# Mechanics 18 – Projectiles 2

Please **complete** this homework by _____. Start it early. If you can't do a question you will then have time to ask your teacher for help or go to a drop in session.

Section 1 – Review of previous topics. Please underline complete all questions.

1. The diagrams below show a light horizontal rod of length 60 cm resting in equilibrium. Find the forces and distances marked with letters.

   a)

   10 N   20 N

   ←—— x ——→

   P

   b)

   P   Q

                40 cm

           30 N
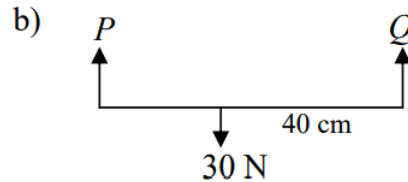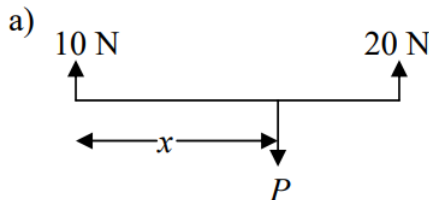
2. A pole vaulter uses a uniform pole of length 4 m and mass 5 kg. He holds the pole horizontally by placing one hand at the end of the pole and the other 75 cm from that end. Find the vertical forces exerted on his hands.

3. A uniform bar AB of length 2.8 m and weight 80 N has loads of 20 N and 40 N attached at A and B respectively. If the bar balances in a horizontal position when smoothly supported at C, find the distance of C from A.

4. A particle of mass 100g is acted upon by three forces F_1, F_2 and F_3. $F_1 = 2\mathbf{i} - 3\mathbf{j}$ N, $F_2 = 4\mathbf{i} + 5\mathbf{j}$ N and $F_3 = -3\mathbf{i} + 3\mathbf{j}$ N. Find the magnitude and direction of the resultant acceleration.

5. A systematic sample, using every 17th value, is taken from the daily rainfall figures of Jacksonville and Perth for May-October 2015. The means were calculated and found to be 8.71 and 18.12 respectively.
   (a) Write down the expected size of each sample. Why may this not be the actual sample size?
   (b) Using your knowledge of the large data set, comment on the mean values found and on their reliability.

1. A particle is projected upwards from ground level at an angle of 30^0 to the horizontal with an initial speed of 40 ms^{-1}. Find the horizontal distance travelled when the particle next hits the ground.

   (5 marks)

2. A particle is projected with an initial speed of 20 ms^{-1} from a point 2.5 m above ground level at an angle of elevation of 40 degrees. Find the time taken for the particle to hit the ground.

   (4 marks)

3. Gina it standing in a sports hall at a distance of 30 m from the end wall. The ceiling is 10 m above the floor. She kicks a ball from the floor at 20ms^{-1} at an angle α above the horizontal.

   (a) If the ball just brushes the ceiling, find the value of α. (3)

   (b) How far up the wall does the ball strike it? (3)

   (6 marks)

4. A particle is projected upwards from a point with a speed of 28ms^{-1} at an angle of α to the horizontal. The particle moves freely under gravity such that when it has moved a horizontal distance of x metres from its point of projection its height above this point is y metres.

   (a) Show that $y = x\tan\alpha - \frac{x^2}{k\cos^2\alpha}$ where k is an integer, stating the value of k.

   (b) If the angle of elevation was 30 degrees, find the horizontal distance travelled when the particle is 2 metres above the point of projection.
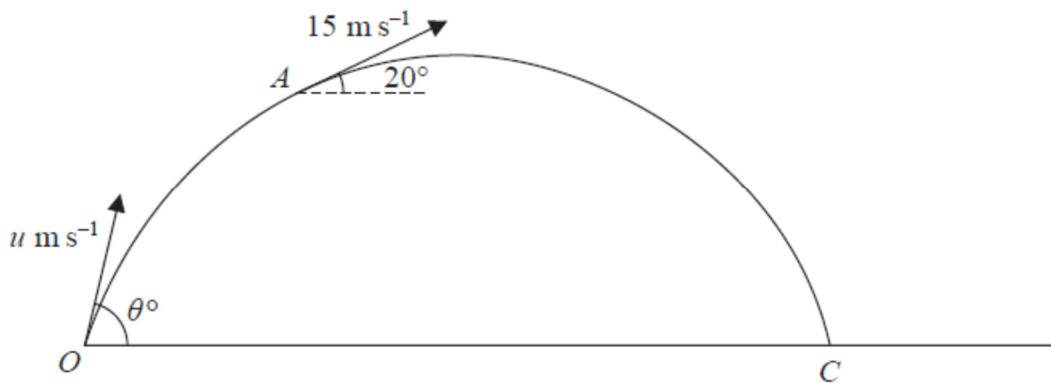
   (10 marks)

5.

Figure 3

At time $t = 0$, a particle is projected from a fixed point O on horizontal ground with speed u m s^{-1} at an angle $\theta°$ to the horizontal. The particle moves freely under gravity and passes through the point A when $t = 4$ s. As it passes through A, the particle is moving upwards at $20°$ to the horizontal with speed 15 m s^{-1}, as shown in Figure 3.

(*a*)   Find the value of u and the value of θ.

(7)

At the point B on its path the particle is moving downwards at $20°$ to the horizontal with speed 15 m s^{-1}.

(*b*)   Find the time taken for the particle to move from A to B.

(2)

The particle reaches the ground at the point C.

(*c*)   Find the distance OC.

(3)

6.   [*In this question, **i** is a horizontal unit vector and **j** is an upward vertical unit vector.*]

A particle P is projected from a fixed origin O with velocity $(3\mathbf{i} + 4\mathbf{j})$ m s^{-1}. The particle moves freely under gravity and passes through the point A with position vector $\lambda(\mathbf{i} - \mathbf{j})$ m, where λ is a positive constant.

(*a*)   Find the value of λ.   **(6)**

(*b*)   Find

(i)   the speed of P at the instant when it passes through A,

(ii)   the direction of motion of P at the instant when it passes through A.   **(7)**

(13 marks)

Total: 50 Marks