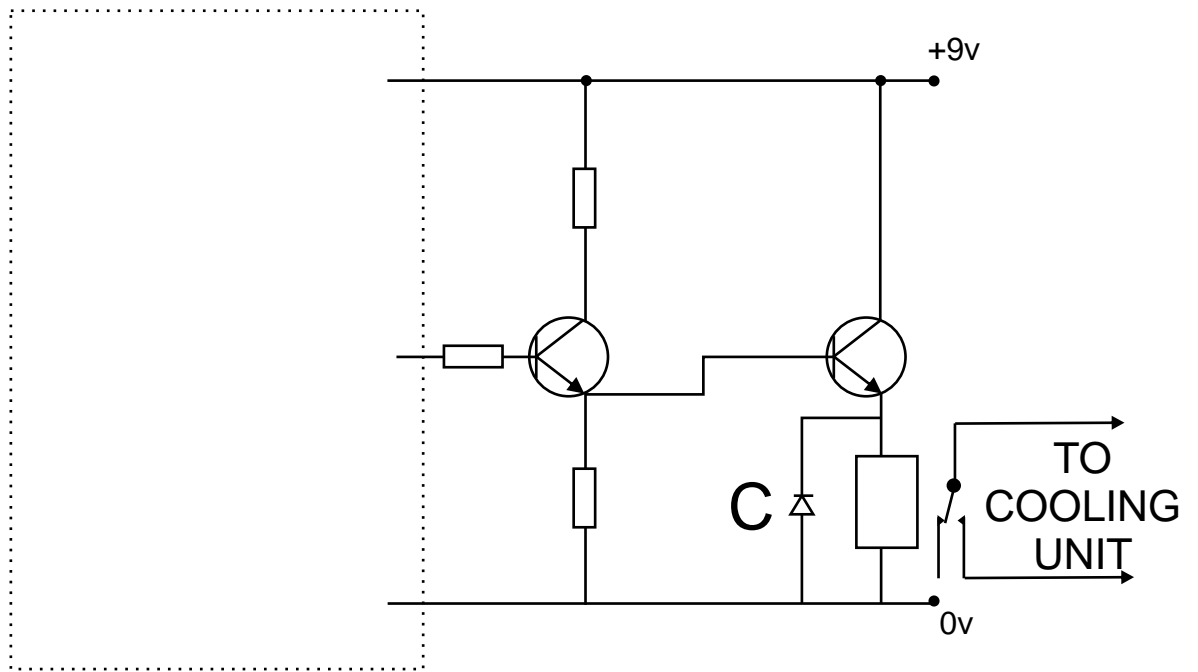


Which component acts as a sensor in this circuit ?

What does the component sense ?

Which component is used to adjust sensitivity of the circuit ?

The ice sensing circuit shown above can be altered to sense heat. In the summer the points can expand due to extreme heat. This can also be dangerous. To counter this problem a cooling unit is to be fitted to the points. Complete the next circuit by adding the heat sensor.



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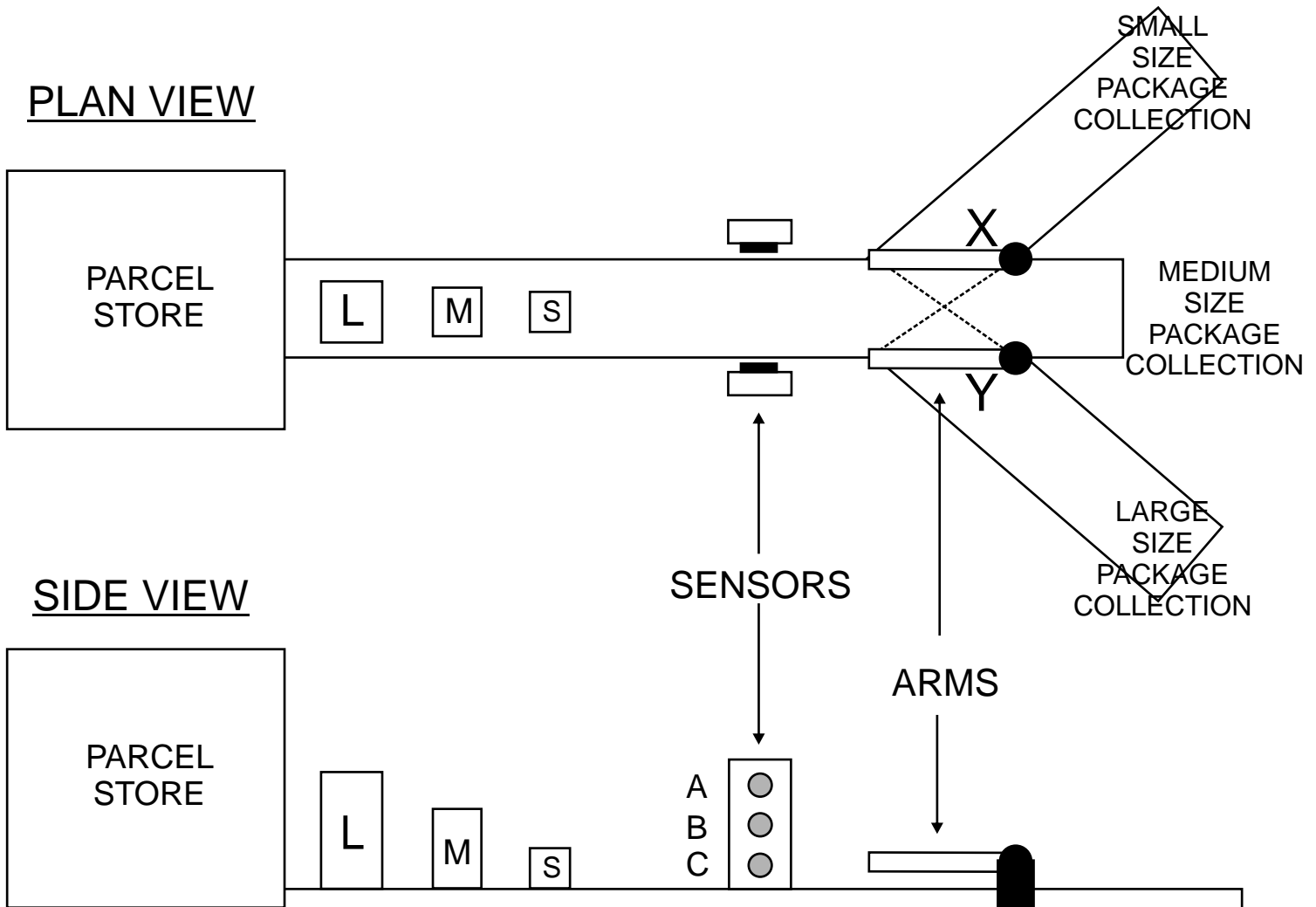
What is the name of component C shown in the heat sensing circuit above?

Name of component C: _____

What is its function ?

The diagrams below shows the plan view and front view of an automatic sorting system. This sorts large, medium and small packages so that they can be collected and placed in the correct carriage of a train, for distribution to customers.

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The sensors detect the size of each package and are connected to two control circuits. One circuit controls arm X and the other arm Y. If the output of either of the control circuits is high (logic 1) then the appropriate arm will swing to the position of the dotted line.

A. Complete the truth table below to show the logic states of the three sensors that would give the correct outputs. The sensors provide a 'high' (logic 1) if they detect a package and a 'low' (logic 0) if no package is detected.

	SENSOR			ARM	
	A	B	C	X	Y
SMALL					
MEDIUM					
LARGE					

Part of each control circuit is composed of AND gates.

In the space below draw a diagram that represents an AND gate. Also, complete the truth table (opposite) for a two input AND gate.

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Inputs		Outputs
A	B	Q

Draw a circuit diagram to show how two of these gates could be used to control arm 'Y'

The inputs from sensors A, B and C are already drawn along with the output - arm 'Y'

SENSOR A _____

SENSOR B _____

SENSOR C _____

_____ ARM 'Y'

The control system has been found to be unreliable. It has been modified by using sensors which give logic 0 when they detect a package and logic 1 for NO package.

What type of gate could be added to your circuit (drawn above) to allow for this change?

Draw the modified circuit in the space below

SENSOR A _____

SENSOR B _____

SENSOR C _____

_____ ARM 'Y'

Suggest a more cost effective modification to the one shown above.

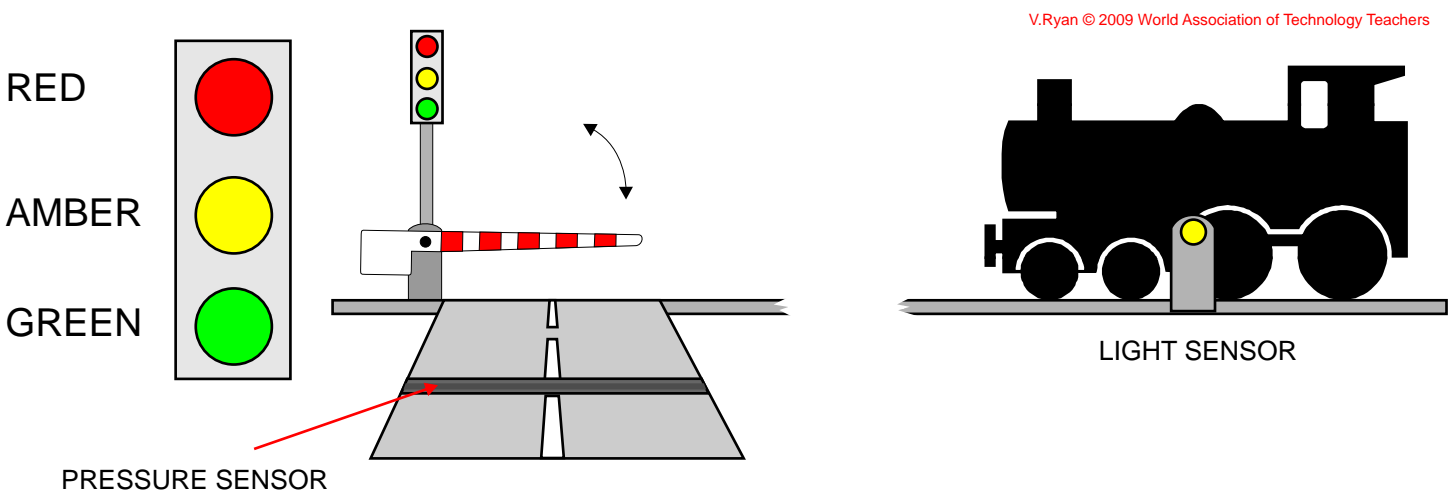
A technology student has developed an automatic traffic control system for a level crossing.

A pressure sensor detects when a car passes over it. The sensor is connected to INPUT 1 of the control system.

A light sensor detects the presence of a train close to the crossing. The light sensor is connected to INPUT 2 of the control system.

When a car is detected the control system checks if a train has passed the light sensor. Then the traffic lights run through a sequence of changes, eventually changing the lights from red to green, raising the barrier and allowing the car to cross the railway line safely.

If a train is present the traffic lights stay on red and the barrier stays lowered / closed.

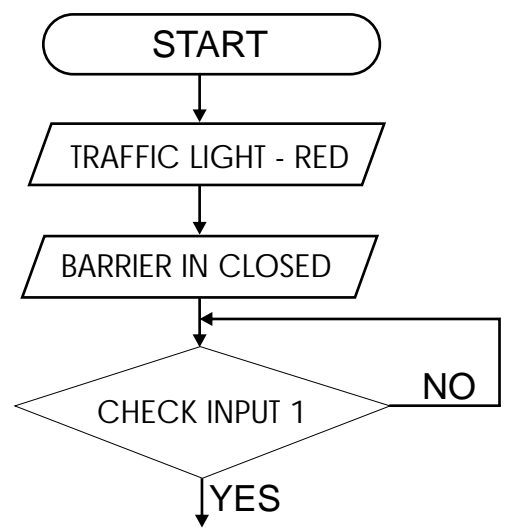
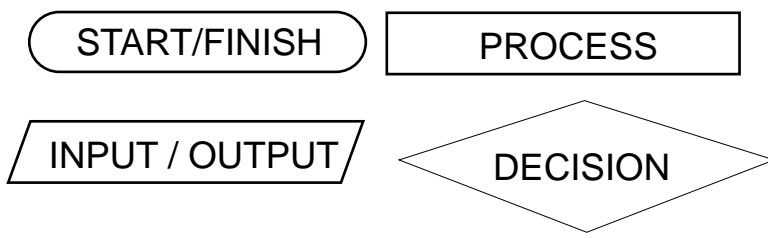


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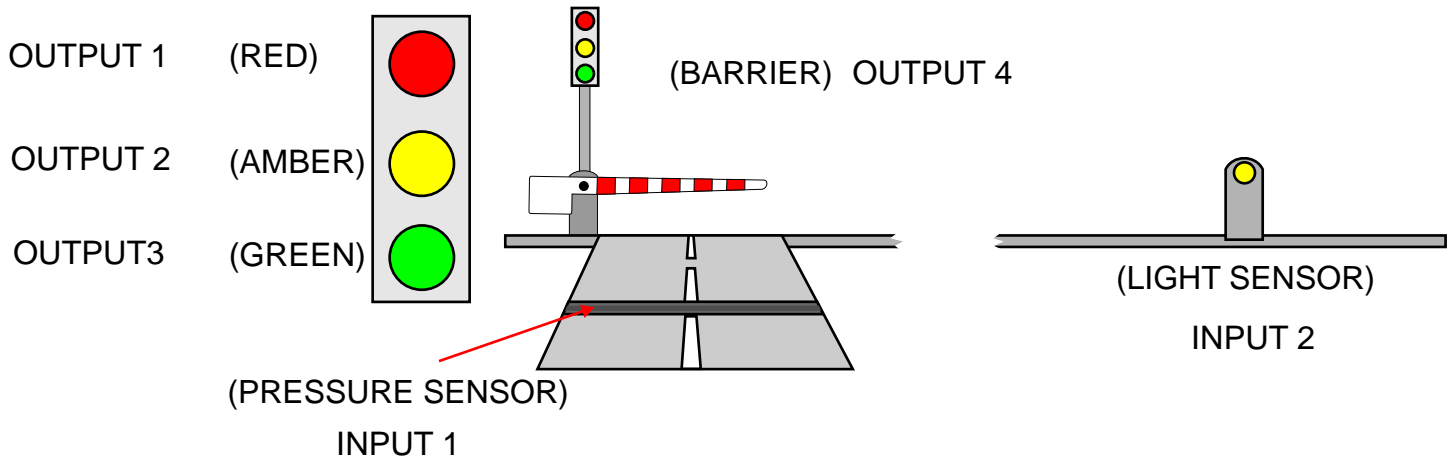
The sequence of events are listed below. However, they are in the wrong order. Write the correct sequence of events in the available space. The first three stages have been completed.

TRAFFIC LIGHTS - AMBER OFF	TRAFFIC LIGHT - RED
BARRIER IN CLOSED POSITION	BARRIER IN CLOSED POSITION
CHECK INPUT 2	CHECK INPUT 1
TRAFFIC LIGHTS GREEN ON	_____
TRAFFIC LIGHTS - AMBER AND RED ON	_____
WAIT 5 SECONDS	_____
TRAFFIC LIGHTS RED + AMBER ON	_____
CHECK INPUT 1	_____
BARRIER OPENS	_____
WAIT 5 SECONDS	_____
TRAFFIC LIGHTS - GREEN OFF	_____
BARRIER LOWERED.	_____
TRAFFIC LIGHTS - AMBER ON	_____
WAIT FIVE SECONDS	_____
WAIT 60 SECONDS	_____
TRAFFIC LIGHTS - RED + AMBER OFF	_____
TRAFFIC LIGHT - RED	_____

Convert your sequence into a flow chart using the boxes also shown below. The first four stages have been completed for you.



The traffic control system shown below has INPUTS and OUTPUTS. Each input and output has a number - these are listed on the diagram below.



Write the control sequence for the following sequence of events: Please note, when the barrier is raised/open it is 'ON'. When the barrier is lowered/closed it is 'OFF'. The first five stages have already been completed.

TRAFFIC LIGHT - RED
 BARRIER IN CLOSED POSITION
 INPUT 1 AND INPUT 2 OFF
 TRAFFIC LIGHTS RED + AMBER ON
 WAIT 5 SECONDS
 TRAFFIC LIGHTS - RED + AMBER OFF
 TRAFFIC LIGHTS GREEN ON
 BARRIER OPENS
 WAIT 60 SECONDS
 TRAFFIC LIGHTS - GREEN OFF
 TRAFFIC LIGHTS - AMBER ON
 WAIT FIVE SECONDS
 TRAFFIC LIGHTS - AMBER AND RED ON
 WAIT 5 SECONDS
 TRAFFIC LIGHTS - AMBER OFF
 BARRIER LOWERED.

OUTPUT 1 ON

 OUTPUT 4 OFF

 IF INPUT 1 OFF AND OUTPUT 2 OFF

 OUTPUT 1 AND OUTPUT 2 ON

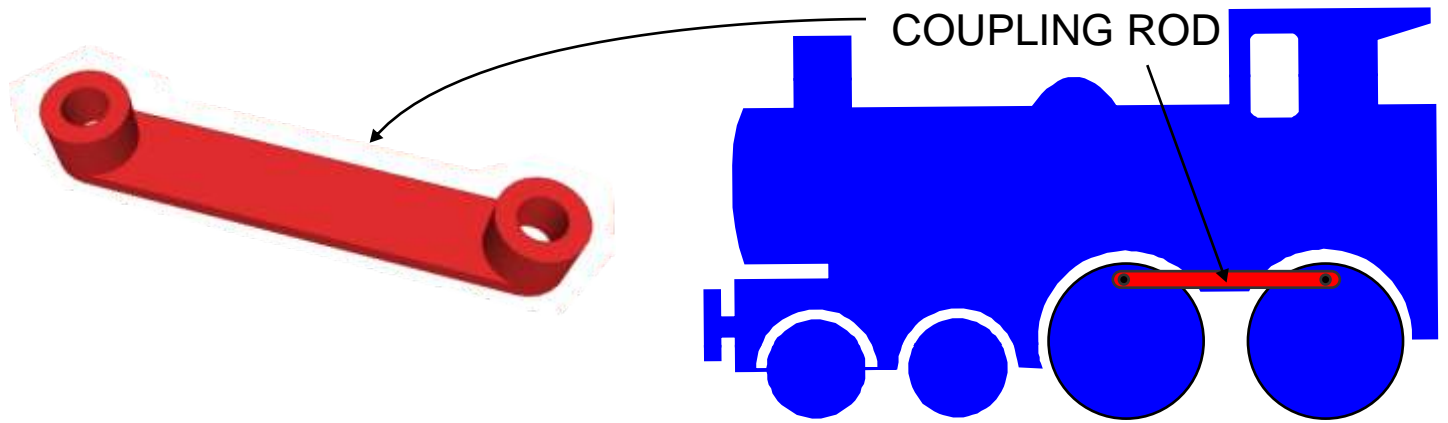
 WAIT 5

Suggest two improvements to the traffic control system shown in the diagram above.

1. _____

2. _____

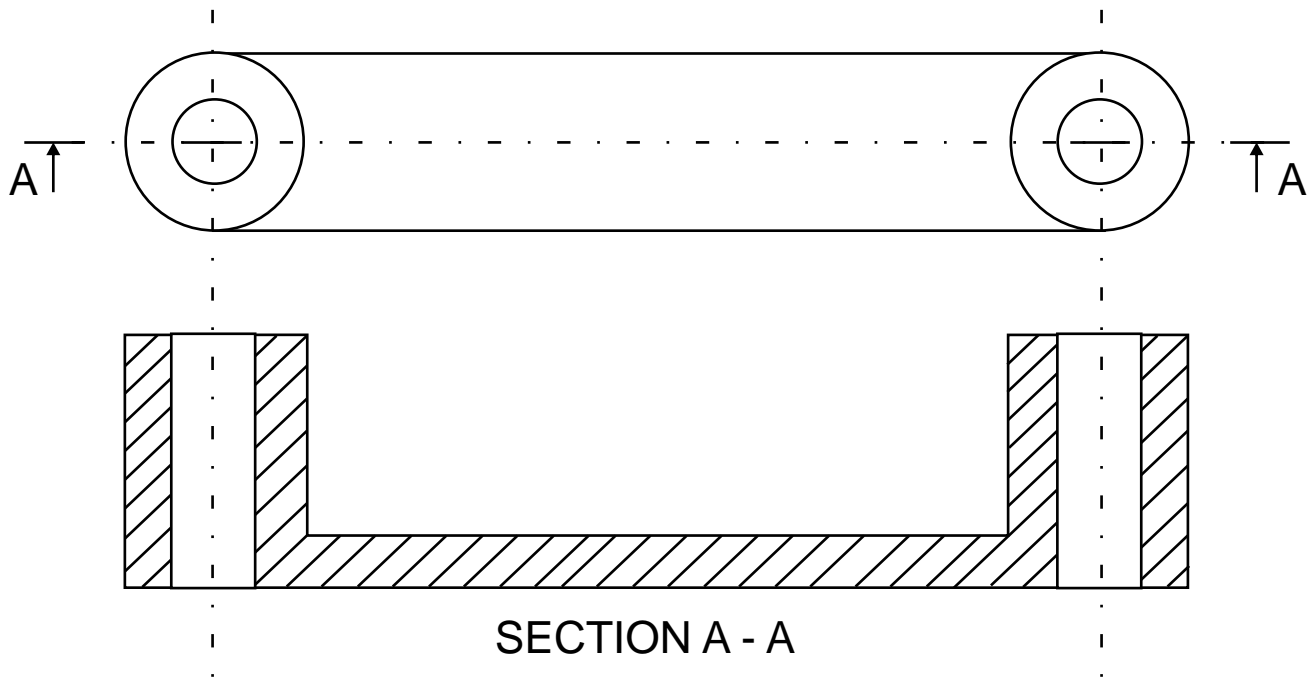
The toy train shown below has been manufactured using a plastic called HDPE High Density Polyethylene. The coupling rod is of great importance as it is linked to both of the main wheels.



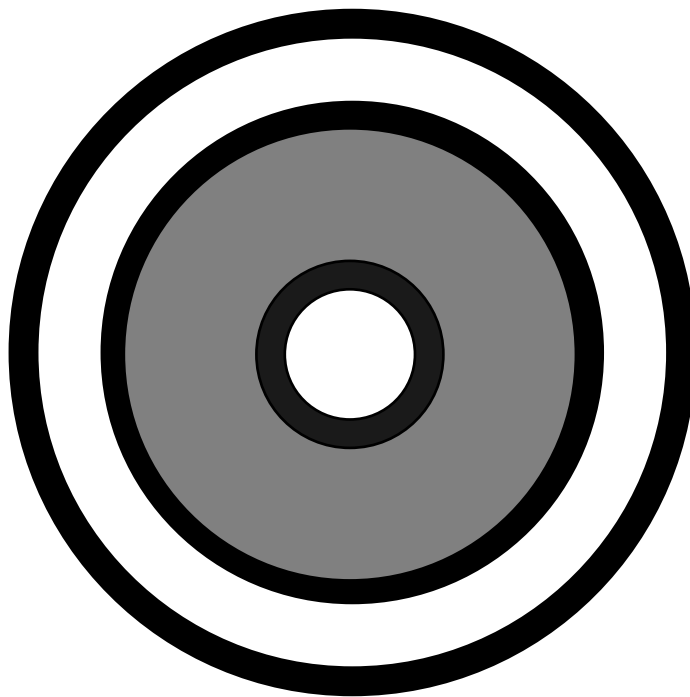
The manufacturing process is called injection moulding. In the space below draw a labelled sketch showing this process. Add explanatory notes.

NOTES

An orthographic drawing of the coupling rod is shown below. There is a potential weakness to the design. Alter the design to show a method of strengthening the coupling. Include a label.



Coupling rods often wear out quickly if bearings are not used to the smooth movement of moving parts. Complete the drawing of the roller bearing shown below.



Underline two of the following materials that are regarded as bearing materials (materials that do not produce much friction when their surfaces 'rub' against other materials).

STEEL

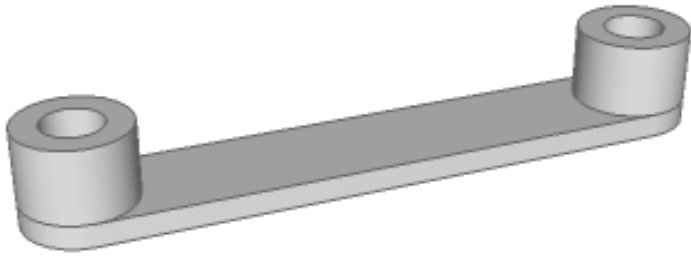
BRASS

NYLON

PINE

IRON

CONCRETE



It has been decided that the plastic being used for the coupling wears out too quickly.

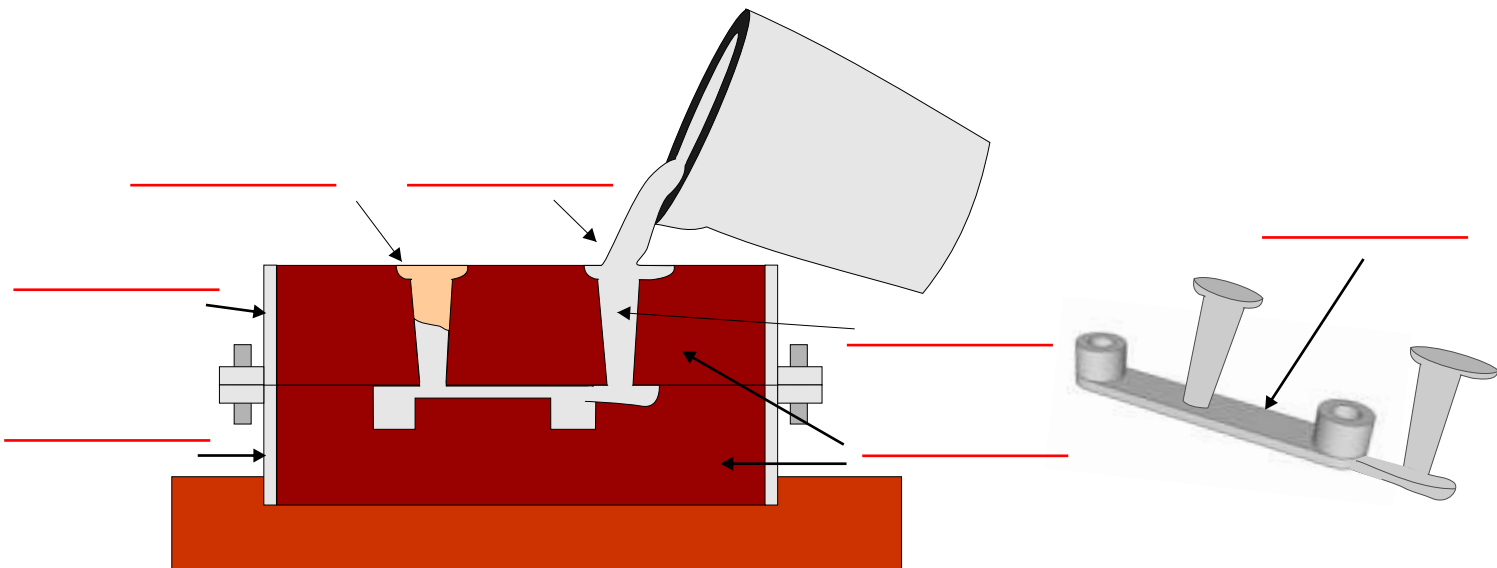
Write two advantages of using aluminium:

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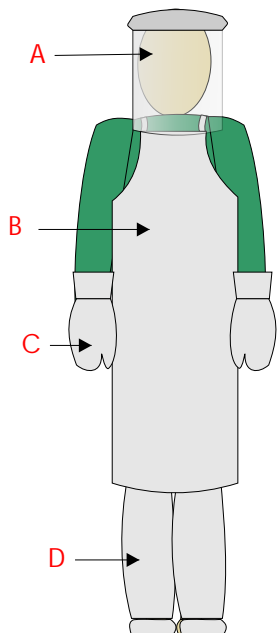
ADVANTAGE ONE: _____

ADVANTAGE ONE: _____

A manufacturing process called casting is to be used to make the new coupling. Complete the diagram of casting shown below by adding appropriate labels.



When casting it is extremely important to wear the correct safety equipment shown on the diagram below. Name each piece of equipment and explain why each is necessary.



NAME A: _____

EXPLANATION: _____

NAME B: _____

EXPLANATION: _____

NAME C: _____

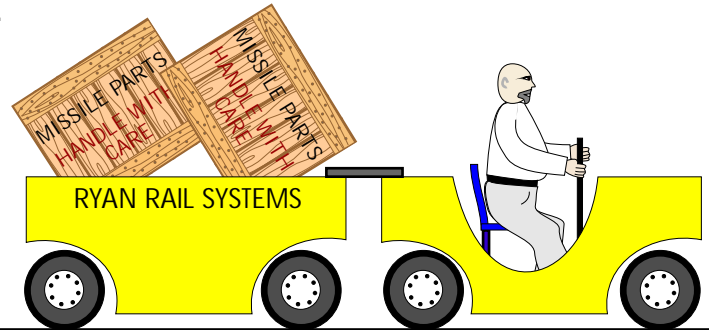
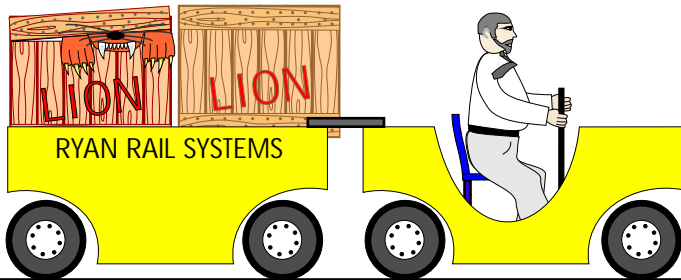
EXPLANATION: _____

NAME D: _____

EXPLANATION: _____

At a railway stock yard everyday goods are moved from one train to another by porters driving small electric trains. These are charged up over night and used during the day time. The trains rely on geared systems to propel them along at speeds exceeding fifteen mph. It has been decided to change the gear system in each of the trains to reduce the speed to ten mph. The old and new replacement gear systems are shown below.

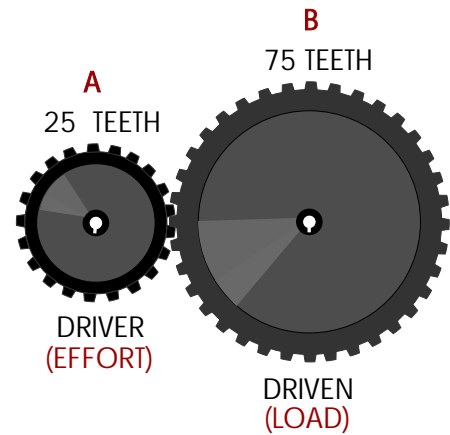
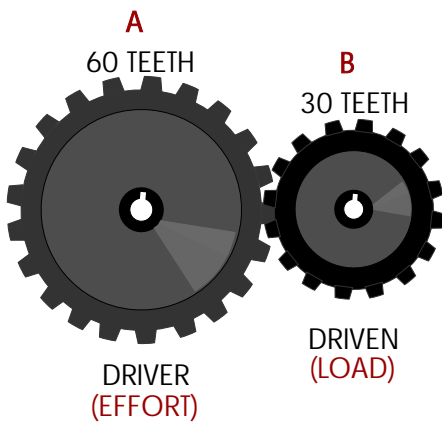
Work out the gear ratio and rpm of gear 'B' for each system.



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OLD GEAR SYSTEM

NEW GEAR SYSTEM



GEAR RATIO / VELOCITY RATIO

GEAR RATIO / VELOCITY RATIO

$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\quad}{\quad}$$

$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\quad}{\quad}$$

$$= \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \frac{\text{Input movement}}{\text{Output movement}}$$

$$= \frac{\text{Driver : Driven}}{\text{RPM}}$$

$$= \frac{\text{Driver : Driven}}{\text{RPM}}$$

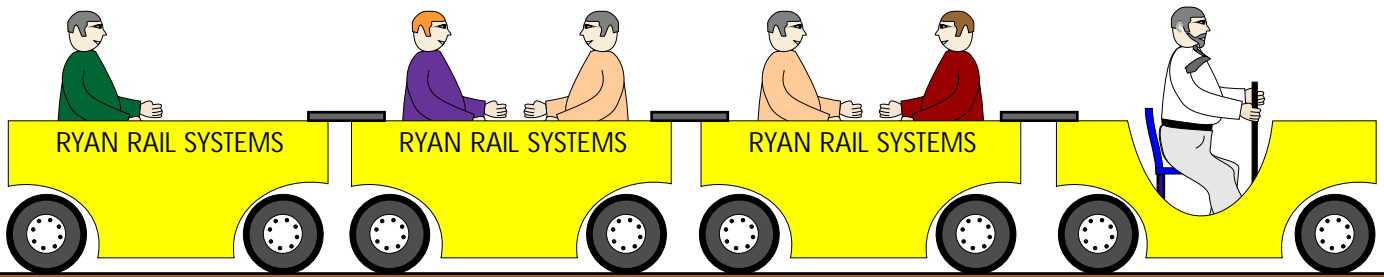
GEAR A	GEAR B
60 teeth	30 teeth
120 rpm	

GEAR A	GEAR B
25 teeth	75 teeth
60 rpm	

$$= \frac{\quad}{\quad} = \text{revs/min}$$

$$= \frac{\quad}{\quad} = \text{revs/min}$$

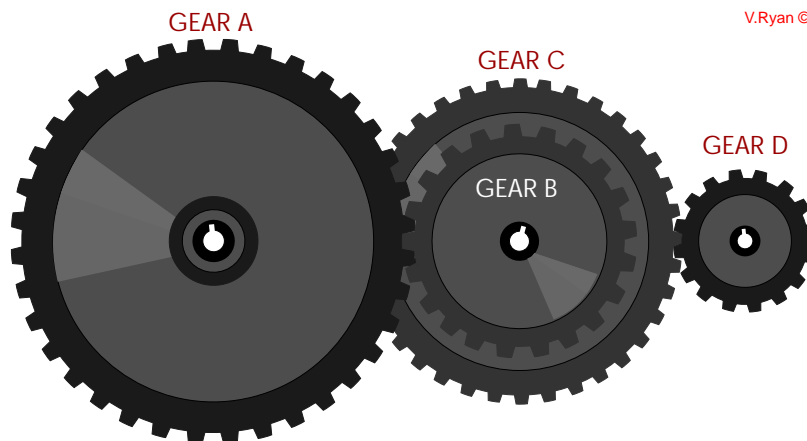
A new gear system has been designed as part of the power transmission system for a electric train. This will be used to ferry passengers and their baggage from platform to platform.



The gear system is shown below. What is the name of this type of gear system?

NAME: _____

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Gear A rotates in a clockwise direction at 30 revs/min. What is the output in revs/min at D and what is the direction of rotation ?

GEAR A	GEAR B	GEAR C	GEAR D
120 teeth	40 teeth	80 teeth	20 teeth

First find revs/min at Gear B.

$$\frac{\text{teeth}}{\text{teeth}} \frac{B}{A} =$$

$$_ \text{ rpm } \times _ = _ \text{ rpm / min}$$

REVS/MIN at C = _____

Next find revs/min at Gear D.

$$\frac{\text{teeth}}{\text{teeth}} \frac{C}{D} =$$

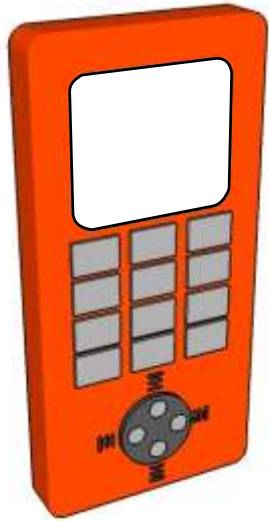
$$_ \text{ rpm (at C) } \times _ = _ \text{ rpm / min}$$

REVS/MIN at D = _____

DIRECTION OF ROTATION at D = _____

SYSTEMS EXAMINATION PREPARATION

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A model railway system is remotely controlled using a handheld unit (shown opposite). The unit is manufactured from plastic and inside is an electronic circuit. The unit controls the movement of model trains, barriers, traffic lights etc.....

Name a suitable plastic for the casing: _____

What are the properties of the plastic you name in the previous question that make it suitable for the manufacture of the handheld control unit?

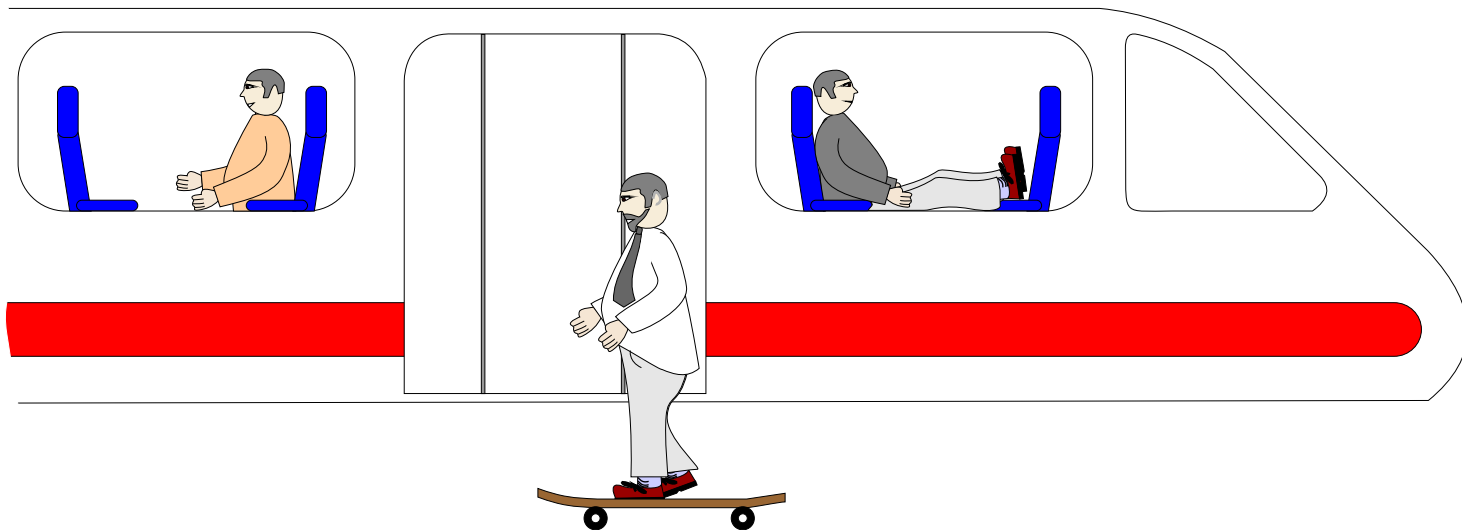
PROPERTIES: _____

It has been decided that the casing is to be manufactured through the process of injection moulding. In the space below draw a suitable diagram representing this process. Include labels and notes explaining the process.

NOTES:

SYSTEMS PREPARATION 2007 - QUESTIONS

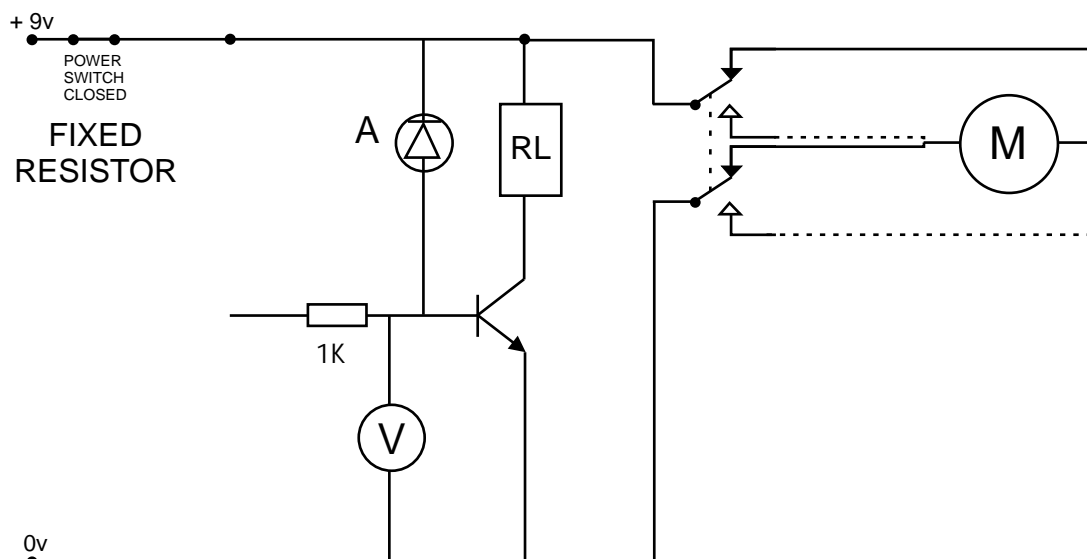
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The drawing shows one of the passenger doors to a train. The passenger doors will only open when the train is stationary at the platform. A sensor circuit controls the opening and closing of doors which open automatically when a passenger approaches.

1. Name a suitable sensor for this procedure.

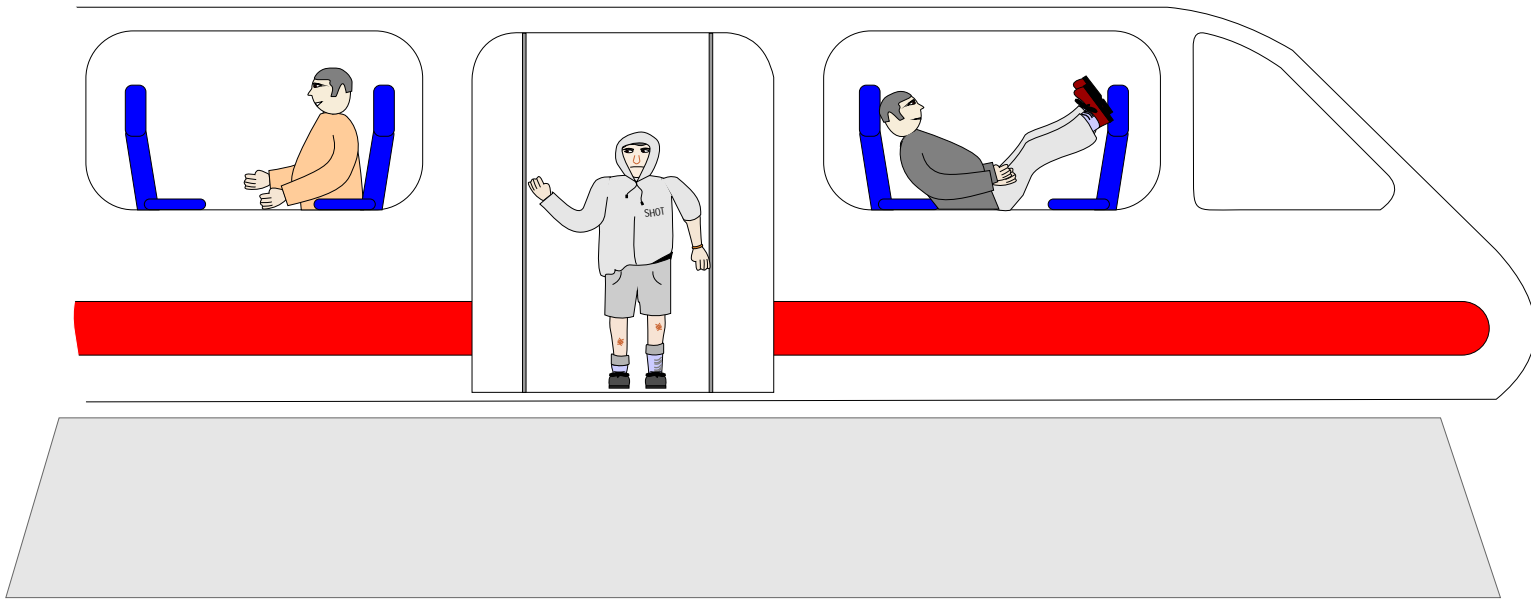
2. The incomplete circuit for the operation of the doors is seen below. Complete the circuit by adding the components required to represent your sensor.



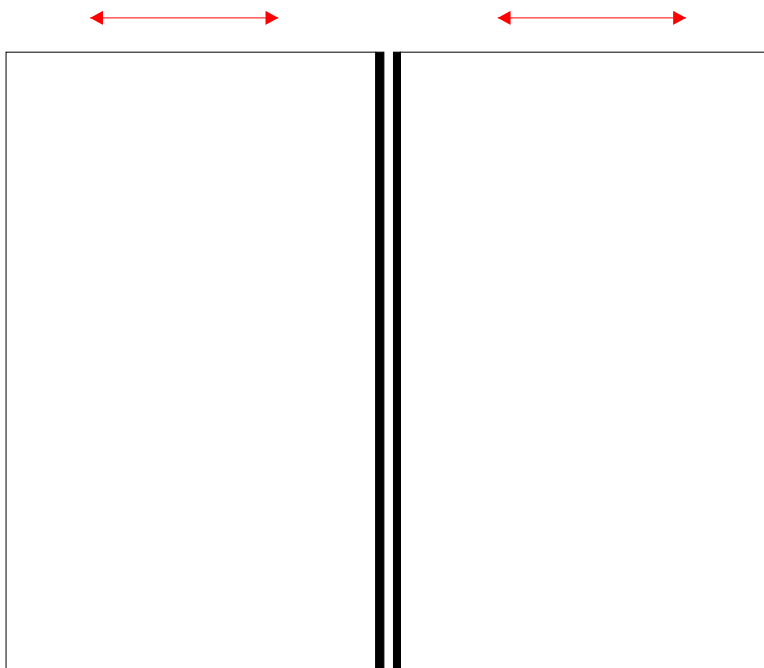
3. Describe on safety feature the door control system should have.

The drawing below shows the sliding doors of a train carriage. However, these trains are rather old and the electric circuits are constantly breaking down. This leaves the doors stuck open or shut. The designers are considering a mechanical backup system that would allow the train guard / porter to open and close the door in the event of an emergency.

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The two doors are shown below. Add to the drawing a suitable mechanical system that would allow the doors to be opened and closed in the event of an electronic failure. Add explanatory notes and labels.



NOTES
