Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE

General Certificate of Secondary Education

WJEC CBAC

CYD-BWYLLGOR ADDYSG CYMRU

Tystysgrif Gyffredinol Addysg Uwchradd

142/04

DESIGN AND TECHNOLOGY

PAPER 2

FOCUS AREA: SYSTEMS AND CONTROL TECHNOLOGY

(Higher Tier – Grades D to A*)

P.M. TUESDAY, 5 June 2007

($1\frac{1}{2}$ hours)

	Leave Blank
Question 1	
Question 2	
Question 3	
Question 4	
Question 5	
TOTAL MARK	

ADDITIONAL MATERIALS

You will need basic drawing equipment, a calculator and coloured pencils for this examination.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. Where the space is not sufficient for your answer, continue the answer at the back of the book, taking care to number the continuation correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

*Answer **all** questions in the spaces provided.*

1. *(a)* Details of a system that will automatically open a curtain when it gets light and close it when it gets dark are shown below.
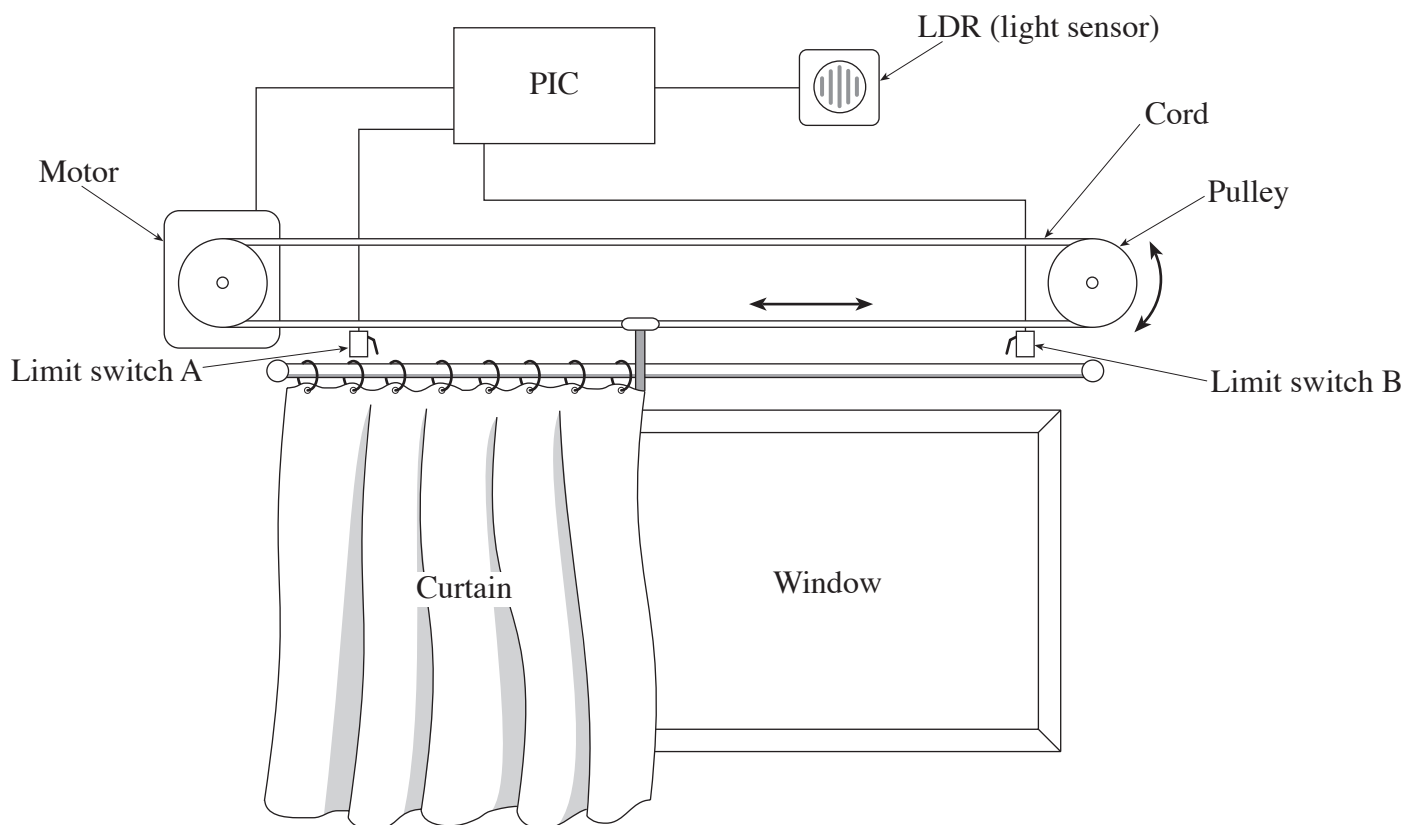
(i) Name a digital input device used in the system. [1]

....

(ii) Name an analogue input device used in the system. [1]

....

(iii) Describe **one** problem that will arise from using an electric motor in the system. [2]

....

....

(iv) Describe **one** problem that will arise when using an analogue sensor in the system. [2]

....

....

(b) Using the commands listed below, complete the flowchart to control the system. The system starts with the curtain open.
(Note: You may use commands more than once. MOTOR FORWARD closes the curtain.)
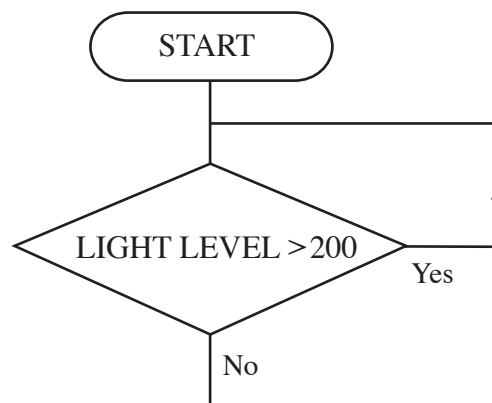
[8]

LIGHT LEVEL > 200   **MOTOR FORWARD**   **MOTOR BACKWARD**

IS LIMIT SWITCH A PRESSED?   **IS LIMIT SWITCH B PRESSED?**

MOTOR STOP

START

LIGHT LEVEL >200   Yes

No

Turn over.

(c) Even when working properly the system may have certain drawbacks. Describe **one** practical problem that could occur when the system is in use and suggest a way of solving the problem.
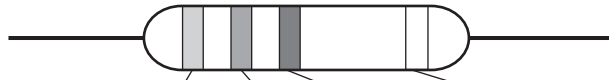
Possible problem: ....

....

[2]

Possible solution: ....

....

....

[2]

2. *(a)* Information about the resistor colour code is shown below.

COLOUR	BAND 1	BAND 2	BAND 3	Tolerance Band
Black	0	0	x 1	
Brown	1	1	x 10	
Red	2	2	x 100	
Orange	3	3	x 1000	
Yellow	4	4	x 10,000	
Green	5	5	x 100,000	
Blue	6	6	x 1,000,000	
Violet	7	7		
Grey	8	8		
White	9	9		
Silver				5%
Gold				10%

(i) **Use** the information to **calculate** the value of **each** of the resistors shown below. [3]

Red   Red   Brown

Green   Violet   Orange

Brown   Black   Black
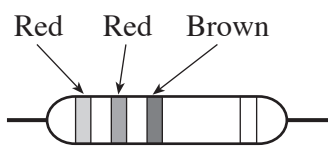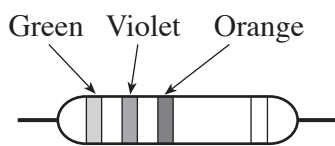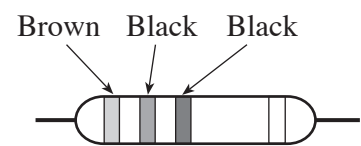
Value: ....

Value: ....

Value: ....

(ii) Calculate the maximum value that the resistor shown below could be. [3]

Brown   Black   Red   Silver

....

....

Maximum value: ....

Turn over.
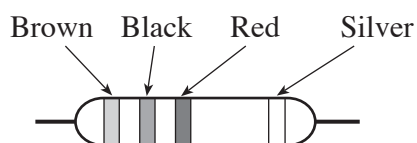
(b) The diagram for a sensing circuit is shown below.
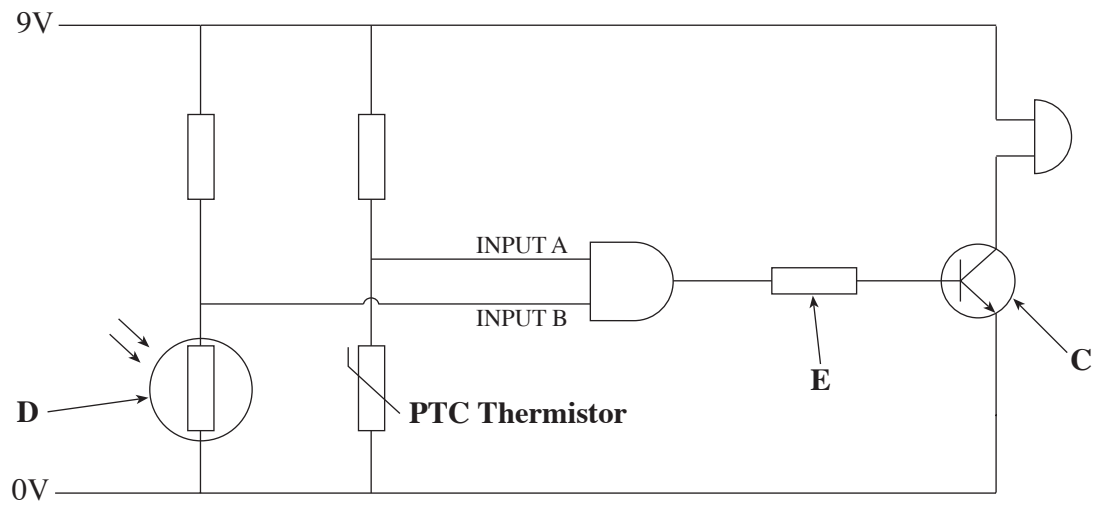
(i) Name component **C**. .... [1]

(ii) Name component **D**. .... [1]

(iii) Explain why resistor **E** is necessary. [2]

....

....

(iv) The system makes use of an AND gate. Complete the truth table for the gate. [4]

AND Gate
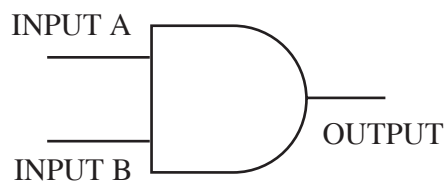
TRUTH TABLE

INPUT A	INPUT B	OUTPUT

(v) Explain how the sensing circuit works. [5]

....

....

....

....

....

(c) A photograph of a multimeter is shown below.

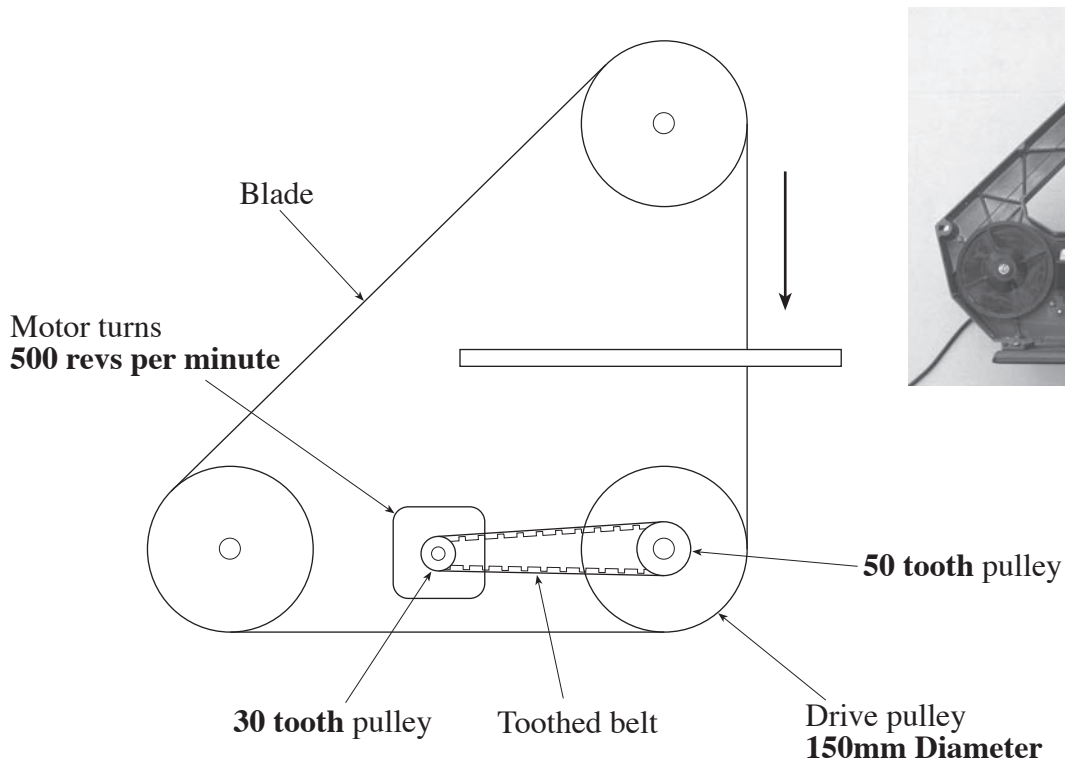(i) State **three** jobs that this multimeter could be used for. [3]

Job 1 ....

Job 2 ....

Job 3 ....

(ii) **State** the value and units that the multimeter in the picture is reading. [2]

....

Turn over.

3. *(a)* Details of the drive system for a small bandsaw are shown below.

Blade

Motor turns
500 revs per minute

50 tooth pulley

30 tooth pulley Toothed belt Drive pulley
150mm Diameter

(i) Calculate the rotational velocity of the drive pulley. [3]
  (Show all workings)

....

....

....

....

(ii) Calculate the linear speed of the bandsaw blade in metres per second.
  (Remember circumference of a circle is $\pi \times$ Dia. and $\pi = 3.14$) S *how all workings*.
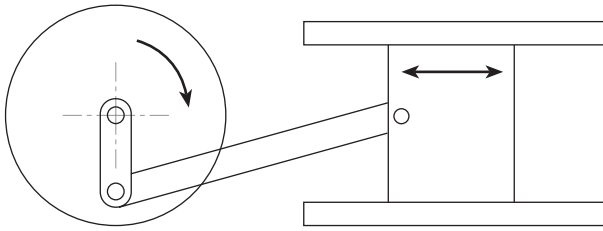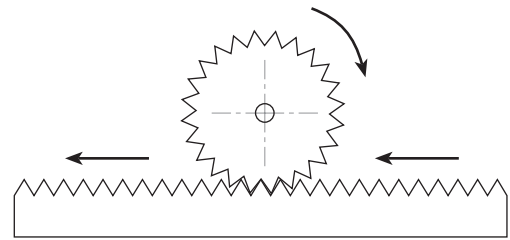 **Hint: work out the circumference of the drive pulley first.** [3]

....

....

....

....

  Blade moves at .... metres per second.

(b) Two simple mechanisms are shown below.

CRANK AND SLIDER   **RACK AND PINION**

Complete the **two** sentences shown below by inserting the correct type of motion.

The .... motion of the crank causes ....
motion in the slider.   [2]

The .... motion of the pinion causes

.... motion in the rack.   [2]

(c) Three different designs for a car brake pedal are shown below.

Fixed pivots

LOAD

LOAD

EFFORT

LOAD

EFFORT

EFFORT

A   **B**   **C**
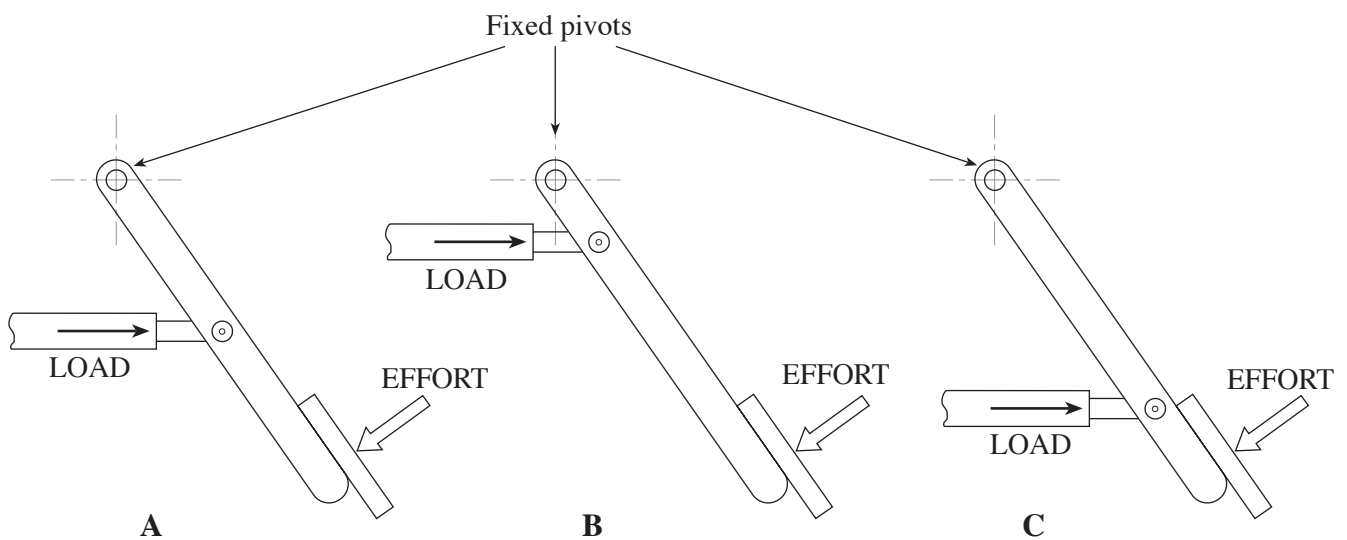
(i) **State** which class of lever is used in the brake systems.   [1]

....

(ii) **State** which system would require the **least** effort to slow the car and give a reason
for your answer.   [3]

....

....

....

Turn over.

(d) Complete an accurate labelled sketch of a cam that matches the following specification. The centre of the cam and the start position of the follower are given below. [5]
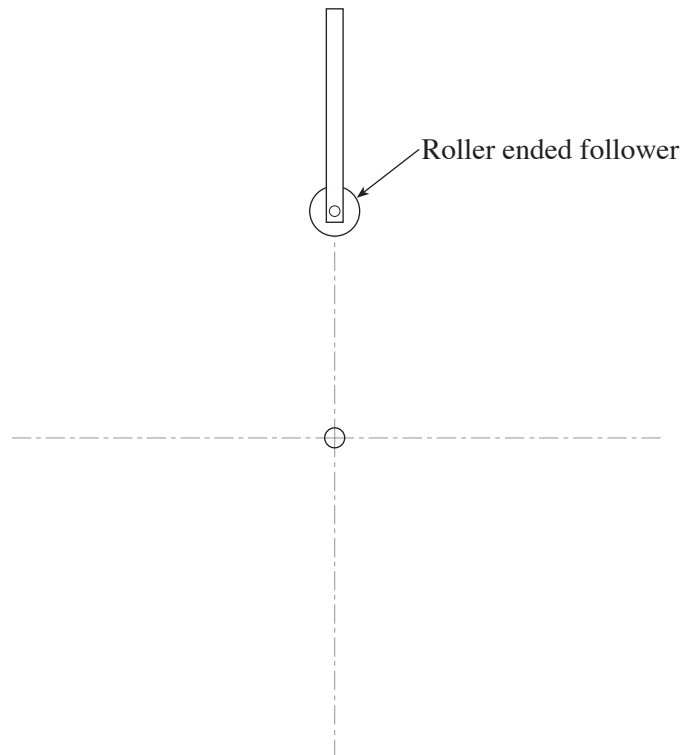
CAM Specification
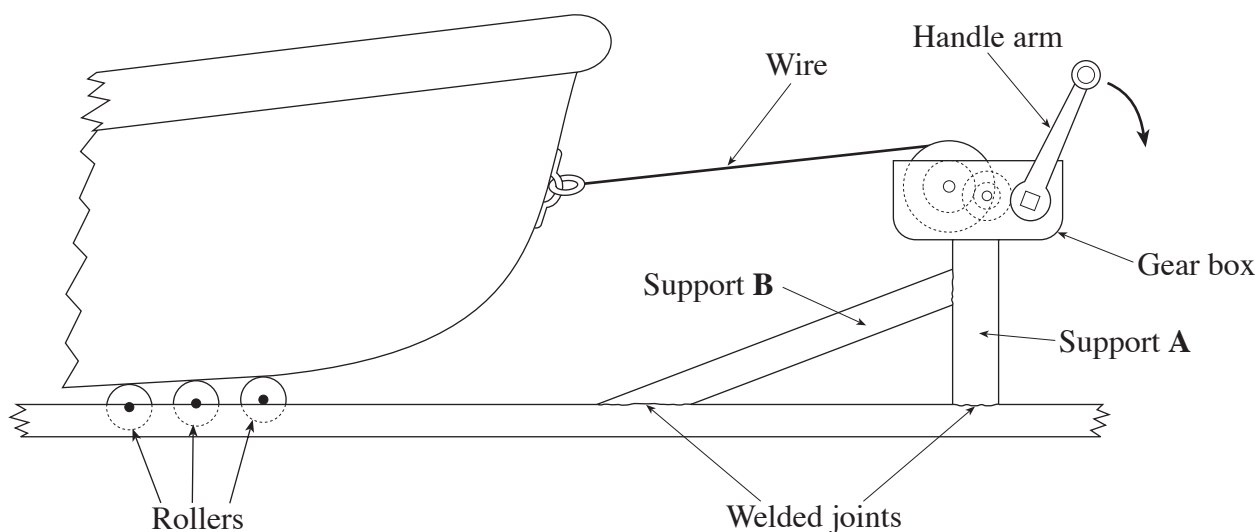
Clockwise rotation.
0° to 90° – Dwell
90° to 180° – Rise 15mm
180° to 270° – Dwell
270° to 360° – Fall 15mm

Roller ended follower

4. *(a)* The drawing below shows a heavy boat being pulled onto its trailer using a winch.

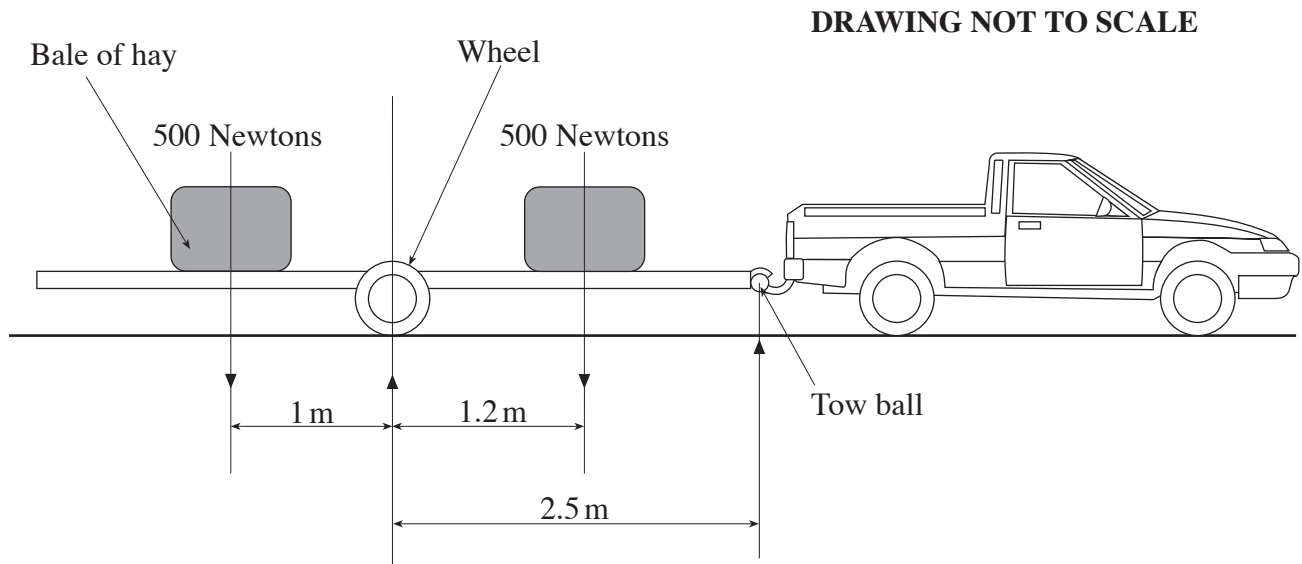(i) Discuss the design of the trailer in terms of its efficiency. [4]

....

....

....

....

(ii) Name a suitable material for the trailer. [1]

....

(iii) Complete the table below by writing the type of force that is present in **each** of the parts named. [4]

PART	FORCE
Support A	....
Support B	....
Wire	....
Handle arm	....

Turn over.

(b) The manufacturer of the vehicle towing the farm trailer shown below has stated that the down force on the tow ball must not exceed 50 newtons. The trailer is shown loaded with two bales of hay. Using the principle of moments, calculate whether the down force on the tow ball is within the permitted limit. *Show all workings.* [5]
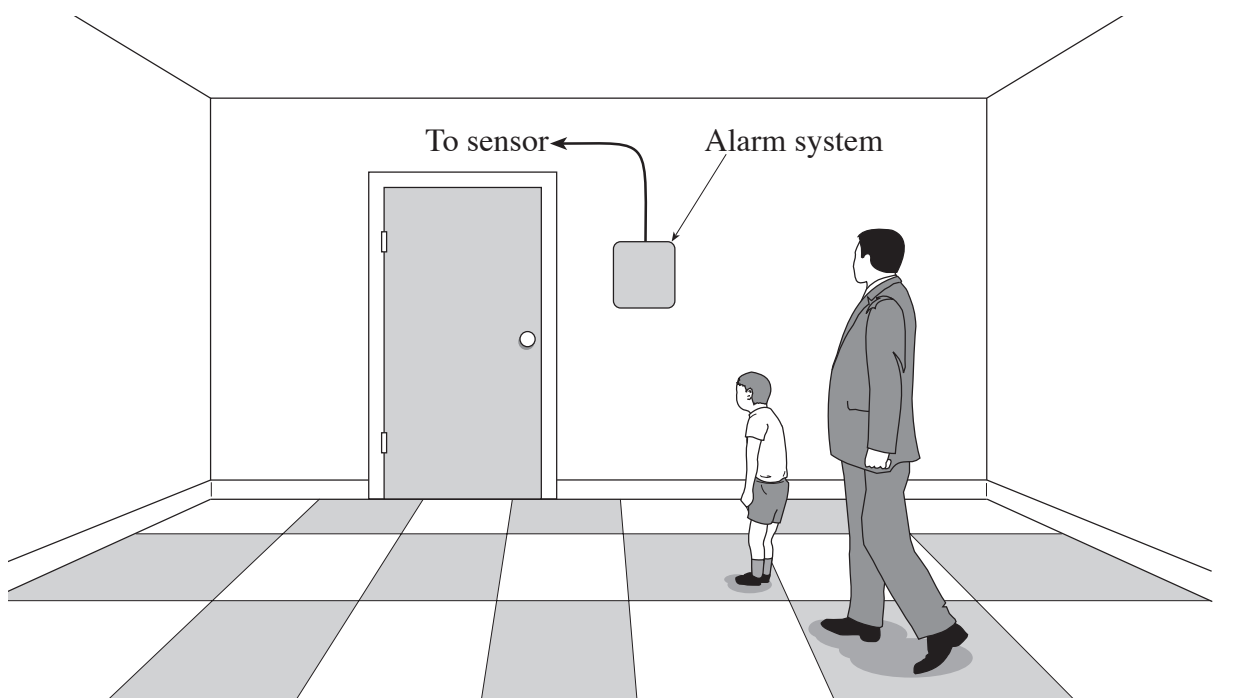
DRAWING NOT TO SCALE

Bale of hay   Wheel

500 Newtons   500 Newtons

Tow ball

1 m   1.2 m

2.5 m

....

....

....

....

....

5. The owner of a local nursery group has asked you to design a latching alarm system that will warn the nursery teacher that the nursery room door has been opened by a child or other person.

SPECIFICATION

The alarm must:

• warn the teacher that the door has been opened;

• be battery powered;

• latch on until reset;

• be able to be armed and disarmed by the teacher but not by a child in the group;

• be securely cased and fixed in an appropriate position.

Sketch your design in the boxes on the following pages.

Marks will be awarded for:

(i) a clear block diagram based on INPUT, PROCESS and OUTPUT of the control system for the latching alarm; [4]

(ii) fully labelled details of the electronic circuit used in the alarm; [6]

(iii) clear details of how the alarm is triggered by the door opening; [4]

(iv) clear details to show how the system fits into a simple case; [3]

(iv) details of how the alarm cannot be armed or disarmed by a child; [2]

(v) quality of communication. [6]

Turn over.

(i)   Draw a block diagram of your system.

(ii)   Draw a labelled circuit diagram of your system.

(iii) Draw details of how the alarm will be triggered when the door is opened.

(iv) Draw designs for a suitable case for the alarm showing how the circuit fits into it and show how the alarm cannot be altered by a child.

Turn over.

For continuation only.