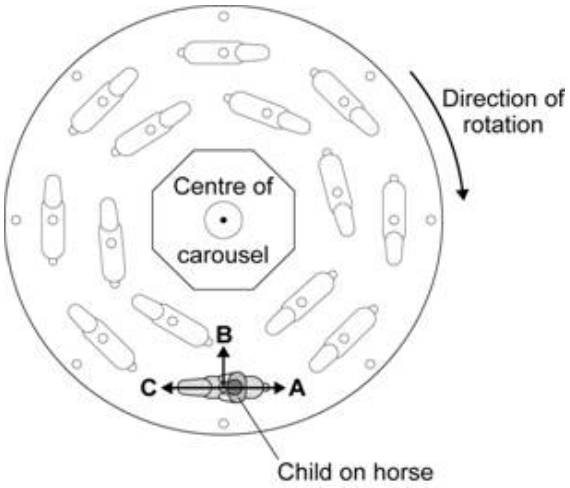
Q1. The picture shows a fairground carousel.

The diagram shows the position of one child, at one point in the ride, viewed from above.

Picture

Diagram



Draw a ring around the correct answer to complete the following sentences.

(a) The resultant force needed to keep the child moving in a circular path is

called the | centripetal / circular / gravitational | force.

(1)

(b) The resultant force on the child acts in the direction | **A.** / **B.** / **C.** |

(1)

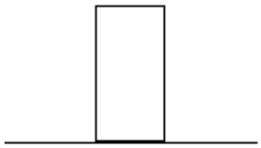
(c) At the end of the ride, as the carousel slows down, the resultant force on

the child | decreases. / stays the same. / increases. |

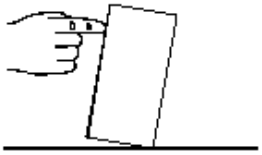
(1)

(Total 3 marks)

Q2. A child stands a wooden brick on its end as shown in the diagram.



The child then pushes the brick to make it tilt.



How far must the brick be tilted to make it fall over?

Explain your answer.

(You may draw a labelled diagram if you wish.)

.....

.....

.....

(Total 2 marks)

Q3. (a) A student investigates the moment of a force.

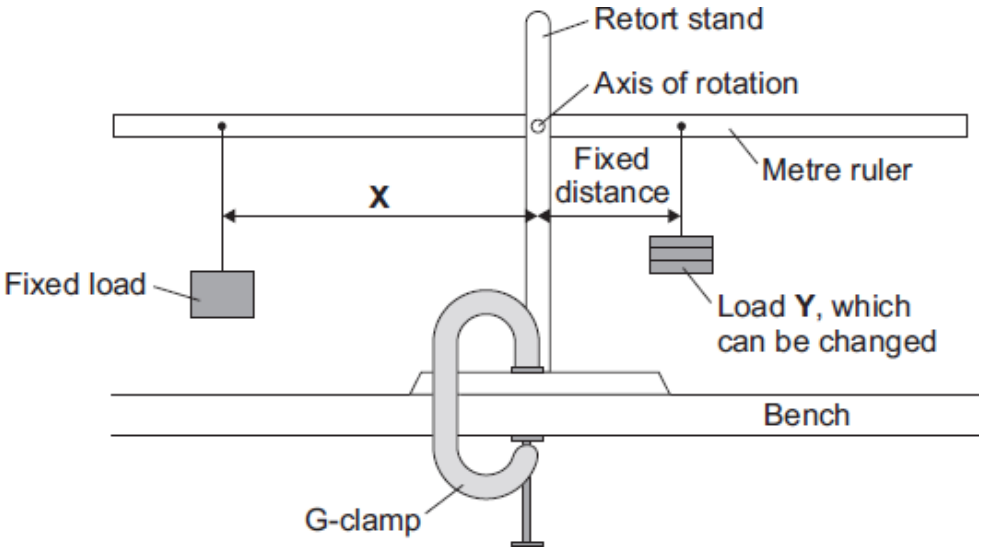
(i) What does the word *moment* mean in this sentence?

.....

.....

(1)

(ii) The diagram shows how she sets up her apparatus.



Suggest the purpose of the G-clamp.

.....

.....

(1)

(iii) A horizontal rod fits into a hole at the centre of the metre ruler. This is the axis of rotation. The student changes the load **Y** and adjusts the distance **X** until the metre ruler is horizontal. She takes six pairs of measurements which are shown in the table.

Load Y in newtons	**Distance X in centimetres**
1	7
2	14
3	21
4	28
5	35
6	42

Explain fully how distance **X** varies with load **Y**.

.....

.....

.....

.....

.....

(2)

(iv) The weight of the ruler can be ignored in this experiment.

Which statement gives the reason why?

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

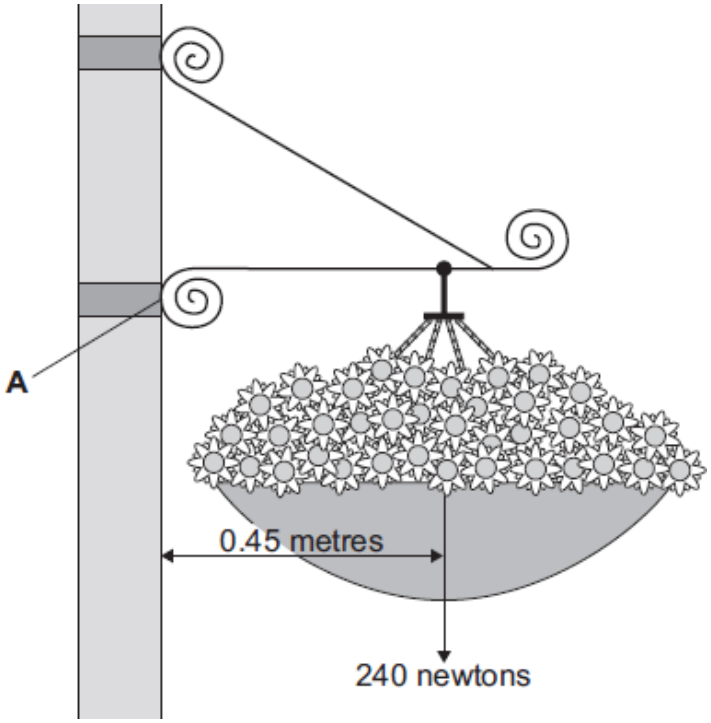
The weight of the ruler is so small it is negligible. ☐

The centre of mass of the ruler is at the axis of rotation. ☐

The ruler is a symmetrical object. ☐

(1)

(b) In the summer, a town council fits hanging baskets to some of its lamp posts.



Use the information in the diagram and the equation in the box to calculate the moment produced by the weight of the hanging basket about an axis through point **A**.

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

Show clearly how you work out your answer **and** give the unit.

.....

.....

.....

.....

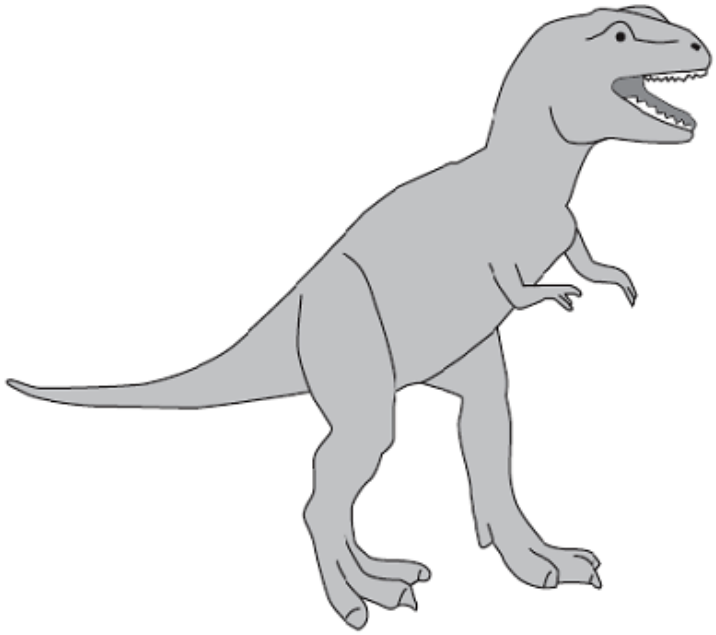
Moment =.....

(3)

(Total 8 marks)

Q4. 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)

Q5. The London Eye is one of the largest observation wheels in the world.

The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

(a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

.....

.....

.....

(2)

(b) In which direction is the resultant force on each capsule?

.....

(1)

(c) The designers of the London Eye had to consider **three** factors which affect the resultant force described in part (b).

Two factors that increase the resultant force are:

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

.....

.....

(1)

(Total 4 marks)

Q6. Forces have different effects.

(a) (i) Use the correct answer from the box to complete the sentence.

slowing	**stretching**	**turning**

The moment of a force is the ..... effect of the force.

(1)

(ii) What is meant by the centre of mass of an object?

.....

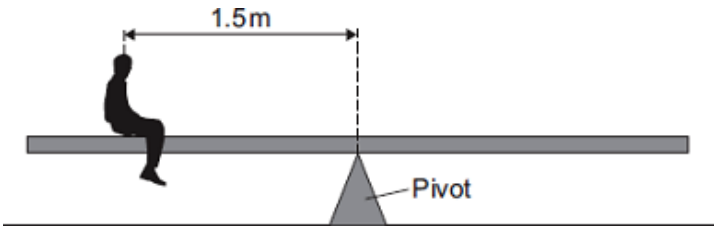
.....

(1)

(b) Some children build a see-saw using a plank of wood and a pivot.
The centre of mass of the plank is above the pivot.

Figure 1 shows a boy sitting on the see-saw. His weight is 400 N.

Figure 1



Calculate the anticlockwise moment of the boy in Nm.

Use the correct equation from **Section A** of the Physics Equations Sheet.

.....

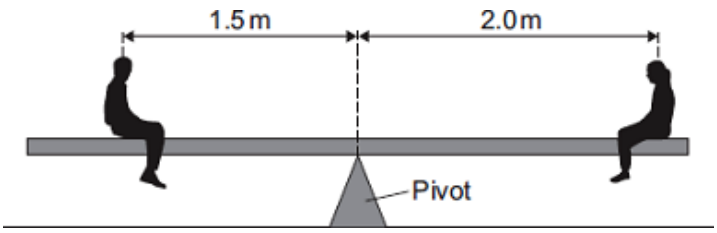
.....

Anticlockwise moment = ... Nm

(2)

(c) **Figure 2** shows a girl sitting at the opposite end of the see-saw. Her weight is 300 N.

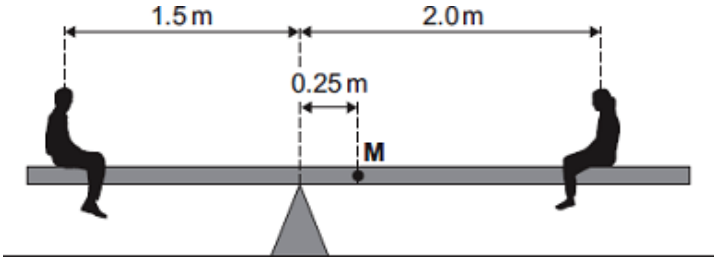
Figure 2



The see-saw is now balanced.

The children move the plank. Its centre of mass, **M**, is now 0.25 m from the pivot as shown in **Figure 3**.

Figure 3



The boy and girl sit on the see-saw as shown in **Figure 3**.

(i) Describe **and** explain the rotation of the see-saw.

.....

.....

.....

.....

.....

.....

.....

(3)

(ii) The boy gets off the see-saw and a bigger boy gets on it in the same place. The girl stays in the position shown in **Figure 3**. The plank is balanced. The weight of the plank is 270 N.

Calculate the weight of the bigger boy.

.....

.....

.....

.....

.....

.....

Weight of the bigger boy = ... N

(3)

(Total 10 marks)

M1. (a) centripetal

1

(b) **B**

1

(c) decreases

1

[3]

M2. *any evidence of idea that* weight acts through/near centre of mass/gravity/brick

gains 1 mark

but *clear indication that brick topples if*
vertical line through centre of mass is outside base line of brick
or line of action of weight is outside base line of brick

gains 2 marks

[2]

M3. (a) (i) turning effect

accept turning force
accept force x distance
(accept symbols only if correctly defined)
*do **not** accept newtons x metres*

1

(ii) stop apparatus falling over

accept holds the stand in place
accept make it safer / stable
references to balanced / equilibrium are insufficient

1

(iii) as *x* increases *y* increases

1

in same proportion / ratios

allow both marks for they are <u>directly</u> proportional
or
a specific example eg doubling y, doubles x
allow both marks for a correct answer giving figures
eg they increase in the ratio of 1 to 7
*allow for **1** mark positive correlation*

1

(iv) the centre of mass of the ruler is at the axis of rotation

1

(b) 108

*allow **1** mark for correct substitution ie 240 x 0.45*

2

newton metres / Nm

symbols must be correct

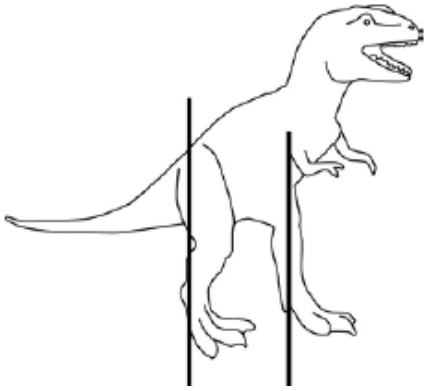
for full credit the unit must be consistent with the numerical answer

1

[8]

M4. (a) (i) centre of **X** above the feet and in the body

*a vertical line from their **X** falls between two lines in diagram – judged by eye*



1

(ii) where the mass seems to be concentrated

accept it's above the <u>base</u> (area)

accept because otherwise it would topple

accept line of action (of weight) passes through the <u>base</u>

*do **not** accept where the mass is concentrated*

1

(b) any **two** from:

- make (the area of) feet / base bigger
- make feet wider apart
- make legs shorter / heavier
- make head smaller / lighter
- make tail touch the ground / make the tail longer

accept 'make centre of mass / gravity lower'

2

[4]

M5. (a) any **two** from:

- (acceleration occurs when) the direction (of each capsule) changes
- velocity has direction
- acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

accept 'the size' for radius
both parts required for the mark

1

[4]

M6. (a) (i) turning

accept turning ringed in the box

1

(ii) point at which mass (or weight) may be thought to be concentrated

accept the point from which the weight appears to act
allow focused for concentrated
*do **not** accept most / some of the mass*
*do **not** accept region / area for point*

1

(b) 600 (Nm)

*400 × 1.5 gains **1** mark provided no subsequent steps shown*

2

(c) (i) plank rotates clockwise

accept girl moves downwards
*do **not** accept rotates to the right*

1

(total) CM > (total) ACM

accept moment is larger on the girl's side

1

weight of see-saw provides CM

answer must be in terms of moment
*maximum of **2** marks if there is no reference to the weight of the see-saw*

1

(ii) W = 445 (N)

*W × 1.5 = (270 × 0.25) + (300 × 2.0) gains **2** marks*

*allow for **1** mark:*

total CM = total ACM either stated or implied

or

(270 × 0.25) + (300 × 2.0)

if no other marks given

3

[10]