Exampro GCSE Physics

P3 Foundation -Moments Hydraulics and CM Self Study Questions

Name:

Class:

Author:

Date:

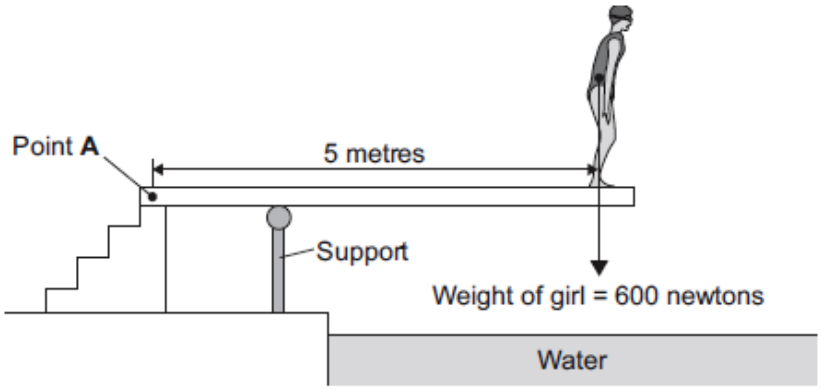
Time: 101

Marks: 101

Comments:

Q1. **Figure 1** shows a girl standing on a diving board.

Figure 1



(a) Calculate the moment of the girl's weight about Point **A**.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

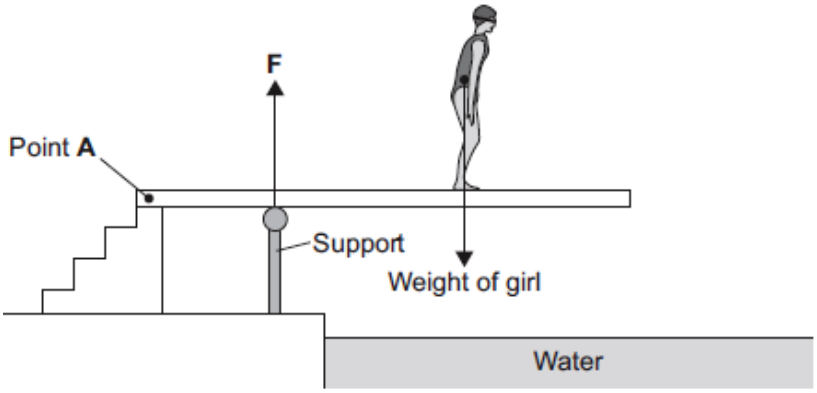
Moment = ... newton metres

(2)

(b) **Figure 2** shows the girl standing at a different place on the diving board.

The support provides an upward force **F** to keep the diving board balanced.

Figure 2



Complete the following sentence.

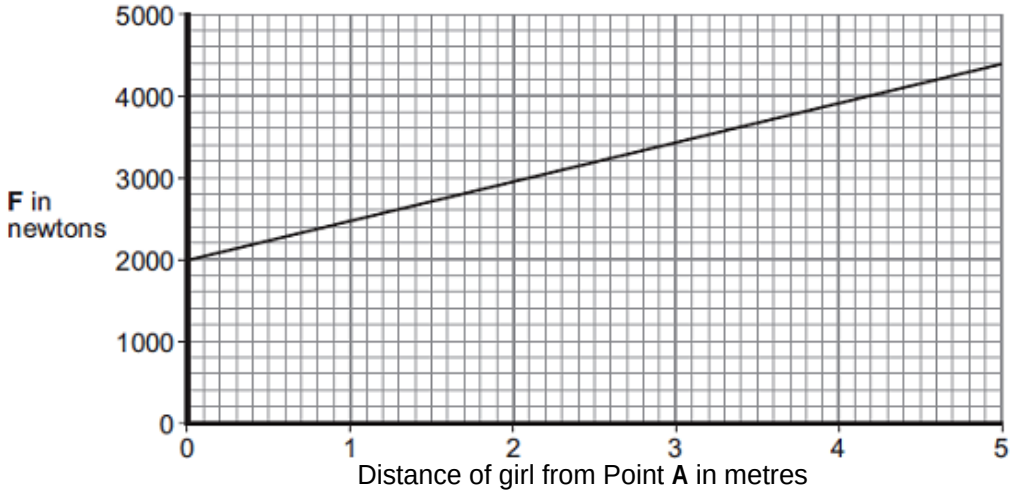
The diving board is not turning. The total clockwise moment is balanced

by the total ..... .

(1)

(c) **Figure 3** shows how the upward force **F** varies with the distance of the girl from Point **A**.

Figure 3



(i) Use **Figure 3** to determine the upward force **F** when the girl is standing at a distance of 3 metres from point **A**.

Upward force **F** = ... newtons

(1)

(ii) What conclusion should be made from **Figure 3**?

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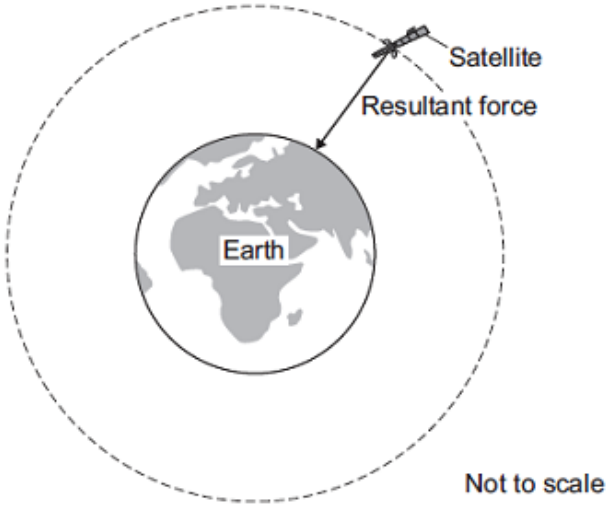
(1)
(Total 5 marks)

Q2. Man-made satellites can orbit the Earth, as shown in the figure below.



The satellite experiences a resultant force directed towards the centre of the orbit.

The resultant force is called the centripetal force

(a) What provides the centripetal force on the satellite?

.....

(1)

(b) State **two** factors that determine the size of the centripetal force on the satellite.

1 .....

2 .....

(2)

(c) The table below gives data for five different satellites orbiting the Earth.

Satellite	Average height above Earth's surface in kilometres	Time taken to orbit Earth once in minutes	Mass of satellite in kilograms
A	370	93	419 000
B	697	99	280
C	827	103	630
D	5 900	228	400
E	35 800	1440	2 030

(i) State the relationship, if any, between the height of the satellite above the Earth's surface and the time taken for the satellite to orbit the Earth once.

.....

.....

(1)

(ii) State the relationship, if any, between the time taken for the satellite to orbit the Earth once and the satellite's mass.

.....

.....

(1)

(d) Over 300 years ago, the famous scientist Isaac Newton proposed, with a 'thought experiment', the idea of satellites.

Newton suggested that if an object was fired at the right speed from the top of a high mountain, it would circle the Earth.

Why did many people accept Isaac Newton's idea as being possible?

Tick (✓) **one** box.

Isaac Newton was a respected scientist who had made new discoveries before. ☐

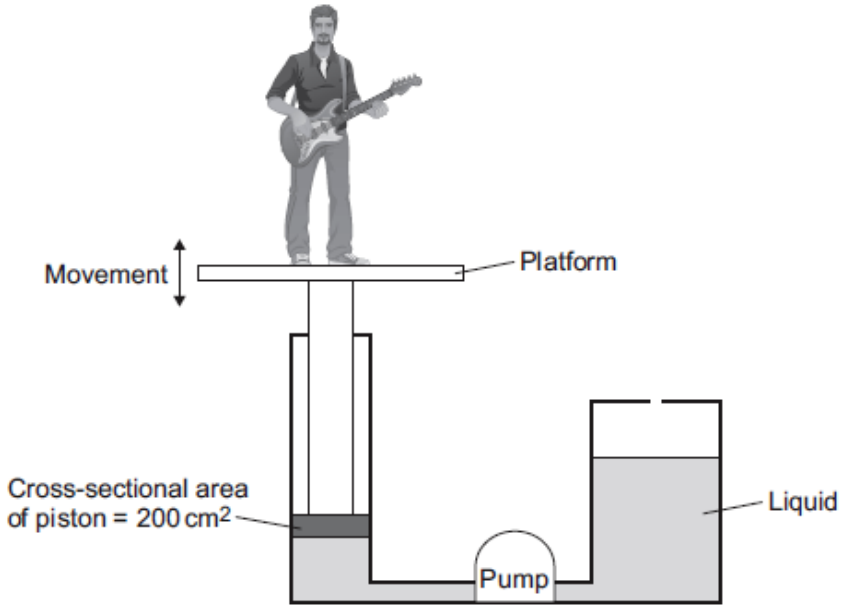
Isaac Newton went to university. ☐

It was a new idea that nobody else had thought of before. ☐

(1)
(Total 6 marks)

Q3. Musicians sometimes perform on a moving platform.

The figure below shows the parts of the lifting machine used to move the platform up and down.



(a) What name is given to a system that uses liquids to transmit forces?

Draw a ring around the correct answer.

electromagnetic **hydraulic** **ionising**

(1)

(b) To move the platform upwards, the liquid must cause a force of 1800 N to act on the piston.

The cross-sectional area of the piston is 200 cm^2.

Calculate the pressure in the liquid, in N / cm^2, when the platform moves.

Use the correct equation from the Physics Equations Sheet.

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.....

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Pressure = ... N / cm^2

(2)

(c) A new development is to use oil from plants as the liquid in the machine.

Growing plants and extracting the oil requires **less energy** than producing the liquid usually used in the machine.

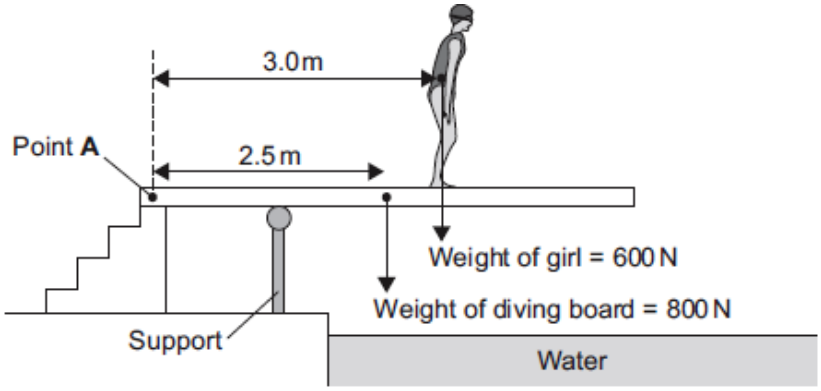
Draw a ring around the correct answer to complete the sentence.

Using the oil from the plants gives | an environmental / an ethical / a social | advantage over the liquid usually used.

(1)
(Total 4 marks)

Q4. (a) **Figure 1** shows a girl standing on a diving board.

Figure 1



Calculate the total clockwise moment of the weight of the diving board and the weight of the girl about Point **A**. Give the unit.

Use the correct equation from the Physics Equations Sheet.

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.....

Total clockwise moment about Point **A** = ...

(4)

(b) **Figure 2** shows the girl standing at a different place on the diving board.

The support provides an upward force **F** to keep the diving board balanced.

Figure 2

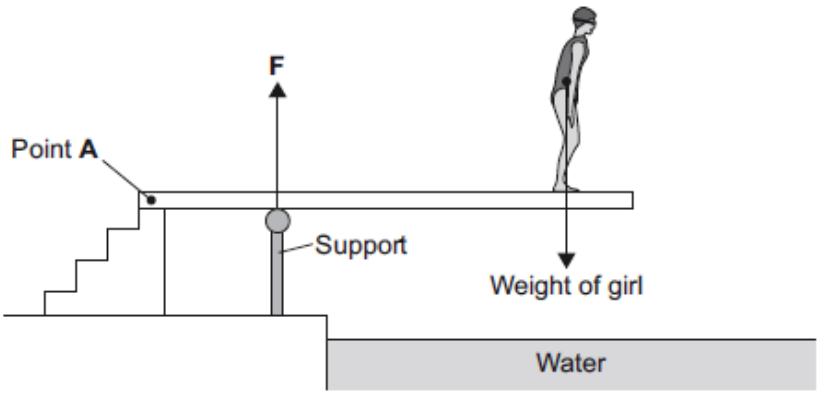
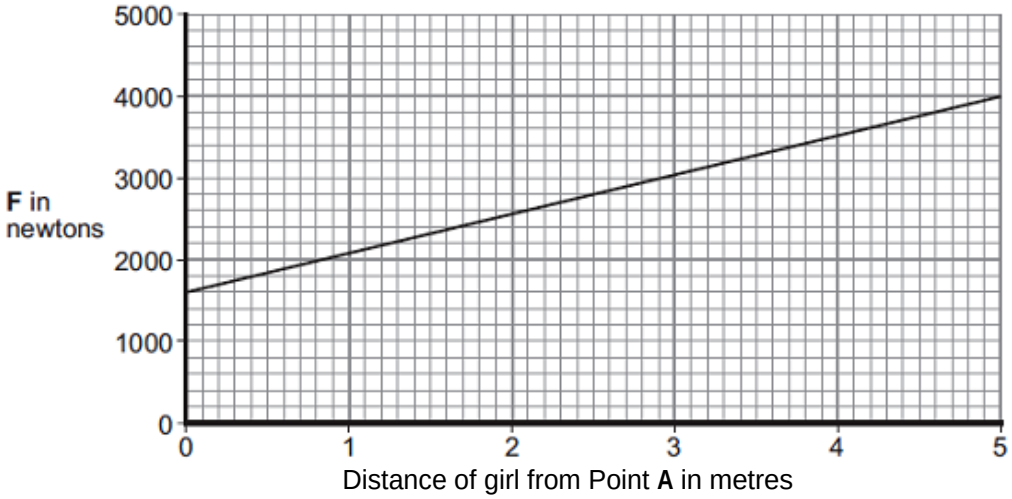


Figure 3 shows how the upward force **F** varies with the distance of the girl from Point **A**.

Figure 3



Explain, in terms of clockwise and anticlockwise moments, why the upward force **F** increases as shown in **Figure 3**.

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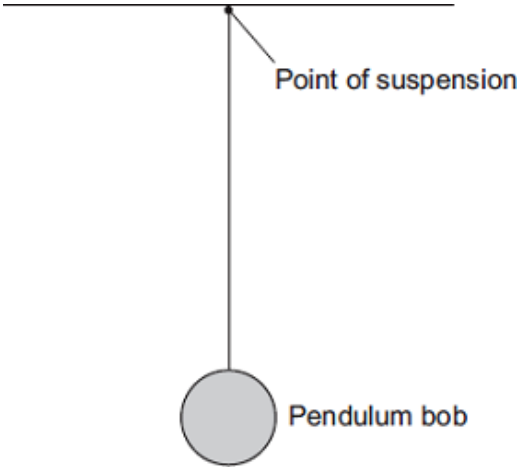
(3)
(Total 7 marks)

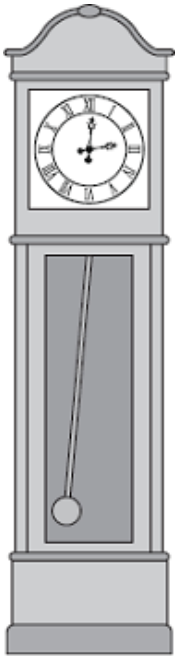
Q5. (a) The diagram shows a pendulum.



Draw an X on the diagram above, so that the centre of the **X** marks the centre of mass of the pendulum bob.

(1)

(b) A large clock keeps time using the swing of a pendulum.



(i) The frequency of the swinging pendulum is 0.5 hertz.

Calculate the periodic time of the pendulum.

Use the correct equation from the Physics Equations Sheet.

.....

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.....

Periodic time = ... seconds

(2)

(ii) Calculate the number of complete swings the pendulum would make in 60 seconds.

Use your answer from part (b)(i) in your calculation.

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.....

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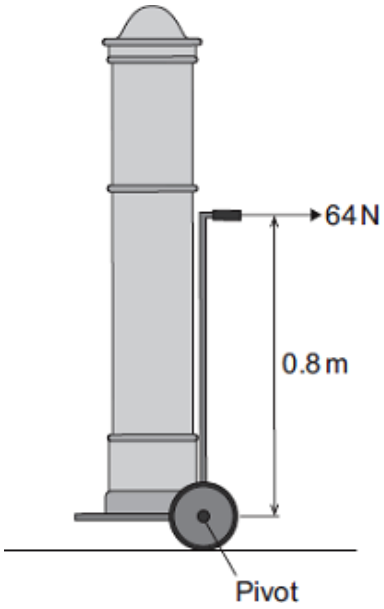
Number of swings in 60 seconds = ...

(2)

(c) The diagram shows a clock on a trolley.

The trolley is being used to move the clock.



Calculate the moment of the 64 N force about the pivot.

Use the correct equation from the Physics Equations Sheet.

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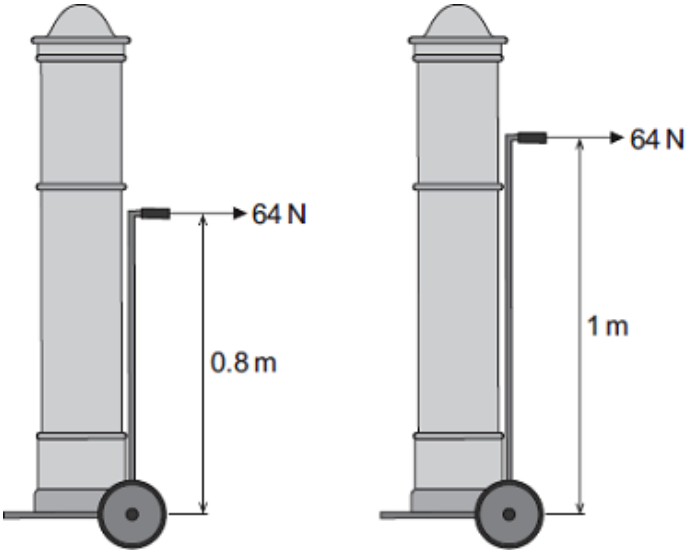
Moment of the force = ... Nm

(2)

(d) The design of the trolley is now changed to make it taller.



How does making the trolley taller affect the moment produced by the 64 N force about the pivot?

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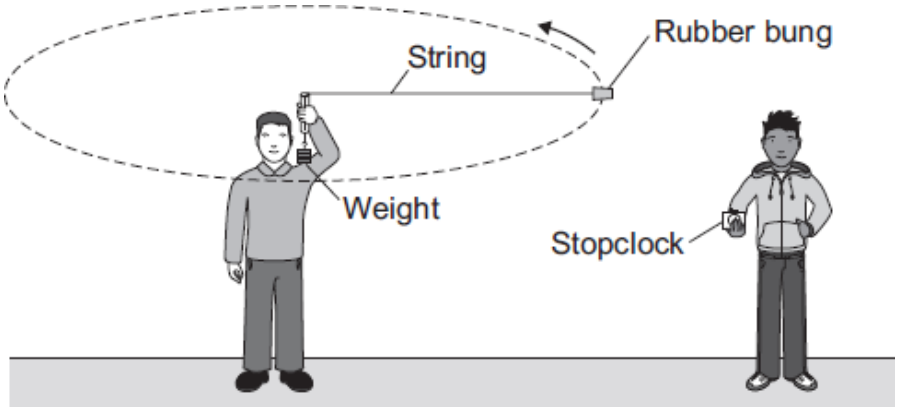
(1)

(Total 8 marks)

Q6. The diagram shows the apparatus used by two students to find out how the centripetal force acting on an object affects the speed of the object.



(a) (i) In which direction does the centripetal force act on the rubber bung?

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(1)

(ii) In this investigation, what provides the centripetal force?

.....

.....

(1)

(b) One student swung the rubber bung around in a circle at constant speed. The second student timed how long it took the rubber bung to complete 10 rotations. The students then calculated the speed of the rubber bung, using the radius of the circle and the time to complete one rotation. The students repeated this for several different values of centripetal force.

(i) During the investigation, the radius of the circle and the mass of the rubber bung were not changed.

Explain why.

.....

.....

.....

.....

(2)

(ii) One of the variables in this investigation was the time taken by the rubber bung to complete 10 rotations.

Which **two** words can be used to describe this variable?

Draw a ring around each of your **two** answers.

continuous **control** **dependent** **independent**

(1)

(iii) The students timed 10 rotations of the rubber bung, rather than just one rotation.

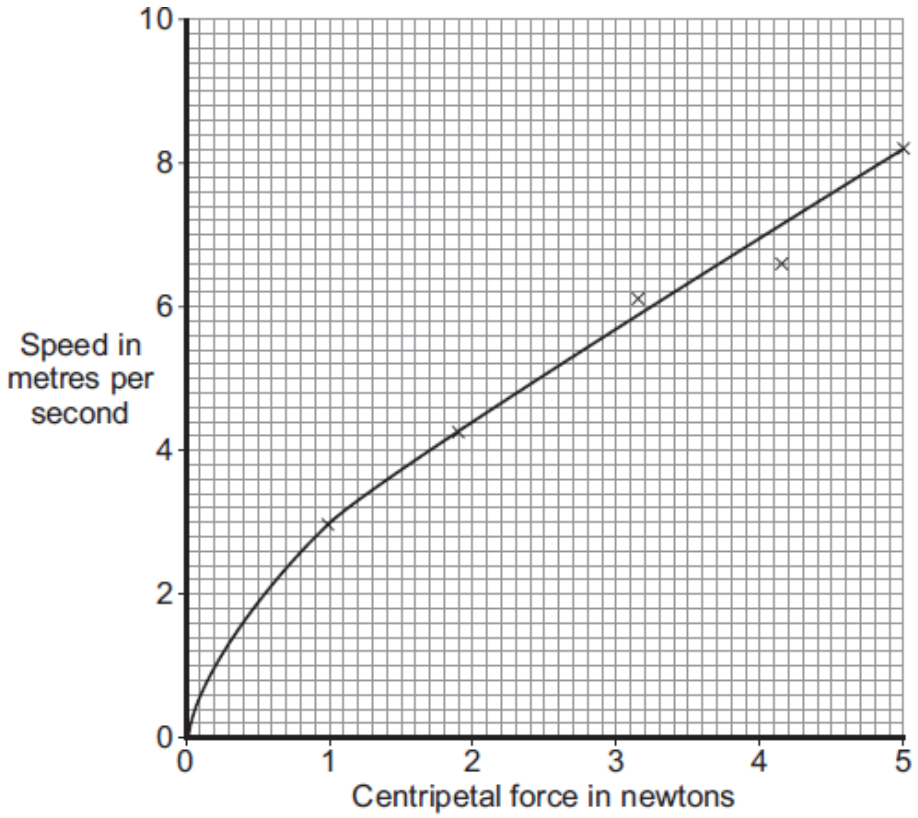
Suggest why.

.....

.....

(1)

(c) The graph shows the students' data.



There is a relationship between the speed of an object moving in a circle and the centripetal force acting on the object.

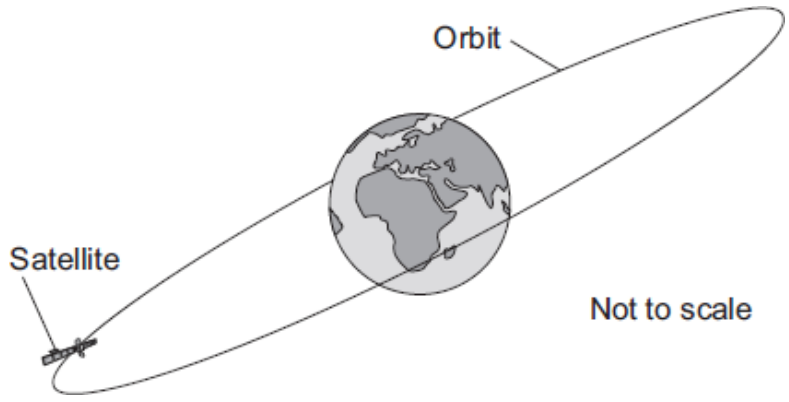
What conclusion about this relationship can the students make from their data?

.....

.....

(1)

(d) The diagram shows a satellite in a circular orbit above the Earth.
The satellite is part of the global positioning system (GPS).
The satellite orbits the Earth **twice** every 24 hours.



(i) What provides the centripetal force needed to keep the satellite in its orbit around the Earth?

.....

(1)

(ii) Is this satellite in a geostationary orbit?

Draw a ring around your answer. **Yes** **No**

Give a reason for your answer.

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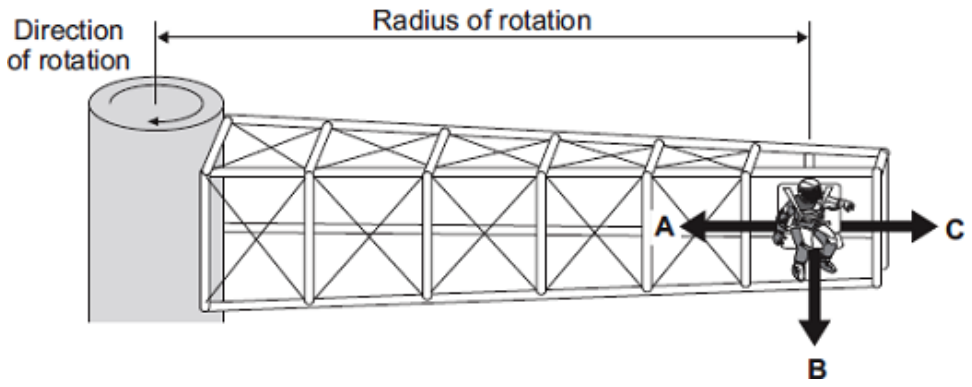
(1)
(Total 9 marks)

Q7. The diagram shows a 'G-machine'. The G-machine is used in astronaut training.



The G-machine moves the astronaut in a horizontal circle.

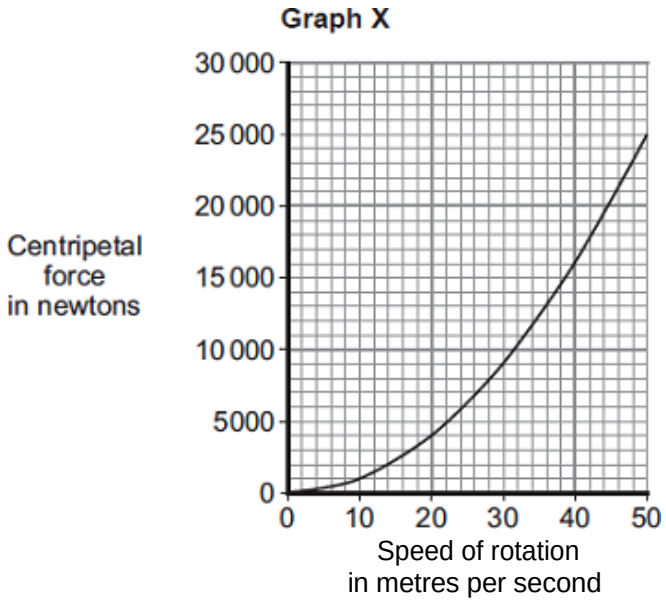
(a) In which direction, **A**, **B** or **C**, does the centripetal force on the astronaut act?

Write your answer in the box. ☐

(1)

(b) The centripetal force on the astronaut is measured.

Graph X shows how the centripetal force is affected by the speed of rotation.
The radius of rotation is kept the same.



(i) Use **Graph X** to determine the centripetal force on the astronaut when rotating at a speed of 30 metres per second.

Centripetal force = ... newtons

(1)

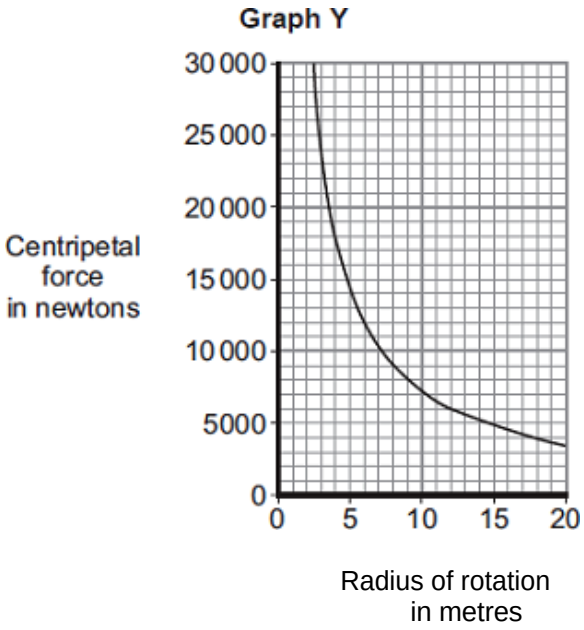
(ii) Complete the following sentence to give the conclusion that can be made from **Graph X**.

Increasing the speed of rotation of a G-machine will .....

the centripetal force on the astronaut.

(1)

(iii) **Graph Y** shows how the centripetal force is affected by the radius of rotation, when the speed of rotation is kept the same.



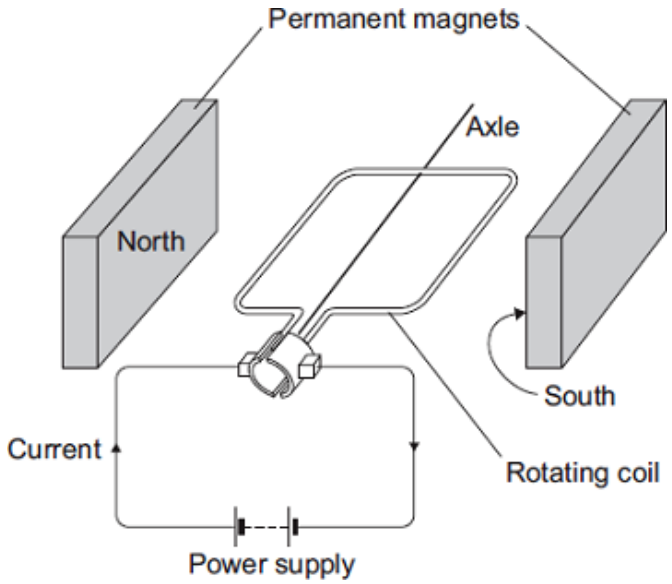
Complete the following sentence to give the conclusion that can be made from **Graph Y**.

The greater the radius of rotation, the ..... the centripetal force

on the astronaut.

(1)

(c) The G-machine is rotated by an electric motor. The diagram shows a simple electric motor.



The following statements explain how the motor creates a turning force. The statements are in the wrong order.

M – The magnetic field interacts with the magnetic field of the permanent magnets.

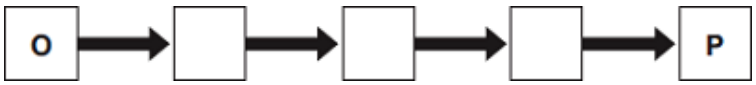
N – A magnetic field is created around the coil.

O – The power supply applies a potential difference across the coil.

P – This creates a force that makes the coil spin.

Q – A current flows through the coil.

Arrange the statements in the correct order. Two of them have been done for you.



(2)

(d) The electric motor produces a turning force.

Give **two** ways of increasing the turning force.

1 .....

.....

2 .....

.....

(2)

(e) Draw a ring around the correct answer to complete the sentence.

It costs a lot of money to send astronauts into space.

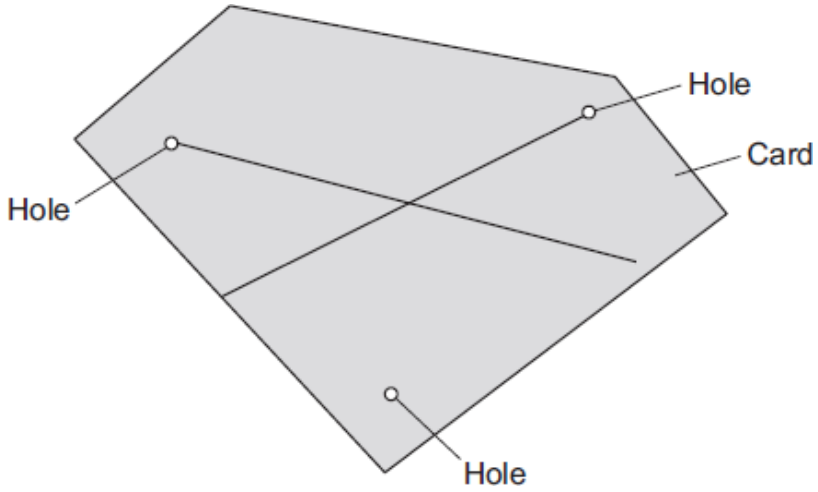
This is

an economic
an environmental
a social

issue.

(1)
(Total 9 marks)

Q8. 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.

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(3)

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

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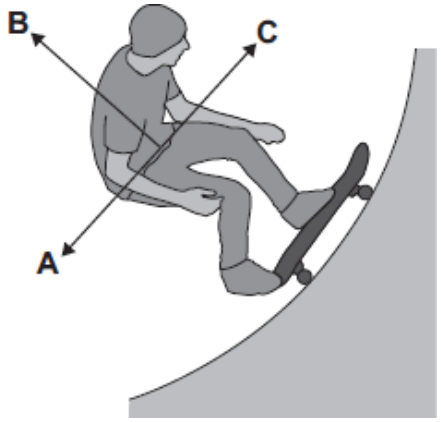
(2)
(Total 5 marks)

Q9. The drawing shows a skateboarder moving in a circular path.

• Centre of circular path



(a) (i) What is the name of the resultant force which allows the skateboarder to move in a circular path?

Draw a ring around your answer.

centripetal force **gravitational force** **weight**

(1)

(ii) In which direction, **A**, **B** or **C**, does this resultant force act on the skateboarder?

Write your answer, **A**, **B** or **C**, in the box. ☐

(1)

(b) Another skateboarder has a smaller mass.

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

(i) She uses the same part of the ramp at the same speed.

The force which allows her to move in a circular path will need

to

decrease.
stay the same.
increase.

(1)

(ii) If she goes faster, this resultant force will need to

decrease.
stay the same.
increase.

(1)

(c) On their website, the managers of a skateboard park give the following information about some of the ramps where skateboarders move in a circular path.

Name of ramp	**Inside radius of the ramp in metres**
Bull pit	6
Dragon's den	11
Tiger cage	8
Witch's cauldron	7

A skateboarder uses each ramp at the same speed.

Name the ramp where the resultant force on the skateboarder will need to be the greatest.

.....

Explain the reason for your answer.

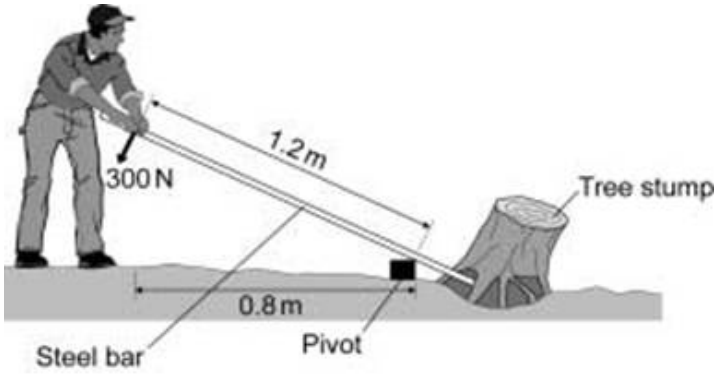
.....

.....

(2)

(Total 6 marks)

Q10. (a) The diagram shows a gardener using a steel bar to lever a tree stump out of the ground.



When the gardener pushes with a force of 300 N the tree stump just begins to move.

Calculate the moment produced by the gardener on the steel bar.

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

.....

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.....

.....

.....

.....

Moment = ...

(4)

(b) Using a longer steel bar would have made it easier for the gardener to lever the tree stump out of the ground.

Explain why.

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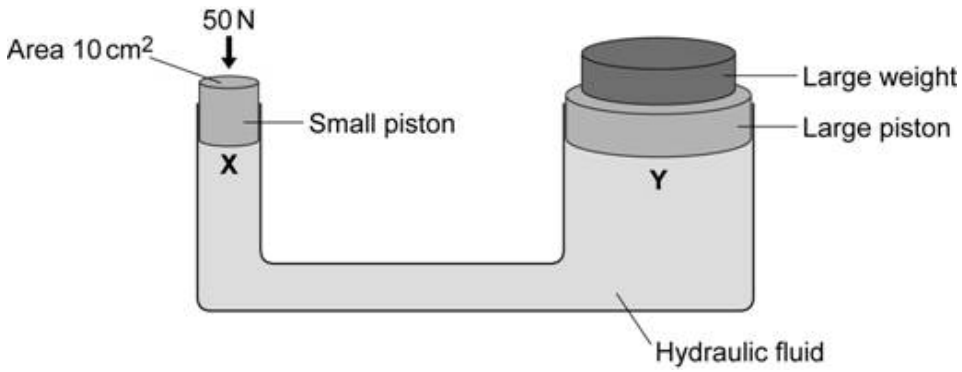
(3)
(Total 7 marks)

Q11. 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 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.

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Pressure = ... N/cm^2

(2)

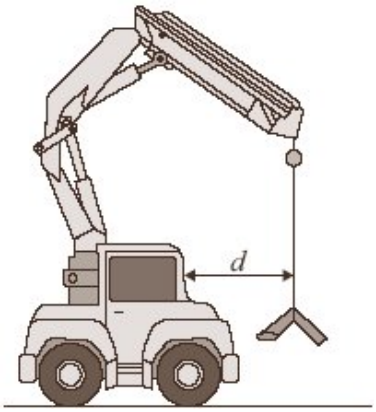
(c) Complete the following sentence.

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

(1)

(Total 4 marks)

Q12. 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)

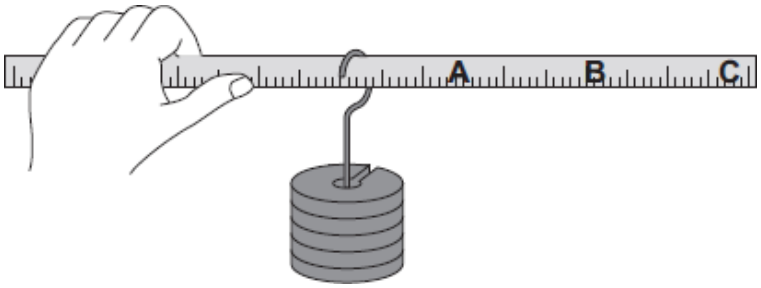
(d) How should the data in the table have been obtained?

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)

Q13. (a) A student holds a ruler at one end and slides a weight along the ruler.



At which point, **A**, **B** or **C**, will the turning effect of the weight feel greatest?

Write your answer, **A**, **B** or **C**, in the box. Point ☐

(1)

(b) Complete the following sentence by drawing a ring around the correct word in the box.

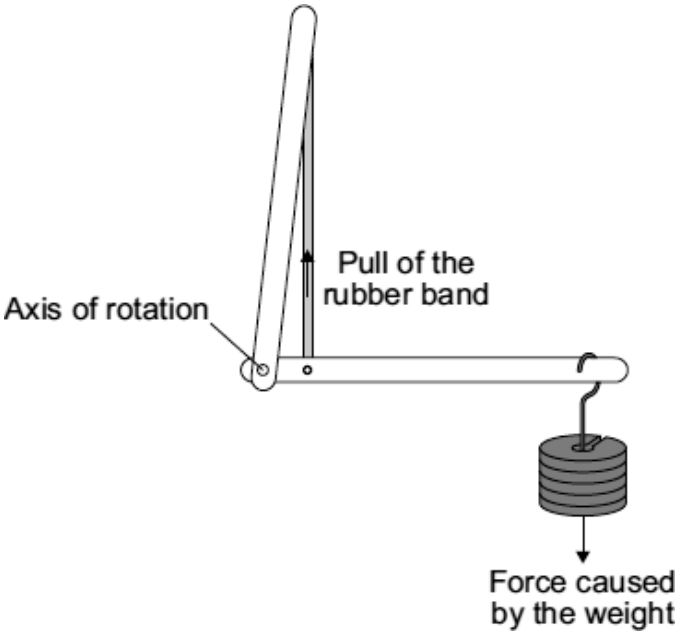
The turning effect of a force is called the

axis
equilibrium
moment

of the force.

(1)

(c) In a human arm, the biceps muscle provides the force needed to hold the arm horizontal. A student uses a model in which a rubber band represents the biceps muscle.



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

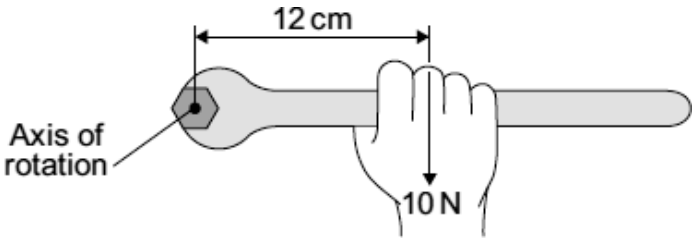
To hold the model arm horizontal, the pull from the rubber band will be

bigger than
smaller than
the same as

the force caused by the weight.

(1)

(d) The diagram shows a long spanner.



Use the equation in the box to calculate the moment, in N cm, being produced.

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.

.....

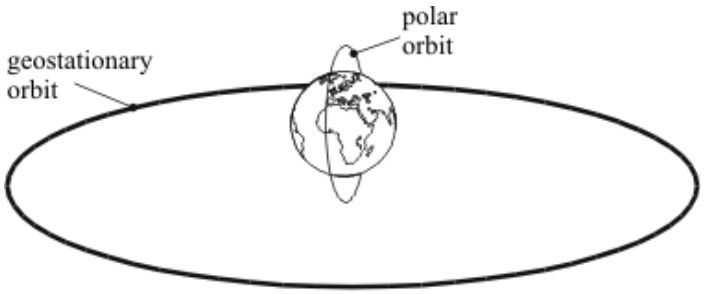
.....

Moment = ... N cm

(2)

(Total 5 marks)

Q14. The diagram below shows the orbits for two types of satellite, a polar orbit and a geostationary orbit.



A satellite in stable Earth orbit moves at a constant speed in a circular orbit because there is a single force acting on it.

(i) What is the direction of this force?

.....

(1)

(ii) What is the cause of this force?

.....

(1)

(iii) What is the effect of this force on the **velocity** of the satellite?

.....

(1)

(iv) In which of the orbits shown above would this force be bigger?
Explain the reason for your answer.

.....

.....

(2)

(v) Explain why the kinetic energy of the satellite remains constant.

.....

.....

.....

(2)
(Total 7 marks)

Q15. 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.

Photograph supplied by Hemera/Thinkstock

(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 .....

.....

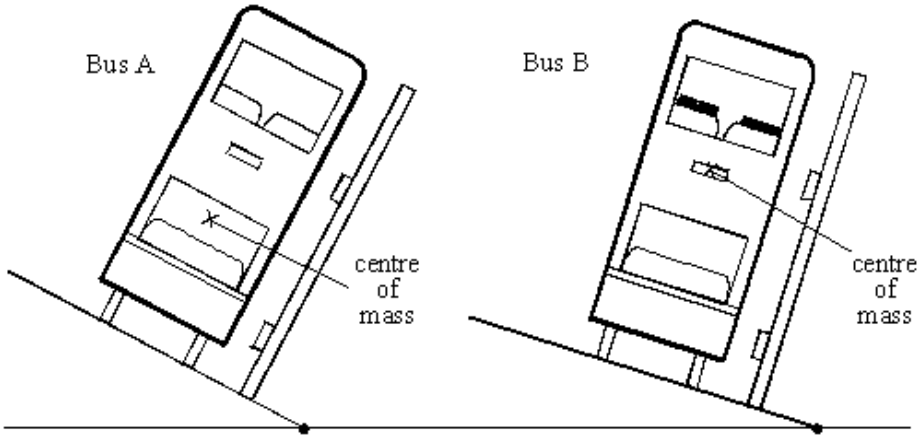
2 .....

.....

(2)
(Total 4 marks)

Q16. The diagram shows two buses. Bus A is empty. Bus B contains bags of sand upstairs to represent passengers.

Each bus has been tilted as far as it can without falling over.



(a) Each bus will topple over if it is tilted any further.

Explain, in as much detail as you can, why this will happen.

(You can draw on one of the diagrams as part of your answer if you want to.)

.....

.....

.....

(2)

(b) What difference does it make to the stability of the bus when the upper deck is full of "passengers"? Explain your answer as fully as you can.

.....

.....

.....

(3)

(c) Why are the bags of sand in bus B only put upstairs?

.....

.....

(1)

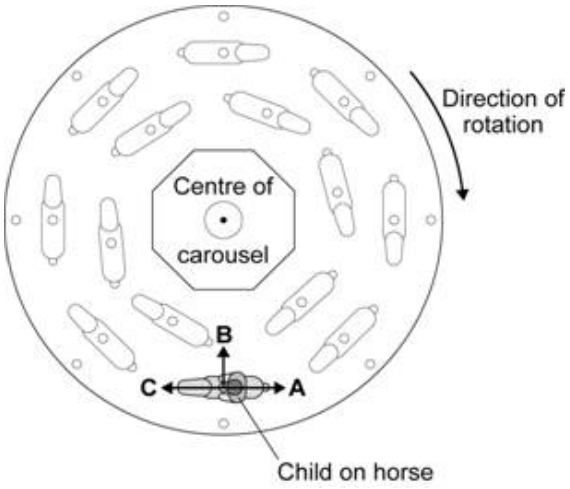
(Total 6 marks)

Q17. 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)

M1. (a) 3000

*allow **1** mark for correct substitution, ie 600 × 5 provided no subsequent step*

2

(b) anticlockwise moment

must be both words

1

(c) (i) 3400

allow 3.4 kilo (newtons)

1

(ii) as the distance (of the girl from point A) increases, force F increases

allow gets bigger for increases

force is (directly) proportional to distance will negate any correct response

1

[5]

M2. (a) gravitational attraction (between the satellite and the Earth)

allow gravity

allow weight of the satellite

1

(b) any **two** from:

- mass of satellite
- speed / velocity (of satellite)
- radius of orbit / circle

allow height above the Earth

radius / height alone is insufficient

2

(c) (i) increasing the height (above the Earth's surface) increases the time (for one orbit)

allow a positive correlation

allow as one gets bigger, the other gets bigger, or vice versa

ignore they are directly proportional

1

(ii) there is no relationship / correlation

1

(d) Isaac Newton was a respected scientist who had made new discoveries before

1

[6]

M3. (a) hydraulic

1

(b) 9

*allow **1** mark for a correct substitution, ie* $\frac{1800}{200}$ *provided no subsequent step*

2

(c) an environmental

1

[4]

M4. (a) 3800

*allow **1** mark for 2000*

*allow **1** mark for 1800*

*if neither of above scored, allow correct substitution for **1** mark (800 × 2.5) + (600 × 3)*

if moments have been calculated incorrectly, allow 1 mark for adding their two moment values correctly

3

newton metres **or** Nm

*do **not** allow nm **or** NM*

1

(b) as the girl increases her distance (from the pivot) the clockwise moment increases

1

(F must increase) as the anticlockwise moment must increase

1

so (the anticlockwise moment) is equalled / balanced by the clockwise moment
or
so resultant / overall moment (on the board) is zero

accept to balance / equal the moments

to balance the board is insufficient

1

[7]

M5. (a) centre of X drawn at centre of pendulum bob

judged by eye

accept dot drawn at centre of circle

1

(b) (i) 2

*allow **1** mark for correct substitution, ie* $\frac{1}{0.5}$ *provided no subsequent step shown*

2

(ii) 30

or

60 ÷ their (b)(i) correctly calculated

allow 1 mark for $\frac{60}{2}$

or $\frac{60}{\text{their (b)(i)}}$

or *0.5 × 60*

provided no subsequent step shown

2

(c) 51.2

*allow **1** mark for correct substitution, ie 64 × 0.8 provided no subsequent step shown*

2

(d) it increases (the moment)

must be comparative

*accept **1** mark for calculation of the moment = 64 (Nm)*

1

[8]

M6. (a) (i) towards the centre of the circle

accept inwards

accept a correct description

'along the string' is insufficient

1

(ii) tension (in the string)

accept pull of the string

'the string' is insufficient

or

weight (on the end of the string)

'the student' is insufficient

'turning action' is insufficient

1

(b) (i) each may (also) affect the speed

accept results for speed

1

so only one independent variable

accept only one variable affects dependent variable

'fair test' is insufficient

'they are control variables' is insufficient

1

(ii) continuous

both required

dependent

1

(iii) reduces (absolute) timing error (for one rotation)

accept too fast to time one

or

increases / improves reliability / accuracy (for one rotation)

ignore checking for anomalous results

to work out an average is insufficient

1

(c) speed increases with centripetal force

accept positive correlation

*do **not** accept proportional*

1

(d) (i) gravitational pull (of the Earth)

accept gravity

1

(ii) **No**

both parts required – however this may have been subsumed within the reason

geostationary orbits once every 24 hours

accept a correct comparative description

1

[9]

M7. (a) A

1

(b) (i) 9000

*an answer of 9 k(N) gains **1** mark*

1

(ii) increase

accept other comparative terms, eg give a bigger

affect / change is insufficient

1

(iii) small<u>er</u>

accept other comparative terms, eg less

1

(c) Q N M

all three in correct boxes

*one statement in correct box gains **1** mark*

2

(d) any **two** from:

- increase the current / p.d. (supplied to the coil)
  *accept reduce the resistance of the coil **or** increase cross sectional area of wire*
  *accept more cells / batteries **or** turn up the power supply*
  increase power is insufficient
- increase number of turns (on the coil)
- increase the area (of the coil)
  accept increase the width of the coil
  increase width / size is insufficient
- increase the (strength of the permanent) magnetic field
  accept move the magnets closer to the coil
  accept use stronger magnets
  *do **not** accept use larger magnets*

2

(e) an economic

1

[9]

M8. *Resource currently unavailable*

M9. (a) (i) centripetal force
accept any unambiguous correct indication

1

(ii) **B**

1

(b) (i) decrease
accept any unambiguous correct indication

1

(ii) increase
accept any unambiguous correct indication

1

(c) Bull pit

1

smallest (inside) radius
accept smallest diameter / circumference

1

[6]

M10. (a) (i) 360

*allow **1** mark for correct length used ie 1.2 m*
*allow **2** marks for substitution into correct equation - ie 300 × 1.2*
*allow **1** mark only for an answer 240*

3

(ii) Newton-metre or Nm

1

(b) the force is applied further from the pivot

1

which causes an increased moment to act on the steel bar

1

and therefore an increased force acts on the tree stump

1

[7]

M11. (a) force

1

(b) 5

*allow **1** mark for substitution into correct equation ie* $\frac{50}{10}$

2

(c) the same as / equal to

accept =

1

[4]

M12. (a) any **two** from:

- inversely proportional
- as the load gets biggerthe (maximum safe) distance gets less

  allow 'as the mass increases the distance decreases'
  accept an unspecified response e.g. 'big load at a short distance' for (1)
- load × distance = 60 (kNm)

2

(b) yes, because 30 × 2 = 60 (2)

accept for (1) a correct but insufficiently explained response e.g. 'yes because it's safe'

accept for (2) a correct response which is sufficiently explained

e.g. 'yes, because 60 (kNm) at 1 metre is safe and 30 (kNm) is half the load at twice the distance

*do **not** accept 'no' and do not accept just 'yes'*

*do **not** accept 'yes, because 30 is between 24 and 40 and 2 is between 2.5 and 1.5'*

*do **not** accept 'the crane/ cable may break' or other dangers*

2

(c) the crane may/will topple over/fall <u>over/forward</u>

1

(d) results of experiments on this mobile crane

accept any unambiguous indication

1

[6]

M13. (a) **C**

1

(b) moment

accept any unambiguous correct indication

1

(c) bigger than

accept any unambiguous correct indication

1

(d) 120 (Ncm)

*allow **1** mark for correct substitution*

ie 12 × 10

2

[5]

M14. (i) towards Earth

for 1 mark

1

(ii) gravity

for 1 mark

1

(iii) changes direction

for 1 mark

1

(iv) polar orbit;
closer

for 1 mark each

2

(v) speed constant (1)
mass constant (1)

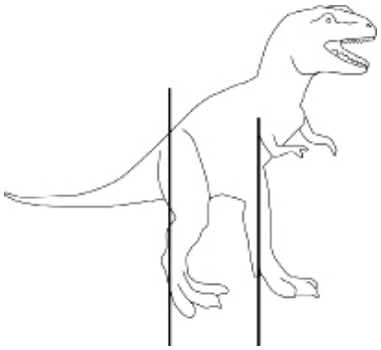
for 1 mark each

2

[7]

M15. (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
- makes 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]

M16. (a) *idea*

- line of action of weight/force/gravity
  (if drawn: a vertical line through the centre of mass)
- falls outside the (wheel) base (mark NOT from diagram)

for 1 mark each

2

(b) ideas that

- less stable/topples more easily
- centre of mass at a higher level
- so need small angle to make line of action of weight fall outside (wheel) base

for 1 mark each

3

(c) idea that

this is the most unstable condition (when bus used)
or
this makes c. of m. as high as it is likely to be

for 1 mark

1

[6]

M17. (a) centripetal

1

(b) **B**

1

(c) decreases

1

[3]