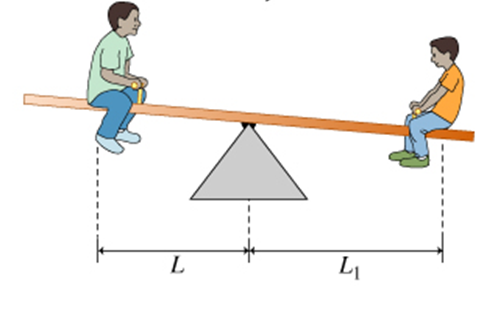


|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year 12 Physics – Test 2 (Task 2)  **Gravity and Motion** | | | | |
|  | | | | |
| Name: | | | | |
| **Time allowed**: 50 minutes + 5 mins reading time (at discretion of teacher) | | | | |
| **Section** | Number of questions | Your Mark | Marks available | Percentage of Test |
| **Section One:**  Short answer | 4 |  | 13 | 30 |
| **Section Two**:  Extended answer | 3 |  | 22 | 50 |
| **Section Three:**  Comprehension  and data analysis | 1 |  | 12 | 20 |
|  | **Total** |  | **47** | **100** |

* Final answers should be given up to three significant figures and include appropriate units where appropriate. Questions containing the instruction "ESTIMATE" should be given two significant figures and include appropriate units where applicable.
* Scientific Calculators are allowed.
* No notes allowed.
* Formula sheet is provided.

**Section One:** Short answer



1. **(3 marks)**

A small boy and his older brother are using a see-saw with adjustable seating positions, as shown.

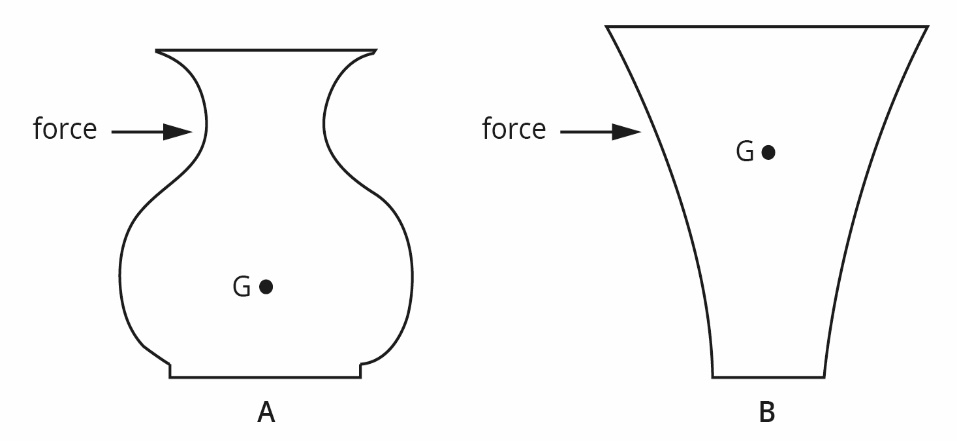
If the smaller boy has a mass of 20.0kg and is 2.20m from the pivot, what is the larger boys mass if he is sitting 1.10 m from the pivot? You may assume the see-saw is horizontal

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ∑ACM = ∑CM | 1 |
| F x r = F2 x r1  F x 1.10 = 20.0 x 9.8 x 2.20  F x 1.10 = 431.2  F = 392 N | 1 |
| m = 392/9.8 = 40.0 kg (or done in previous step) | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kg

1. **(4 marks)**

The diagrams below show designs for two vases. The centre of mass, G, is marked on each.



State which of the two vases is more stable and therefore least likely to be tipped over. Using the diagrams and appropriate physics principles, explain your answer.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Vase A is more stable. | 1 |
| For B, the distance / angle through which it must travel to reach the point when G is outside the base is less than it is for A. | 1 |
| At the point where G is outside the base, there is a clockwise moment about the pivot which will cause the vase to tip over. | 1 |
| Appropriately labelled lines | 1 |

1. **(4 marks)**

Astronauts in training for weightlessness are given some practice in a plane, which flies in vertical loop of radius 600 m at such a speed that at the top of the path they feel “weightless”. At what speed must the plane be flying to achieve this effect? Carefully explain your logic using appropriate equations or vector diagrams.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| When weightless Fn = zero | 1 |
| Fc = Fn + Fw  therefore Fc = Fw | 1 |
| mv2/r = mg  v = √gr | 1 |
| v= √ 9.8 x 600  v = 76.7 ms-1 | 1 |

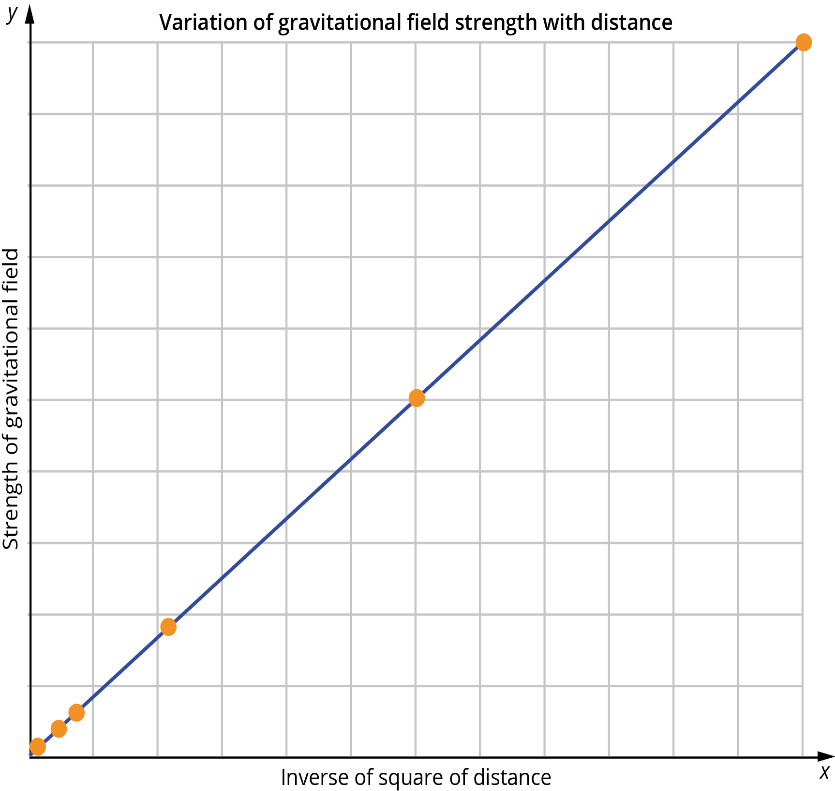
Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **(2 marks)**

A researcher measured the strength of the gravitational field (*g*) of an object of mass (*m*) at a range of distances (*r*) from the object and plotted the inverse of the square of the distance from the object against gravitational field strength. The graph below shows the plot.

Describe what the shape of the graph indicates about the relationship between gravitational field strength and distance from the object.

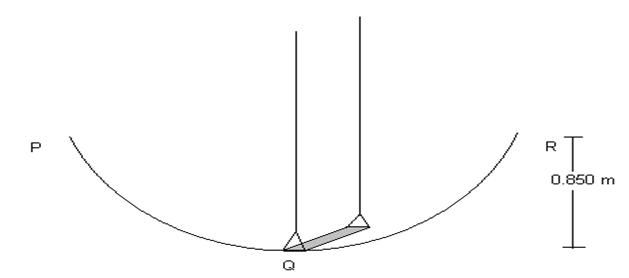
|  |  |
| --- | --- |
| **Description** | **Marks** |
| Recognition only that as distance from the object increases the gravitational field strength decreases | 1 |
| For full marks, recognition that there is a linear relationship between field strength and inverse square of distance  (i.e. ) | 2 |



**Section Two:** Extended answer

1. **(8 marks)**

Sharon is playing on a swing which is supported by two 2.60m long cables. The combine mass of Sharron and the swing is 39.4 kg.



She is able to swing to a height of 0.850 m (points P and R) above the lowest point of the swing (point Q).

1. At which point in the swing will Sharon have the greatest velocity and what is her velocity at that point?

(3 Marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Point Q | 1 |
|  | 1 |
| masses cancel out | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. The tension in the two cables will vary as the swing moves through its arc. What will be the maximum tension in each cable?

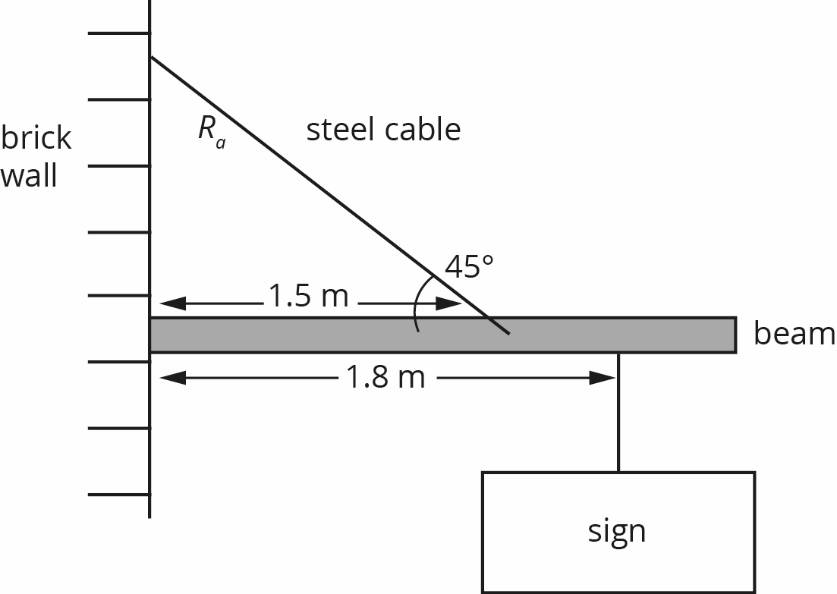
(5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Net force = Centripetal Force  T  W | 1 |
|  | 1 |
|  | 1 |
| Tension per cable (2) | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N

1. **(9 marks)**

A 75 kg sign is suspended from a uniform 8.5 kg wooden beam of length 2.2 m. The sign is 1.8 m from the wall and a steel cable is attached to the beam 1.5 m from the wall at an angle of 45°.



1. Determine the tension in the steel cable.

(5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Sum of moments at pivot point (hinge) = 0 | 1 |
|  | 1-3 |
|  | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N

1. Determine the size and direction of the force supplied by the brick wall on the beam.

(4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| In vertical direction | 1 |
|  | 1 |
|  | 1 |
|  | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N Direction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **(5 marks)**

Ben, whose total mass is 1.20 x 102 kg (Ben and space suit) is on a spacewalk 725 km above the Earth. Assuming that the force of the nearby space ship is insignificant compared to the force of the Earth,

1. What gravitational acceleration does Ben experience on his spacewalk?

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | 1 |
|  | 1 |
|  | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What gravitational force is on Ben?

(2 marks)

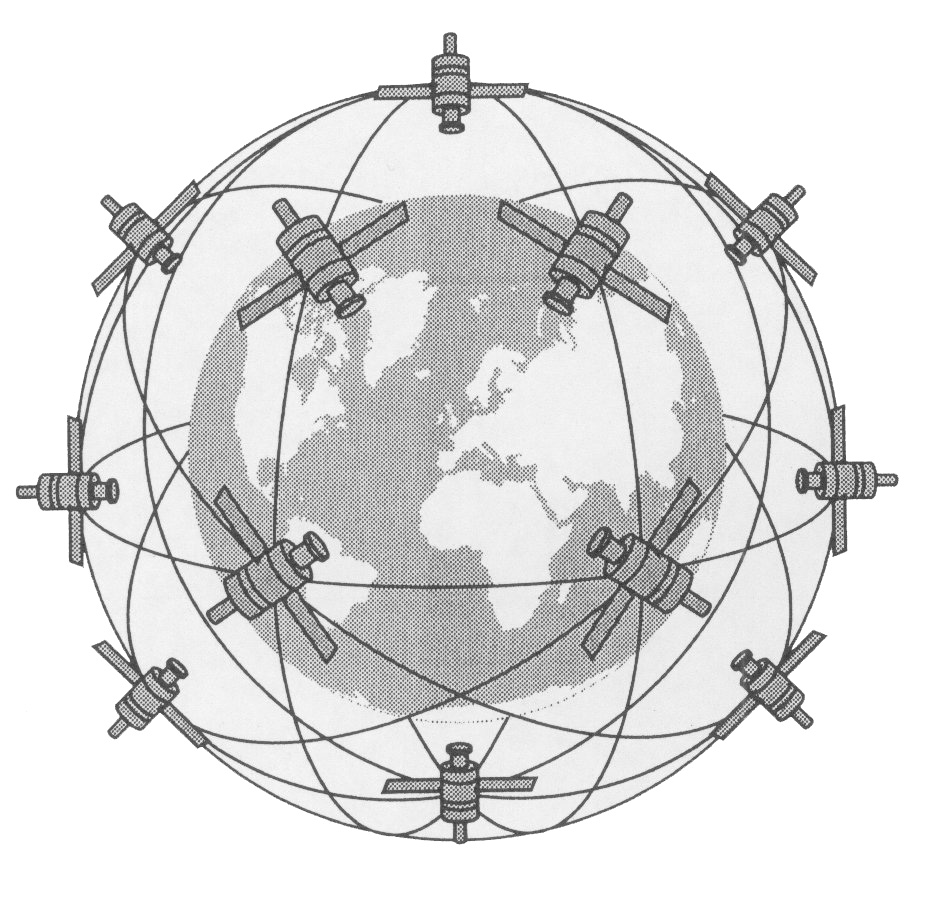
|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | 1 |
|  | 1 |

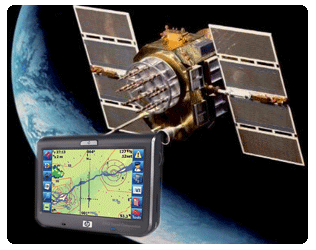
Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N

**Section Three:** Comprehension and data analysis

1. **(12 marks)**

In 10 years Global Positioning System [GPS] has gone from the USA military to being navigator tools to being a normal feature in many luxury cars today. They work by transmitting a beam of electro-magnetic radiation from an aerial on your car roof to one of 24 satellites surrounding the Earth. The reflected beam is received also by an aerial on your roof and your location on the ground can be determined to 50 m. In military application the resolution is less than 10 cm.





1. If the height of any one of these satellites is 17 800 km, what is the time for 1 orbit?

(4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | 1 |
|  | 1 |
|  | 1 |
|  | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ s

1. Calculate how far such a satellite will travel in 10 mins.

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | 1 |
|  | 1 |
|  | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m

1. Determine the strength of Earth’s gravitational field at this orbiting height.

(2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  | 1 |
|  | 1 |

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Carefully explain why satellites can only be in geostationary orbit around the equator. Use vector diagrams to support your answer

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Explains that geostationary orbit is orbiting above the same place on the earth. | 1 |
| Vector diagram that identifies centripetal force towards centre of rotation at equatior, not towards centre of rotation when not at equator. | 1 |
| Shows that there will be a net force up that is towards orbiting at equator. Therefore cannot maintain geostationary orbit unless at equator. | 1 |

E**nd of Test**