Projectile Questions

1. An Extreme Boules player must lob the steel "boule" so that it lands as close as possible to the "jack", a small white ball which lies 10m away. However the player must clear a large bush with his throw, so he gives it an angle of 70° above the horizontal. His throw is made from ground level (assume it will land at ground level).

(a) Show that the time of flight $t = \dfrac{2v_0 \sin 70°}{g}$

Note: use $a_V = -g$ /3

(b) Hence show that the final horizontal component of velocity $v_H = \dfrac{s_H\, g}{2v_0 \sin 70°}$ /2

(c) Hence calculate the initial velocity required for the boule to land directly on the jack. /3
Hint: the initial and final horizontal components of velocity are the same.

2. An invading soldier is trying to sneak close to a castle and is currently lying on the ground 10m away horizontally from the castle wall. A castle defender throws a small rock horizontally from a castle turret 10m above the ground, with a speed of $7.0 ms^{-1}$.

a) Calculate the range of the rock and hence state whether the invading soldier is likely to be clobbered. /4

b) Calculate the speed the rock is going at the end of its flight. /3

3. Calculate the maximum height of a student fired out of a cannon with an initial speed of $50 ms^{-1}$ at an angle of 70° above the horizontal. The cannon is placed on top of a 10m tall tower.

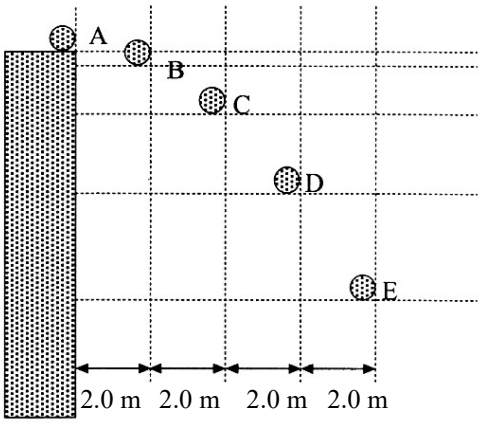
/3

4. Two physicists are performing an experiment with a Vortex (those balls that whistle as they fly). They connect a microphone to a computer and measure that the Vortex whistles for 5.62 seconds. The Vortex is thrown and caught at a height of 1.59m.
Calculate the maximum height the Vortex reached during its flight.

/3

5. Draw a diagram showing the path of a projectile thrown upwards at an angle from level ground. At the start, maximum height and end:
- draw a vector showing the direction and magnitude of velocity
- draw a vector showing the direction and magnitude of the acceleration /3

6. The multi-image diagram below represents a projectile that has been thrown horizontally from the top of a cliff. The time interval between images is 0.20s.



(a) Explain how the diagram shows the horizontal component of acceleration is zero throughout the projectile's motion. /2

(b) Calculate the velocity of the projectile 0.34 s after it has been thrown.

Include somewhere in your working a vector diagram showing how the horizontal and vertical components add to give the final velocity. /5

7. Two projectiles are launched with the same initial speed, and from the same initial height, but at different launch angles. They result in the same range.

(a) Draw a diagram showing both flight paths. /1

(b) Discuss the relationship between the two launch angles. /2

8. Describe the effect air resistance has on both the horizontal component and the vertical component of velocity, and hence the time of flight and the range, of a projectile launched horizontally from a height. /3

9. An evil but very precise student throws a textbook from the 89.99 cm height of his desk at 7.164 ms^{-1}, at an angle of 26.20° above the horizontal. It lands on another student's desk which just so happens to be the same height.

(a) Calculate the distance between the desks /4

(b) Calculate the maximum height of the throw /3

10. For a tennis ball and a table tennis ball travelling at the same speed:

(a) State two reasons why the tennis ball has a greater force of air resistance. /2

(b) State why the table tennis ball has greater acceleration due to air resistance. /1