Centre of Mass

Question Paper

Level	GCSE
Subject	Physics
Exam Board	AQA
Unit	P3
Topic	Centre of Mass
Difficulty Level	Silver Level
Booklet	Question Paper

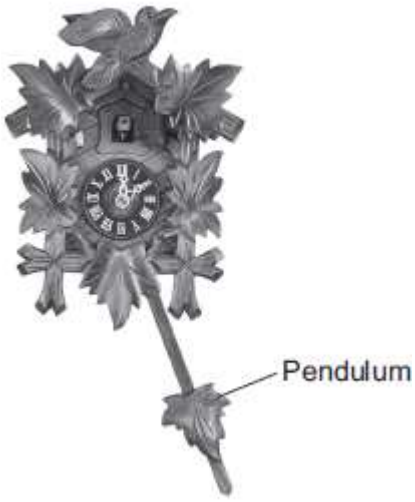
Time Allowed: **59 minutes**

Score: **/57**

Percentage: **/100**

Q1. The clock shown in **Figure 1** uses a pendulum to keep time.

Figure 1



(a) The pendulum has a frequency of 0.80 Hz.

Calculate the periodic time of the pendulum.

Use the correct equation from the Physics Equations Sheet.

.....

.....

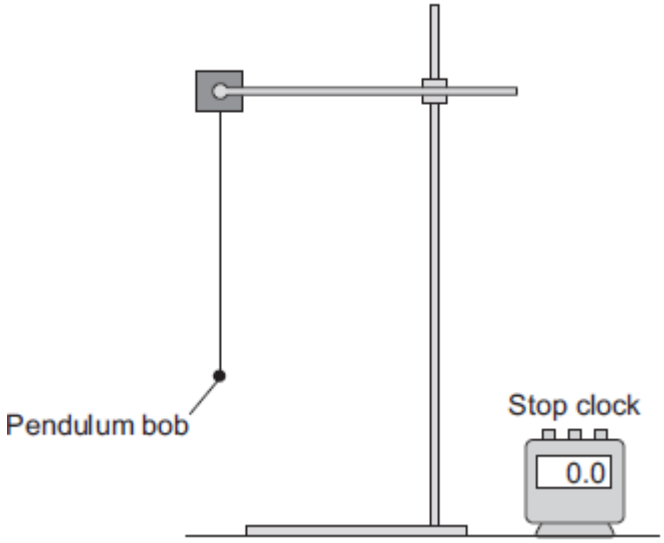
.....

Periodic time = ... seconds

(2)

(b) A student investigated the factors affecting the oscillation of a pendulum. The student set up a pendulum as shown in **Figure 2**.

Figure 2



The student investigated how many complete oscillations the pendulum made for different lengths of the pendulum and different masses of the pendulum bob.

The results are shown in the table.

Length of the pendulum in millimetres	Mass of the pendulum bob in grams	Number of complete oscillations made by the pendulum in 20 seconds
200	100	22
200	200	22
400	100	15
400	200	15
600	50	13
600	100	13

(i) State **two** conclusions that the student should make from the results shown in the table.

1.....

.....

2.....

.....

(2)

(ii) The student wants to be more certain that her conclusions are correct.

Suggest **two** ways in which the investigation could be improved.

1.....

.....

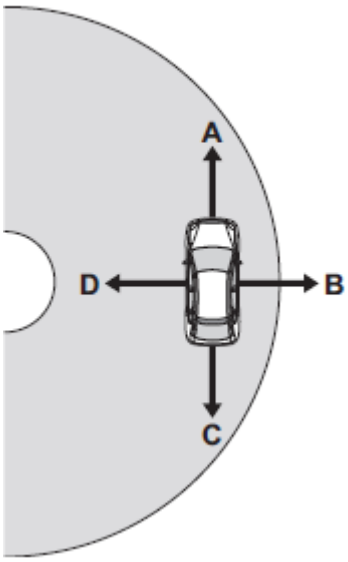
2.....

.....

(2)
(Total 6 marks)

Q2.(a) **Figure 1** shows a car travelling around a bend in the road. The car is travelling at a constant speed.

Figure 1



There is a resultant force acting on the car. This resultant force is called the centripetal force.

(i) In which direction, **A**, **B**, **C** or **D**, does the centripetal force act on the car?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(ii) State the name of the force that provides the centripetal force.

.....

(1)

(iii) State **two** factors that affect the size of the centripetal force acting on the car.

1 .....

2 .....

(2)

(b) **Figure 2** shows a racing car.

Figure 2

© braverabbit/iStock/Thinkstock

The racing car should not roll over when racing.

State **two** features of the car that make it difficult for the car to roll over.

1.....

.....

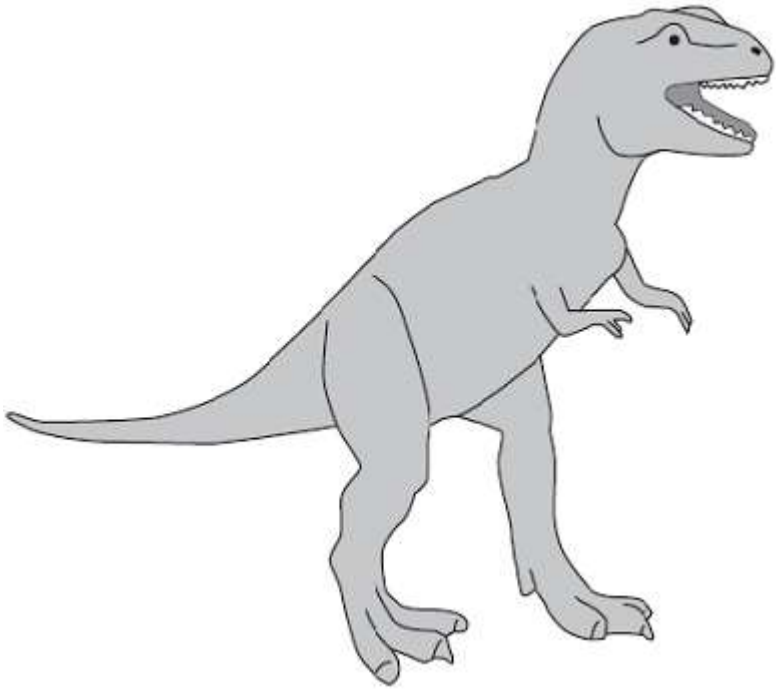
2.....

.....

(2)
(Total 6 marks)

Q3. The drawing shows a plastic toy which can stand on its feet.

(a) (i) Draw an **X** on the diagram so that the centre of the **X** marks the likely position of the centre of mass of the toy.



(1)

(ii) Explain the reason for your choice in part (a)(i).

.....

.....

(1)

(b) Suggest **two** ways in which the design of the toy could be altered to make the toy more stable.

1 .....

.....

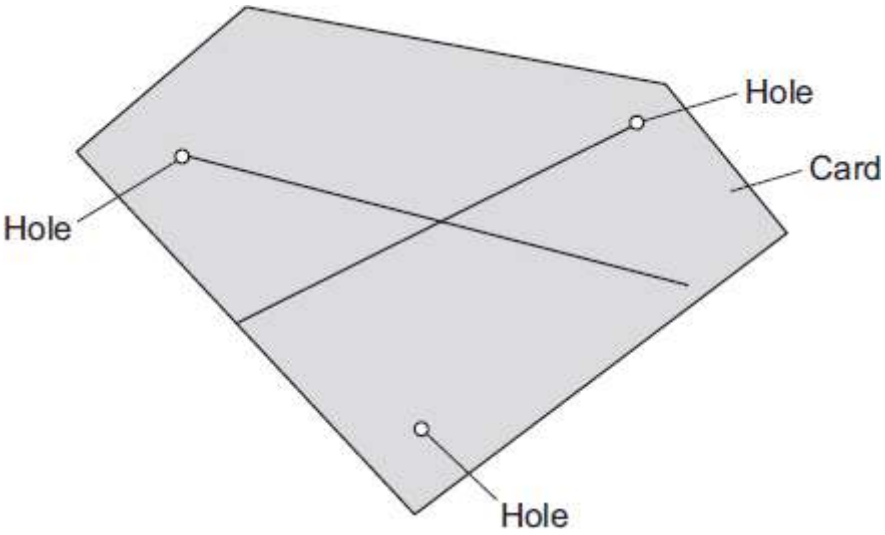
2 .....

.....

(2)

(Total 4 marks)

Q4. A student was asked to find the centre of mass of a thin sheet of card. The diagram shows the result of the student's experiment. The student drew two lines onto the card. The centre of mass is where the two lines cross.



(a) Describe how the student found the correct positions to draw the **two** lines.

You may include a labelled diagram in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(b) Explain how the student can check that the position found for the centre of mass is accurate.

.....

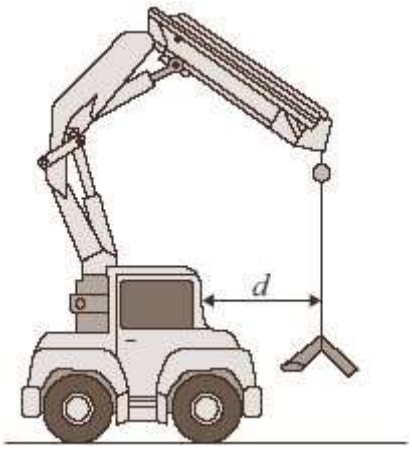
.....

.....

.....

(2)
(Total 5 marks)

Q5. 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)

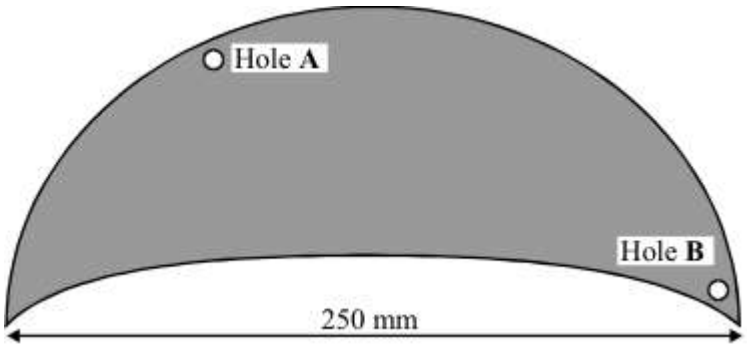
Q6. (a) Every object has a *centre of mass*. What is meant by the *centre of mass*?

.....

.....

(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 I 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.

.....

.....

.....

.....

.....

.....

.....

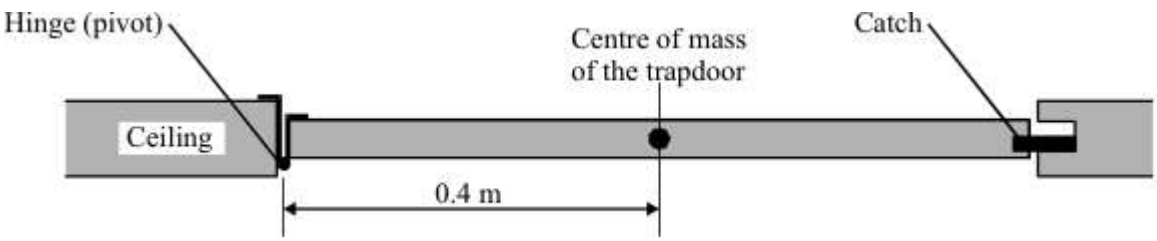
.....

.....

.....

(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.

.....

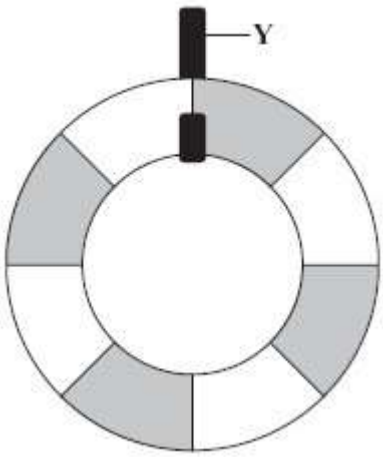
.....

Turning effect = ...

(3)
(Total 10 marks)

Q7. (a) The diagram shows a lifebelt. It is hanging freely from hook **Y**.

(i) On the diagram, mark with an **X** the point where you think the centre of mass of the lifebelt will be.



(1)

(ii) Explain why you have chosen this point.

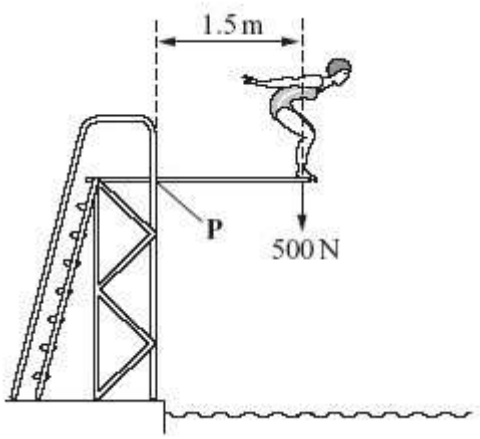
.....

.....

.....

(2)

(b) The drawing shows Susan on a diving board. She is 1.5 metres from point **P** and she weighs 500 N.



Calculate her moment (turning effect) about point **P**.
Show clearly how you work out your answer and give the unit.

.....

.....

Moment about **P** = ...

(3)

(c) Susan has a case with wheels.

When she packs this case, she puts the heaviest items at the end where the wheels are.
This means that the heaviest items are less likely to crush the other contents and it helps her to find things when she opens the case.

Explain another advantage of packing her case in this way.

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.

.....

.....

.....

.....

.....

.....

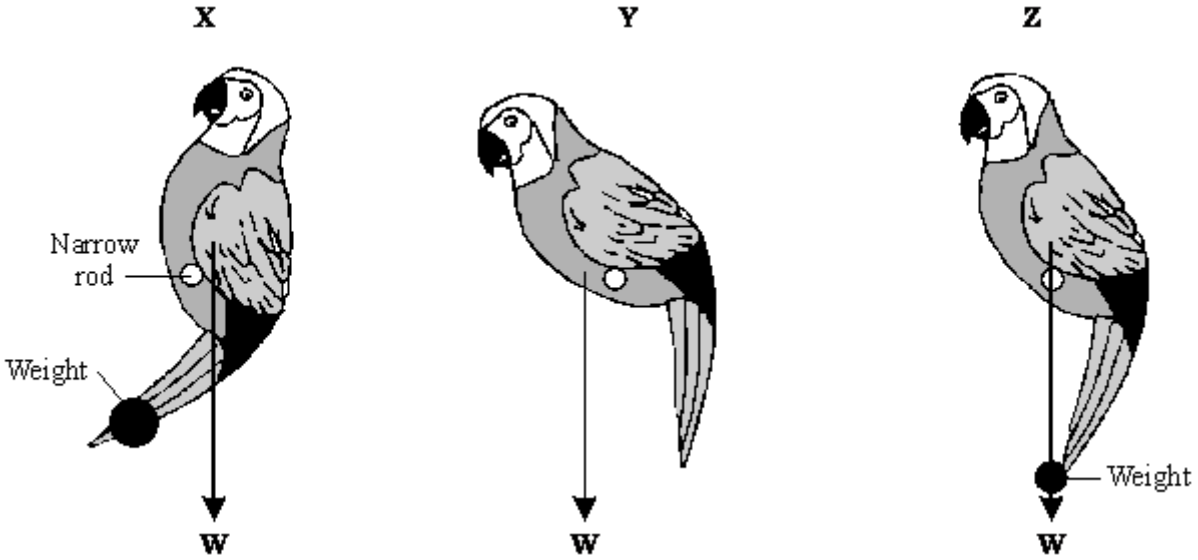
.....

.....

(4)
(Total 10 marks)

Q8. (a) The diagram shows three similar toys. Each toy should be able to balance on a

narrow rod. The arrows show the direction in which the weight of the toy acts.



Only one of the toys balances on the rod, the other two fall over. Which **one** of the toys is balanced? Explain the reason for your choice.

.....

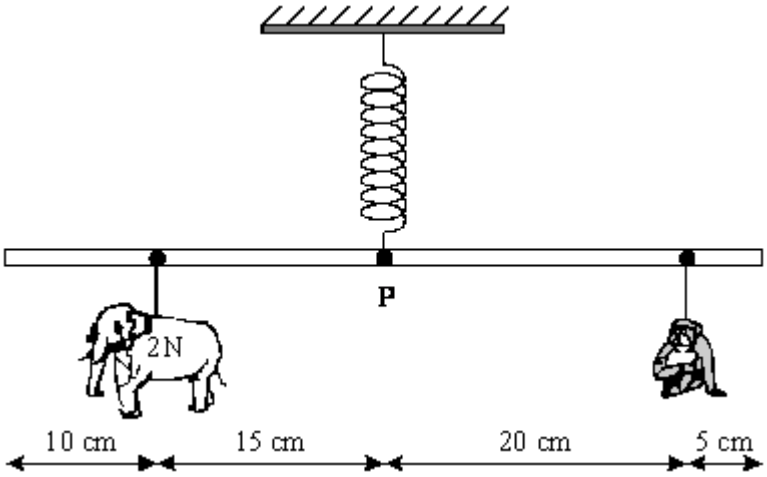
.....

.....

.....

(3)

(b) The diagram shows a simple toy. Different animal shapes can be positioned so that the 50 cm rod balances horizontally.



(i) Use the following equation to calculate the moment exerted by the elephant shape of weight 2N about the pivot **P**. Show clearly how you work out your answer and give the unit.

moment = force × perpendicular distance from pivot

.....

.....

Moment = ...

(3)

(ii) Use the following relationship to calculate the weight of the monkey shape.

total clockwise moment = total anticlockwise moment

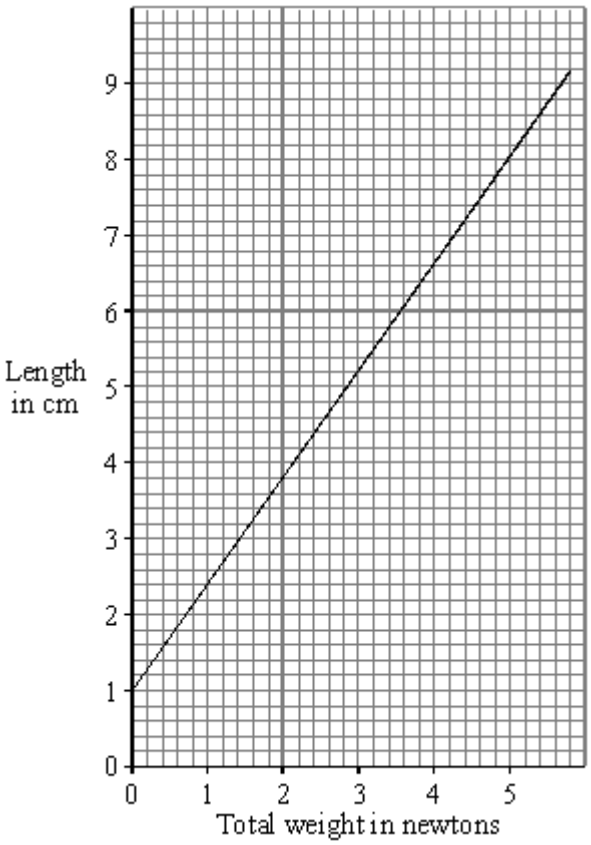
.....

.....

Weight = ... N

(2)

(c) The graph shows how the length of the spring changes as the total weight of the different animal shapes change.



Use the graph to find how much the spring extends when the elephant shape and the monkey shape are hung from the rod. Show how you get your answer.

.....

.....

Extension of spring = ... cm

(2)

(Total 10 marks)