ALL SAINTS' COLLEGE

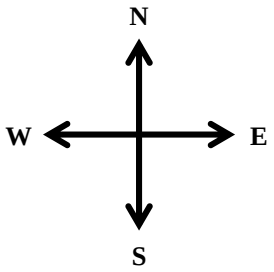
Ewing Avenue, Bull Creek, Western Australia

12 Physics ATAR Motion & Forces Test 1 February 2017

Time allowed: 50 minutes
Total marks available: 50
Show calculation answers to 3 significant figures

Student Name: _____

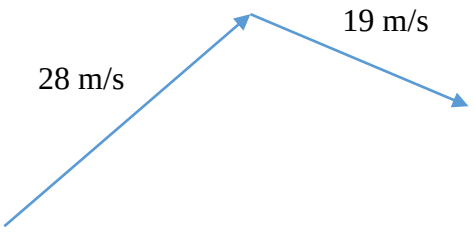
1. A bee is flying West at 0.700 m s^{-1} when it is hit by a wind acting North at 0.160 m s^{-1}



a) What direction should the bee point to maintain a resultant velocity in a direction due West? You must use a vector diagram in your answer.

(3)

2. A rubber ball is moving at 28 m s^{-1} in a direction N 45º E. It hits a wall and rebounds at 19 m s^{-1} in a direction E 30º S



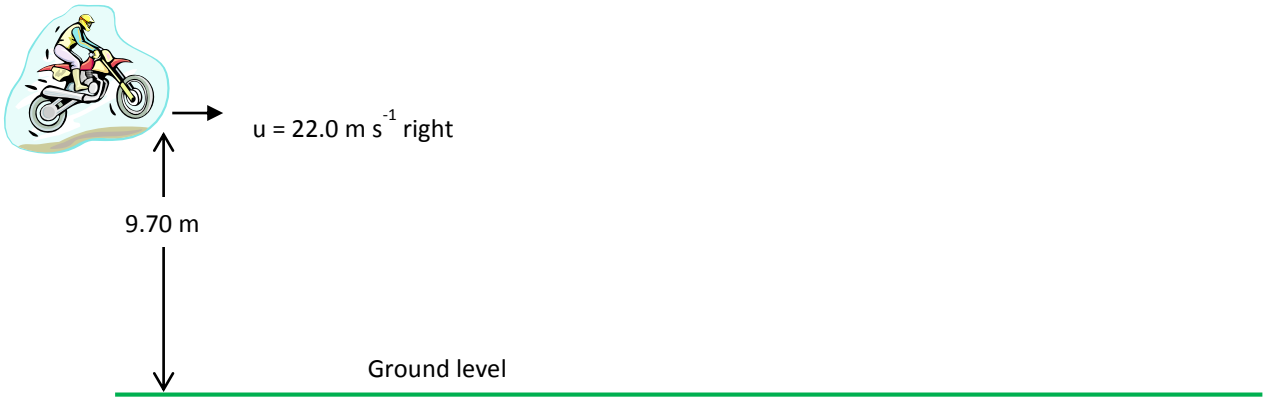
a) Construct a vector diagram that shows the change in velocity of the ball.

(2)

b) Calculate the change in velocity of the ball in this collision with the wall. You must state magnitude and direction in your solution.

(4)

3. A motocross stunt bike of mass 185 kg is driven horizontally over the edge of a jump at a speed of 22.0 m s^{-1}. The ground lies 9.70 m vertically below the launch position.



a. Calculate the time it takes for the bike to reach ground level.

(2)

b. Calculate the horizontal range of the bike.

(1)

c. Calculate the **velocity** (magnitude and direction) of the bike as it arrives at ground level.

(5)

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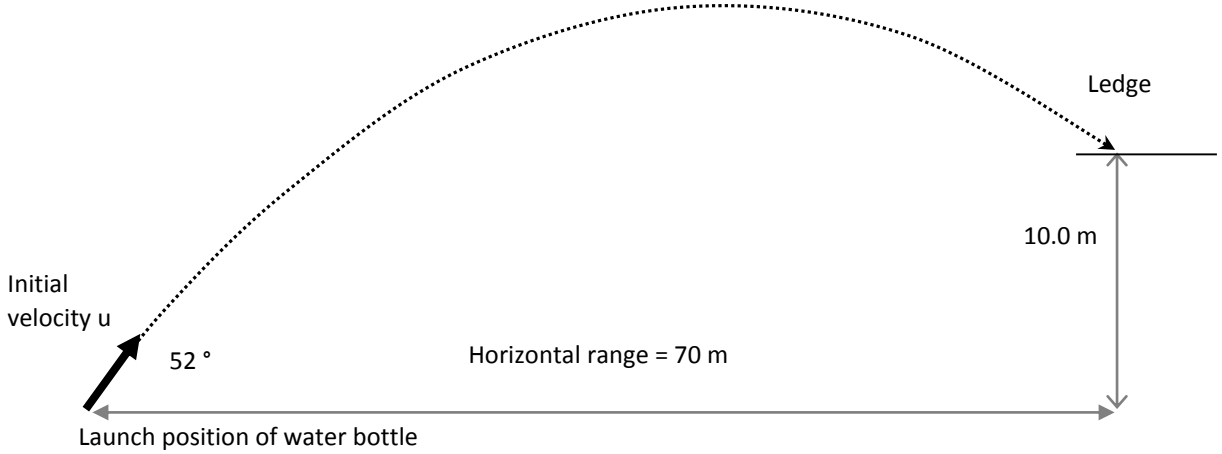
4. A student launches a projectile of mass 2.40 kg at an angle of 52° to the horizontal. He launches the projectile from a position 10.0 m below a ledge and it reaches the ledge after travelling a horizontal distance of 70 m.



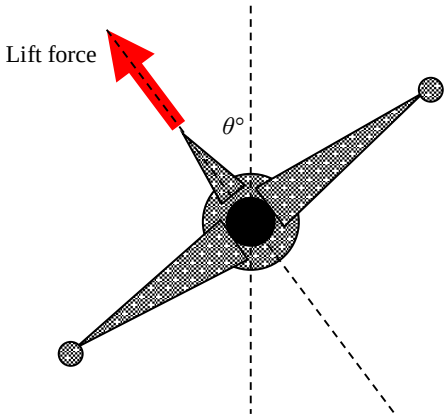
a) Calculate the magnitude of the initial velocity u at an angle 52º.

(5)

b) Calculate the maximum height above the launch position reached by the projectile. If you could not solve for part a) use a value of 28.2 m s^{-1} for u.

(3)

5. When an aircraft is turning in flight it tilts its wings from the horizontal. The lift force from the wings acts perpendicular to the wings as shown on the diagram below.



Aircraft viewed from the rear whilst turning in a horizontal circle.

a) Explain how the lift force can keep the aircraft at a fixed altitude **and** enable the aircraft to follow a horizontal circular path.

(2)

b) For an aircraft of mass 9500 kg calculate the magnitude of lift force required from the wings to maintain a horizontal circular path of radius 1.42 km at a speed of 342 km per hour.

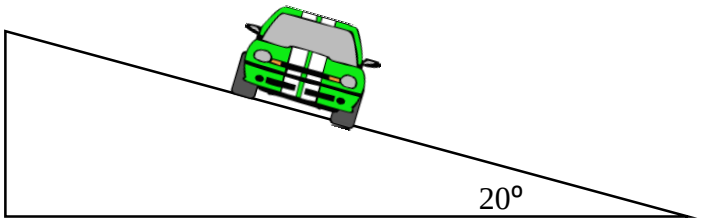
(4)

c) Calculate the angle (θ) from the vertical that that the aircraft must lean in order to achieve this motion.

(2)

Continued on next page

6. A car of mass 2000 kg is in horizontal circular motion on a banked track. The car has a speed of 12.0 m s^{-1} and is relying on friction to stay at a fixed height on the banked track. The radius of the circle is 30.0 m. The track is banked at an angle of 20.0^0 to the horizontal.



a) Is the car travelling faster or slower than the design speed? Justify your answer. (the design speed is the speed which has no reliance on friction)

(3)

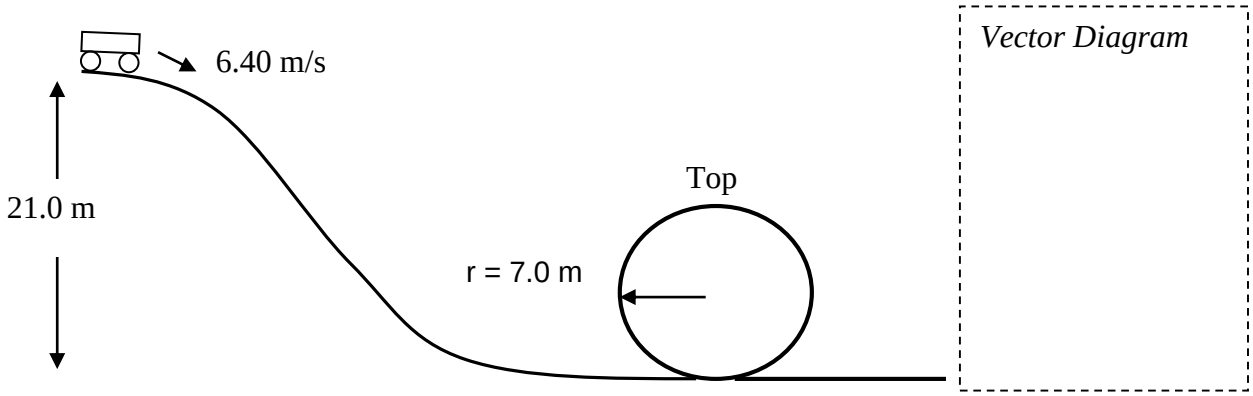
b) Construct a vector diagram (above right) to show the forces acting on the car and the sum of forces.

(2)

c) Calculate the magnitude of friction acting on the car from the banked surface.

(4)

7. A roller coaster car has a mass of 670 kg and starts from a height of 21.0 m above the ground. The car relies on mechanical energy only to go around the loop. The bottom of the circular loop is at ground level and the loop has a radius of 7.0 m. The car is moving at a speed of 6.40 m s^{-1} at the start height. *(ignore air resistance and friction in this question)*



a) Use the principle of conservation of mechanical energy to demonstrate that the speed of the car at the top of the loop is 13.3 m s^{-1}. (4)

b) On the diagram show the forces acting on the car at the top of the loop, then transfer these forces to a *vector diagram* that shows the sum of these forces (ΣF) in the space provided.

(1)

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c) Calculate the normal reaction force acting on the car at the top of the loop.

(3)

End of test