Problems of Kinematics: Motion in 2 dimensions

1) We throw a television set horizontally from a tower with a speed of 370 m/s. The tower has a height of 335 m. Calculate:

a) How much time it takes to fall.

b) How far from the base of the tower it hits the ground.

c) The total velocity of the television set when it hits the ground.

Answer: **a)** 8.27 s **b)** 3059.3 m **c)** 378.77 m/s.

2) We throw a hammer horizontally from a cliff with a speed of 360 m/s. The cliff has a height of 195 m. Calculate:

a) How much time it takes to fall.

b) How far from the base of the cliff it hits the ground.

c) The total velocity of the hammer when it hits the ground.

Answer: **a)** 6.31 s **b)** 2271 m **c)** 365.27 m/s.

3) A ball is thrown from a height of 80 m with a speed of 330 m/s at an angle of 45° above the horizontal. Find:

a) How much time it takes to reach the maximum height.

b) Maximum height (from ground).

c) Horizontal range.

d) The total velocity of the ball when it hits the ground.

Answer: **a)** 23.81 s **b)** 2858.1 m **c)** 11191.7 m **d)** 332.37 m/s.

4) A discus is thrown from ground level with a speed of 320 m/s at an angle of 45° above the horizontal. Calculate:

a) How much time it takes to reach the maximum height.

b) Maximum height.

c) How much time it takes to hit the ground.

d) Horizontal range.

Answer: **a)** 23.09 s **b)** 2612.2 m **c)** 46.18 s **d)** 10449 m.

5) A stone is thrown from a height of 140 m with a speed of 190 m/s at an angle of 45° above the horizontal. Find:

a) How much time it takes to reach the maximum height.

b) Maximum height (from ground).

c) Horizontal range.

d) The total velocity of the stone when it hits the ground.

Answer: **a)** 13.71 s **b)** 1060.9 m **c)** 3818.7 m **d)** 197.09 m/s.

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6) A hammer is thrown from ground level with a speed of 240 m/s at an angle of 60° above the horizontal. Calculate:

a) How much time it takes to reach the maximum height.

b) Maximum height.

c) How much time it takes to hit the ground.

d) Horizontal range.

Answer: **a)** 21.21 s **b)** 2204.1 m **c)** 42.42 s **d)** 5090.1 m.

7) A pulley 30 cm in radius rotates at a constant rate of 263 rpm. Calculate: **a)** The angular velocity (in rad/s) and the speed at the edge. **b)** The centripetal acceleration at the edge. **c)** The number of revolutions for the time interval from 0 to 40 s.

Answer: **a)** 27.54 rad/s 8.26 m/s **b)** 227.43 m/s^2 **c)** 175.33 revolutions.

8) We have a wheel with 235 cm in radius. It rotates at a constant speed of 16.49 m/s at the edge. Find: **a)** Its angular velocity in rad/s and rpm. **b)** The centripetal acceleration at the edge.

Answer: **a)** 7.02 rad/s = 67 rpm **b)** 115.71 m/s^2.

9) At the edge of a tire with 235 cm in radius the centripetal acceleration is 352.71 m/s^2. Determine: **a)** Speed at the edge (in m/s). **b)** The angular velocity in rad/s and rpm. **c)** Number of revolutions for the time interval from 0 to 9 s.

Answer: **a)** 28.79 m/s **b)** 12.25 rad/s = 117 rpm **c)** 17.55 revolutions.

10) A pulley has a speed of 35.51 km/h at its edge. The number of revolutions in 36 s was 282.6. Calculate: **a)** Its angular velocity in rad/s and rpm. **b)** The radius. **c)** Centripetal acceleration at the edge.

Answer: **a)** 49.32 rad/s = 471 rpm **b)** 20 cm **c)** 486.1 m/s^2.

11) The position vector of a particle is $\vec{\boldsymbol{r}}(t) = 3t^2\,\hat{\mathbf{i}} + (t^3 + 12)\,\hat{\mathbf{j}}$ where r is in meters and t is in seconds. Find: **a)** The tangential component of the acceleration as a function of time. **b)** The normal (radial) component of the acceleration as a function of time. **c)** The radius of curvature of the path at t = 1 s.

Answer: **a)** $a_t = \dfrac{6t^2 + 12}{\sqrt{t^2 + 4}}$ **b)** $a_n = \dfrac{6t}{\sqrt{t^2 + 4}}$ **c)** 16.77 m.