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| Description: LogoDescription: KOTM SPOT FLAT RGB | **Newton Moore Senior High School**  **Year 12 Physics ATAR Unit 3 & 4**  **2019**  **Task 3: Experiment 4.1 Validation** | **Result:**  **/ 44** |

Going around in circles – Experiment 4.1 Validation Test

(Use diagrams where appropriate)

1. How is the centripetal force provided when using the apparatus in this experiment? (2 Mark)

\_*The force is provided by the slotted masses attached to the string (1) and the force of gravity acting on the mass. (1)*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Explain why the tape in the apparatus must not touch the bottom of the tube. (2 Marks)

\_*The tape touching the bottom will provide a frictional force (1) that will impede the motion. (affect the results) (1)* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Write a valid hypothesis for this experiment (either part A or B). (3 Marks)

\_\_*If the mass supplying the centripetal force is increased/decreased (1), then …. velocity/acceleration/period of rotation (1) will increase/ decrease. (1)* Or

*If the radius of the rotation is increased/decreased (1), then …. velocity/acceleration/period of rotation (1) will increase/ decrease. (1)*

*Note: Only 2 marks total if the independent or dependent variable is vague and not provided as an expected result eg “If the mass supplying the centripetal force is changed, then …. velocity/ acceleration/period of rotation will change.”*

1. What did the gradient of the centripetal vs. velocity squared represent? Demonstrate using formula manipulation. (3 Marks)

\_\_*The gradient is the mass of the object undergoing circular motion divided by the radius of the circle.* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1)

*mass/radius = gradient*

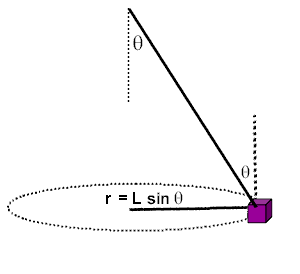
Fc=mv2

r (1)

Fc = m

V2 r (1)

1. Does the fact that the string holding the stopper is not exactly horizontal affect the relationship between Fc and v? Explain. (3 Marks)

*Yes. If the angle of the stopper drops this decreases the radius of rotation.*

Fc=mv2

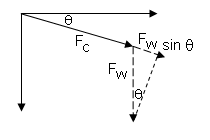
r

*If r decreases, v2 must also decrease to maintain the same Fc and this affects its relationship.*

***While the radius does decrease a more important point is that that there is now an increase in the tension due to a component of the weight force acting downwards. This is shown in diagram below:***

***Assumption made is that if horizontal, tension in string is total due to Fc and calculation of v is used to find Fc.***

***As , with m and r constant, Fc ∝ v2 or v ∝ (1) + (1 diagram)***

*****However, if not horizontal, tension in string is actually:***

***FT = Fc + (Fw sin θ) which is greater than Fc. so actually,***

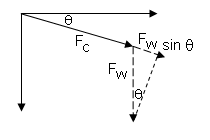
***v2 ∝ (Fc + Fw sin θ). (1)***

***This is a complex situation as while radius does decrease, the tension increases. Without knowing θ you actually can’t accurately determine if the velocity increases or decreases. All you can accurately say is that v ∝ where T = (Fc + Fw sin θ).***

1. Determine the relationship between F and v in terms of the angle **between the string and the horizontal**. (θh) (3 Marks)

**This is probably answered in question 5; v2 ∝ (Fc + Fw sin θ). Students could also add back in m and r.**

***As , with m and r constant, Fc ∝ v2 or v ∝ (1)***

*****However, if not horizontal, tension in string is actually:***

***FT = Fc + (Fw sin θ) which is greater than Fc. so actually,***

***v2 ∝ (Fc + Fw sin θ). (1)***

***v ∝ where T = (Fc + Fw sin θ). (1)***

1. The bob of a pendulum swings through a circular arc of constant radius. At what point of the swing does the cord holding the bob exert the greatest centripetal force on the bob? Explain. (3 Marks)

\_\_\_*As the pendulum swings, it will have greatest kinetic energy at the base and hence greatest velocity. (1) As mass and radius are constant, increasing velocity will increase the centripetal force (1) according to the following formula:*

Fc=mv2 *(1)*

R

**OR**

**A better approach is using the answer below rather than kinetic energy.**

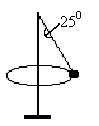
**As and we assume that ‘m’, ‘v’ and ‘r’ are constant, (1)**

**then the centripetal force is constant throughout the swing.**

**It is the TENSION that changes as FT = Fc + Fw sin θ. (1)**

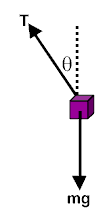
**The tension is greatest at the bottom of the swing**

**when FT = Fc + Fw with Fw = mg (1)**



1. In a game of totem tennis, a 0.120 kg ball is moving at a constant velocity in a horizontal circle around the pole as shown. The rope forms an angle of 25.00 to the pole and the horizontal radius of the ball is 1.20 m. The ball takes 0.800 s for one revolution.

1. Draw and label the forces acting on the ball. (2 Marks)



**Tension shown and labelled – 1 mark**

**Weight shown and labelled – 1 mark**

**Students can show Fc as long as they label it F net NOT Fc. It doesn’t attract any marks by can be ignored.**

1. What is holding the ball up? (3 Marks)

***The force holding up the ball is the vertical component (1) of the tension (1) which is equal in magnitude to the weight force. (1) It is not the tension itself. The acceleration is not a force so doesn’t hold up the ball.***

1. What is the ball’s acceleration? (2 Marks)

v = 2πr/T r = 1.2m T = 0.8s

a = 4π2 r/T2

v = (2 x π x 1.2)/0.8 = 4 x π2 x 1.2/ 0.82

= 9.425 ms-1 (1) OR = 74.0 ms-2

a = v2/r

= (9.425)2/1.2

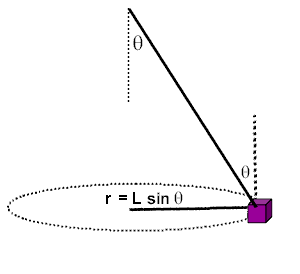
= 74.0 ms-2 (1)

OR

**r = 1.2 m**

**T = 0.8 s v 9.42 m s-1 ac = 74.0 m s-2**

1. What is the tension in the string? (3 Marks)



Fg = 0.12 x 9.8

= 1.176 N (1)

cos 25 = 1.176/Ft (1)

Ft = 1.30 N (1)

**Question has a problem with conflicting information so have to accept the following answer which gives a totally different answer:**

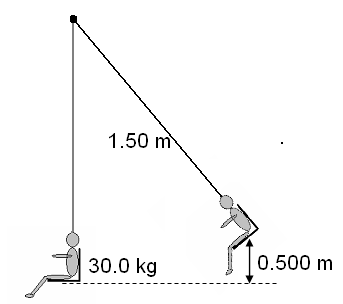
**Fw = 0.12 x 9.8**

**= 1.176 N (1)**

**Fc = mac**

**= 0.12 x 73.9**

**= 8.87 N (1) FT = 8.95 N (1)**

1. A child is sitting on a swing and has been pulled back so that the seat is 0.500 m above the lowest point in the swing. The seat is then released.
2. Calculate the velocity of the swing at its lowest point. (2 Marks)

Ep = mgh

= 30 x 9.8 x 0.5 = 147J (1)

Ek = 0.5mv2

147 = 0.5 x 30 x v2

v = 3.13ms-1 (1)

1. Calculate the tension in the ropes of the swing when a 30.0 kg child is moving through the lowest point in the swing, which has a length of 1.50 m. (3 Marks)

at the lowest point, FT = Fc + Fw

(1)

FT = 196 + 294 (1)

= 490

tension = 4.90 x 102 N (1)

1. A hammer thrower is swinging his 7.25 kg hammer at an angle of 40.00 to the horizontal at a speed of 10.0 ms-1. If the length of his arms are 0.500 m and the length of the wire is 0.700 m, calculate:

The centripetal acceleration. (2 Marks)

a = v2/r

= 102/0.7+0.5 R = 0.919 if taken as a conical pendulum (-1)

=83.3 ms-2

The centripetal force. (2 Marks)

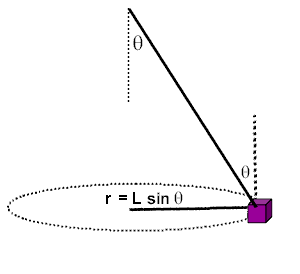
**The most logical answer is to use the calculated ‘a’**

**Fc = mac**

**= 7.25 x 83.3**

**Fc = 604 N cf = 788 N**

The tension in the wire at the top of the swing just as the ball is on the way down.

(3 Marks)

Ftop = Ft – Fg Ft = Fg /cos θ

= 71.05/cos50

= 110.53 N

Ftop = Ft – Fg

= 110.53 – 71.05

= 39.5 N

**Again a question that has different answers depending on the method used.**

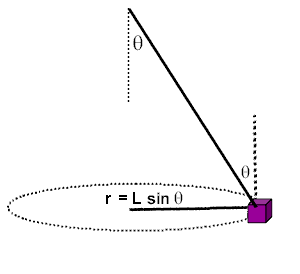
**Fw = W sin φ FT = Fc – FW**

**= mg sin 40 = 604 – 45.67**

**= 7.25 x 9.8 x sin 40 FT = 558 N**

**= 45.67 N**

The tension in the wire at the bottom of the swing just as the ball is on the way up. (3 Marks)

Ftop = Ft + Fg Ft = Fg /cos θ

= 71.05/cos50

= 110.53 N

Ftop = Ft + Fg

= 110.53 + 71.05

= 182 N

**Again another answer is possible depending on method used.**

**FT = Fc + Fw**

**= 604 + 45.67**

**FT = 650 N**

END OF VALIDATION