Equipment needed: stopwatch, calculator

The Pharoah's Curse has two gondolas for passengers which swing in opposite directions. As the gondolas swing backwards and forwards, the angle increases each time until the gondolas go over the top. The length of the arms are 9 metres.

Full rotation

1. When the gondolas reach full rotation, measure the time for one rotation, calculate the average speed of rotation. ($v=2\pi r/T$)

   ___

2. Assuming this speed is constant, what is the relative 'cross-over' speed as the two gondolas pass each other?

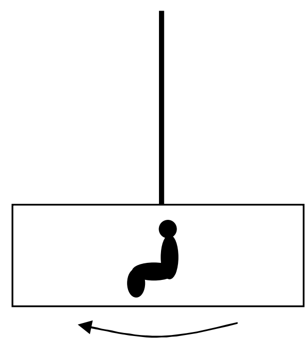
   ___

3. Assuming this speed is constant, what is the size of the centripetal acceleration? ($a = v^2/r$, $a = 4\pi^2 r/T^2$)

   ___

4. Draw, on the figure of you in the diagram, arrows to represent:
   a) the centripetal acceleration,
   b) your weight force (labelled as Force by Earth on You $F_{\text{Earth on You}}$) and
   c) the reaction force by the seat on you (labelled as $F_{\text{Seat on You}}$).

   Consider both the size and direction of these two forces.



Gondola at the bottom of its swing

5. Estimate the kinetic energy of each gondola as it rotates in a full rotation.? The mass of each gondola is 2100kg, estimate the total mass of the passengers.

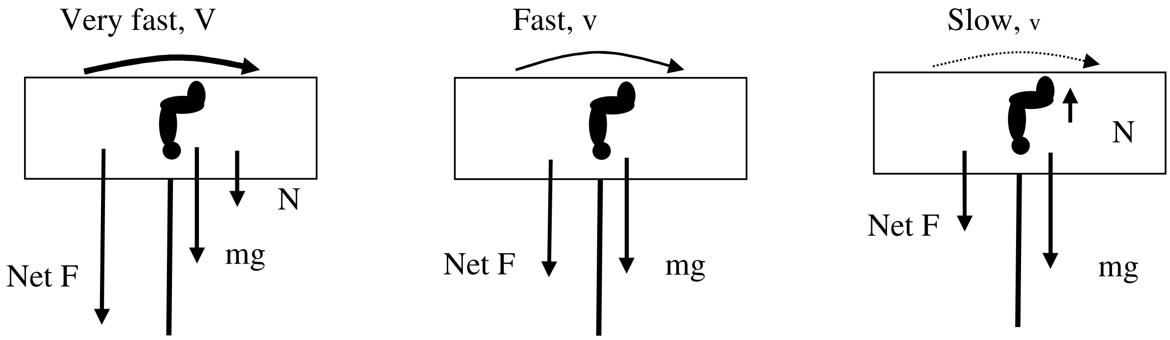
   ___

6. Looking at your answer to Q'n 5, can you suggest why the drive mechanism is hydraulic rather than mechanical? Consider the effect of gears and sudden changes in speed or power loss.

   ___

   ___

Feeling Lighter at the Top



N: Force by seat on you, down:
$N + mg = \text{Net Force} = mV^2/r$
… pressure on your backside from the seat

No force from seat
$N = 0$, $mg = mv^2/r$
You would feel …
… weightless, floating

N: Force by restraint on you, up
$mg - N = m\,v^2/r$
… pressure on your shoulders from the restraint

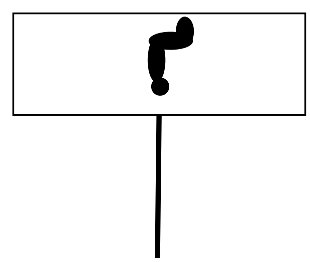
7. Determine the speed of the gondola at the top if you were to feel weightless?

____

Stationary at the top

8. Why don't the passengers fall out of the gondola at the top when it is at rest?

____



9. For the position when the gondola is stationary at the top, draw, on the figure of you in the diagram, arrows to represent:
   a) your acceleration,
   b) your weight force (labelled as Force by Earth on You $F_{\text{Earth on You}}$) and
   c) the reaction force by the gondola on you (labelled as $F_{\text{Gondola on You}}$).

   Consider both the size and direction of these two forces
10. If all the gondola's gravitational potential energy at the top was converted into its kinetic energy at the bottom, how fast would the gondola be travelling at its lowest point? (radius = 9.0m)

____

____

11. Determine the centripetal acceleration at this lowest point.______________________________
12. Determine the size of the net force that would be on you at this point (assume an estimate for your mass). ______________________________
13. At this point, the Reaction force (N) – weight force (mg) = Net force = ma, $N - mg = ma$. Determine the size of the reaction force. How many times greater than your weight is this?

____

The reaction force is what you feel, the ratio indicates how many times heavier you feel. At about a ratio of 4 pilots experience reduced vision leading to blackout. For this reason there is an hydraulic drag as the gondolas come down from the stationary position at the top.
14. Measure the time from stopped at the top to the bottom. Calculate the average speed. Assume the speed at the bottom is twice the average. How does this compare with Q'n 10.

____