

## Additional Questions: Advanced Physics Topics

Take  $g = 10 \text{ N kg}^{-1}$  where needed

### Projectile Motion

- 1 An object is launched at a velocity of 20 m/s in a direction making an angle of  $25^\circ$  upward with the horizontal.
- (a) What is the maximum height reached by the object?
  - (b) What is the total flight time (between launch and touching the ground) of the object?
  - (c) What is the horizontal range of the object?
  - (d) What is the magnitude of the velocity of the object just before it hits the ground?

[ (a) 3.57 m, (b) 1.69 s, (c) 30.6 m, (d) 20 m/s ]

- 2 A ball is to be kicked so that, at the highest point of its path, it just clears a horizontal cross-bar on a pair of goal-posts. The ground is level and the top of the cross-bar is 2.00 m from the ground. The ball is kicked from ground level with an initial velocity of 7.0 m/s.
- (a) Calculate the angle of projection of the ball as it is kicked and leaves the ground.
  - (b) Determine the time the ball is in the air until it passes over the cross-bar.
  - (c) Calculate the horizontal velocity of the ball as it passes over the cross-bar.
  - (d) Calculate the horizontal distance of the point where the ball is kicked from the goal-post.

[ (a)  $64.6^\circ$ , (b) 0.63 s, (c) 3.0 m/s, (d) 1.89 m ]

Want more questions? Try these sites:

<https://serdarakimoglu.wikispaces.com/file/view/PROJECTILE+MOTION+-+PRACTICE+QUESTIONS.pdf>

### Circular Motion & Gravitational Fields

Take  $G = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$  where needed

- 1 A car drives along a road at 20 m/s. What is the angular speed of rotation of the car wheel if the diameter of the wheel is 45 cm?

[ 89 rad/s ]

- 2** The Whirligig is a ride in an amusement park. The ride consists of long swings which spin in a circle at relatively high speeds. The riders travel through a circle with a radius of 6.5 m and make one turn every 5.8 seconds. Determine the speed of the riders on the Whirligig.

[ 7.0 m/s ]

- 3** The tallest Ferris wheel in the world is located in Singapore. Standing 42 stories high and holding as many as 780 passengers, the Ferris wheel has a diameter of 150 metres and takes 30 minutes to make a full circle. Determine the speed of riders (in m/s) on the Singapore Flyer.

[ 0.26 m/s ]

- 4** During the spin cycle of a washing machine, the clothes stick to the outer wall of the barrel as it spins at a rate of 1800 revolutions per minute. The radius of the barrel is 26 cm.

**(a)** Determine the speed of the clothes (in m/s) which are located on the wall of the spin barrel.

**(b)** Determine the acceleration of the clothes.

[ (a) 49 m/s, (b)  $9.2 \times 10^3 \text{ m/s}^2$  ]

- 5** Elmira, New York boasts of having the fastest carousel ride in the world. The merry-go-round at Eldridge Park takes riders on a spin at 8.0 m/s. The radius of the circle about which the outside riders move is approximately 7.4 m.

**(a)** Determine the time for outside riders to make one complete circle.

**(b)** Determine the acceleration of the riders.

[ (a) 5.8 s, (b)  $8.6 \text{ m/s}^2$  ]

- 6** Determine the force of gravitational attraction between the Earth and the sun. Their masses are  $5.98 \times 10^{24} \text{ kg}$  and  $1.99 \times 10^{30} \text{ kg}$ , respectively. The average distance separating the Earth and the sun is  $1.50 \times 10^{11} \text{ m}$ .

[  $3.53 \times 10^{22} \text{ N}$  ]

- 7** Determine the acceleration of the moon about the Earth. (GIVEN:  $M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg}$  and Earth-moon distance =  $3.84 \times 10^8 \text{ m}$ )

[  $2.70 \times 10^{-3} \text{ m/s}^2$  ]

- 8** Determine the acceleration of the Earth about the sun. (GIVEN:  $M_{\text{sun}} = 1.99 \times 10^{30} \text{ kg}$  and Earth-sun distance =  $1.50 \times 10^{11} \text{ m}$ )

[  $5.90 \times 10^{-3} \text{ m/s}^2$  ]

- 9 Use Newton's law of gravitation to determine the acceleration of an 85-kg astronaut on the International Space Station (ISS) when the ISS is at a height of 350 km above Earth's surface. The radius of the Earth is  $6.37 \times 10^6$  m. (GIVEN:  $M_{\text{Earth}} = 5.98 \times 10^{24}$  kg)

[  $8.83 \text{ m/s}^2$  ]

- 10 Determine the orbital speed of the International Space Station - orbiting at 350 km above the surface of the Earth. The radius of the Earth is  $6.37 \times 10^6$  m. (GIVEN:  $M_{\text{Earth}} = 5.98 \times 10^{24}$  kg)

[  $7.70 \times 10^3 \text{ m/s}$  ]

- 11 Determine the orbital speed of the Earth as it orbits about the Sun. (GIVEN:  $M_{\text{sun}} = 1.99 \times 10^{30}$  kg and Earth-sun distance =  $1.50 \times 10^{11}$  m)

[  $2.98 \times 10^4 \text{ m/s}$  ]

- 12 Geostationary satellites are satellites which are orbiting the Earth above the equator and make one complete orbit every 24 hours. Because their orbital period is synchronized with the Earth's rotational period, a geostationary satellite can always be found in the same position in the sky relative to an observer on Earth. (GIVEN:  $M_{\text{Earth}} = 5.98 \times 10^{24}$  kg)

(a) Determine the orbital radius of a geostationary satellite.

(b) Determine the orbital speed of a geostationary satellite.

(c) Determine the acceleration of a geostationary satellite.

[ (a)  $4.23 \times 10^7$  m, (b)  $3.07 \times 10^3$  m/s, (c)  $0.223 \text{ m/s}^2$  ]

- 13 In 2009, NASA's Messenger spacecraft became the second spacecraft to orbit the planet Mercury. The spacecraft orbited at a height of 125 miles above Mercury's surface. Determine the orbital speed and orbital period of Messenger. (GIVEN:  $R_{\text{Mercury}} = 2.44 \times 10^6$  m;  $M_{\text{Mercury}} = 3.30 \times 10^{23}$  kg; 1 mi = 1609 m)

[Speed:  $2.89 \times 10^3$  m/s, Period:  $5.75 \times 10^3$  s ]