

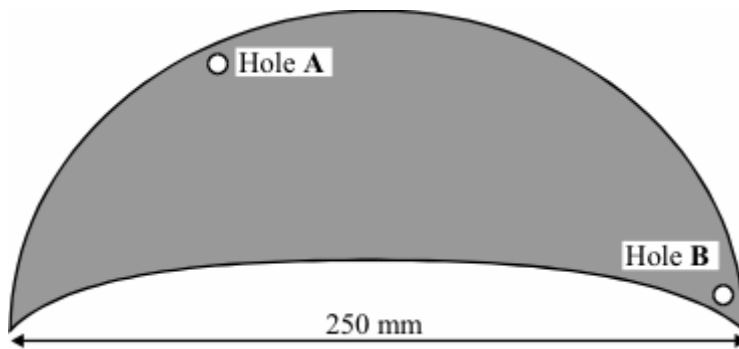
Using physics to make things work

1. (a) Every object has a *centre of mass*. What is meant by the *centre of mass*?

.....  
.....

(1)

(b) The drawing shows a thin sheet of plastic. The sheet is 250 mm wide. Two holes, each with a radius of 2 mm, have been drilled through the sheet.



Describe how you could use:

- a clamp and stand
- a steel rod 100 mm long and with a radius of 1 mm
- a weight on a thin piece of string (= a plumb line)
- a ruler
- a pen which will write on the plastic sheet

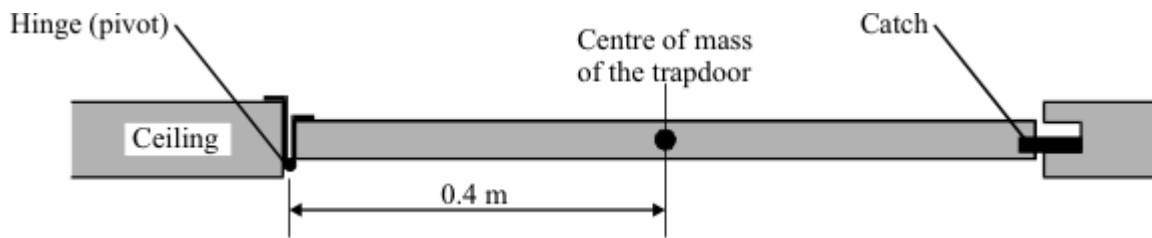
to find the centre of mass of the plastic sheet.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

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.....  
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.....  
.....  
.....

(5)

- (c) There is a trapdoor in the ceiling of a house. The trapdoor weighs 44 N. The drawing shows a side view of the trapdoor.



- (i) Complete the **three** spaces to give the equation which is used to calculate the turning effect of a force.

..... = ..... × perpendicular.....  
 between line of action and pivot

(1)

- (ii) Calculate the turning effect, about the hinge, due to the weight of the trapdoor. Show clearly how you work out your final answer and give the unit.

.....  
 .....

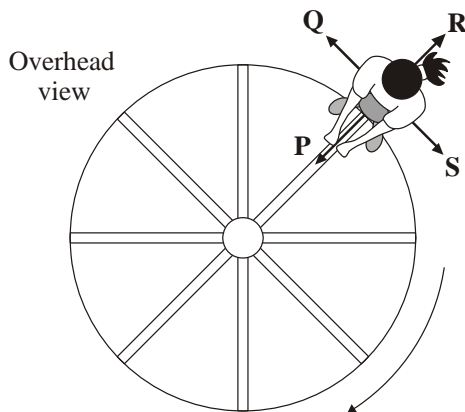
Turning effect = .....

(3)

(Total 10 marks)

2. A girl and her father visit a children's playground.

- (a) The diagram shows the girl holding on to a roundabout which is turning.



A centripetal force must act because the girl moves in a circular path.

- (i) In which direction, **P**, **Q**, **R** or **S**, does the centripetal force act?

Direction .....

(1)

- (ii) What provides this centripetal force?

.....  
 .....

(1)

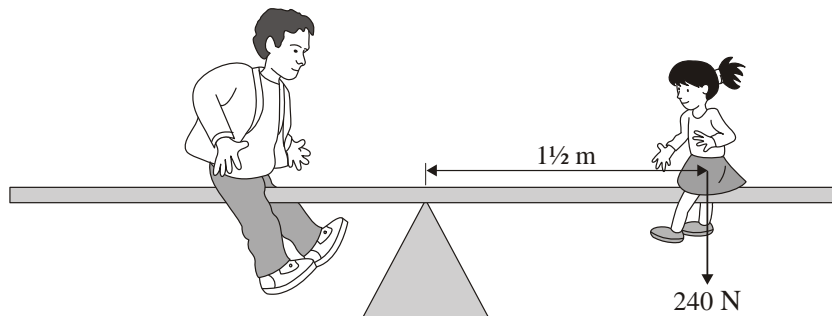
- (iii) Her father pushes the roundabout so that it turns faster. The girl continues to stand on the same part of the roundabout.

Complete the following sentence by drawing a ring around the correct line in the box.

The centripetal force on the girl	decreases
	does not change
	increases

(1)

- (b) The diagram shows the girl and her father on a see-saw.



- (i) Use the equation in the box to calculate the moment of the girl.

moment = force × perpendicular distance from the line of action of the force to the axis of rotation

.....  
 .....

Moment of the girl = ..... Nm

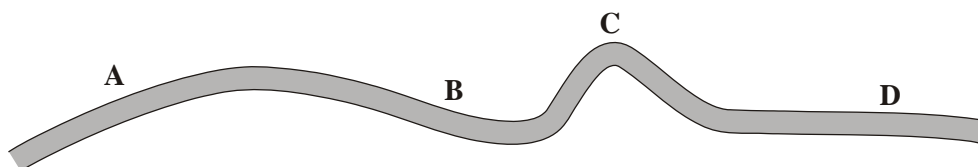
(2)

- (ii) What must her father do to increase his moment?

.....  
 .....

(1)

- (c) The diagram shows part of a level road that they take when they drive home. They drive at a steady speed.



- (i) At which point, A, B, C or D, will the centripetal force on the car be greatest?

Centripetal force is greatest at .....

(1)

(ii) What provides the centripetal force when the car goes round a bend?

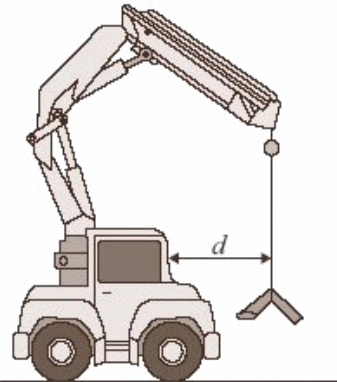
.....  
 .....

(1)  
 (Total 8 marks)

3. The diagram shows a small mobile crane. It is used on a building site.

The distance,  $d$ , is measured to the front of the cab.

The table shows information from the crane driver's handbook.



Load in kilonewtons (kN)	Maximum safe distance, $d$ , in metres (m)
10	6.0
15	4.0
24	2.5
40	1.5
60	1.0

(a) What is the relationship between the load and the maximum safe distance?

.....  
 .....  
 .....

(2)

(b) The crane driver studies the handbook and comes to the conclusion that a load of 30 kN would be safe at a distance,  $d$ , of 2.0 metres.

Is the driver correct? Explain your answer.

.....  
 .....  
 .....

(2)

(c) What is the danger if the driver does not follow the safety instructions?

.....  
 .....

(1)

(d) How should the data in the table have been obtained?

Put a tick (✓) in the box next to your answer.

average results from an opinion poll of mobile crane drivers

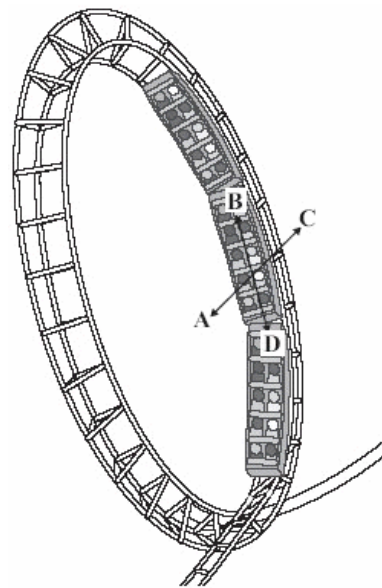
copied from a handbook for a similar crane

results of experiments on a model mobile crane

results of experiments on this mobile crane

(1)  
(Total 6 marks)

4. The drawing shows a set of carriages on a roller coaster. The carriages are moving upwards in a nearly circular path at a constant speed.



(a) Complete the following sentences by drawing a ring around the correct line in each box.

(i) The carriages will accelerate because of a change in their

direction  
mass  
speed

(1)

(ii) The resultant force which causes the carriages to accelerate is the

direction  
mass  
speed

force.

(1)

(b) In which direction, **A**, **B**, **C** or **D**, does the resultant force act?

Write your answer in the box.

(1)

(c) Complete the following sentence by drawing a ring around the correct line in the box.

The resultant force will need to be greater if the

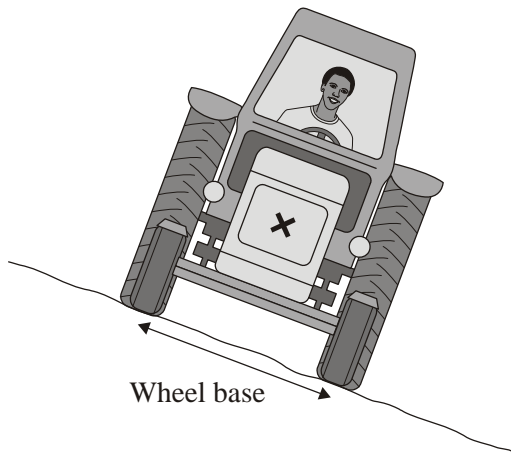
- |  |
|--|
| mass of the passengers is greater<br>radius of the circle is greater<br>speed of the carriages is less |
|--|

(1)

(Total 4 marks)

5. Tractors are often used on sloping fields, so stability is important in their design.

On the diagram, the centre of the **X** marks the centre of mass of the tractor.



(a) Explain why the tractor has **not** toppled over. You may add to the diagram to help you to explain.

.....

.....

.....

.....

(3)

(b) Give **two** features of the tractor which affect its stability and state how each feature could be changed to increase the tractor's stability.

Feature 1 .....

.....

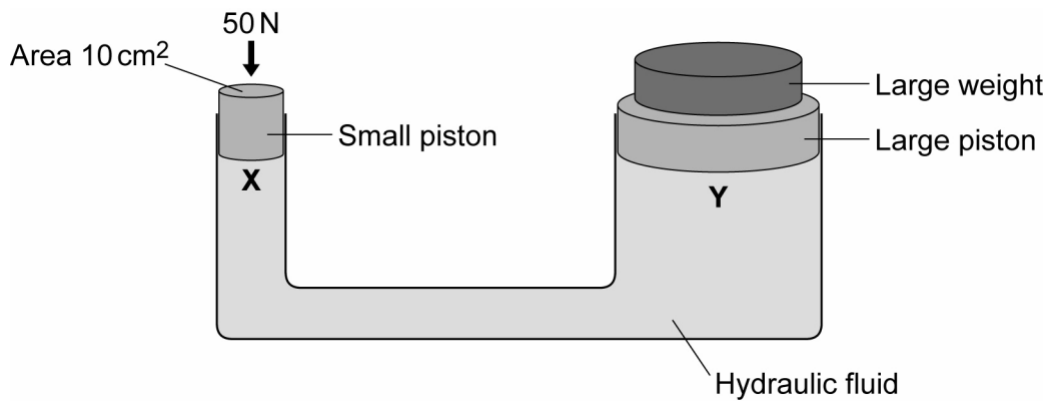
Feature 2 .....

.....

(2)

(Total 5 marks)

6. The diagram shows a simple hydraulic jack. The jack is designed to lift a large weight using a much smaller force.



- (a) Complete the following sentence.

A hydraulic jack is an example of a..... multiplier

(1)

- (b) Calculate the pressure, in  $\text{N/cm}^2$ , created on the small piston by the force of 50 N pushing downwards.

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

.....

.....

.....

.....

Pressure = .....  $\text{N/cm}^2$

(3)

- (c) Complete the following sentence.

The pressure at Y will be ..... the pressure at X.

(1)

(Total 5 marks)