

Your Name: _____

PHY203
Exam #1
Chapters 1,3,4
Fri., Feb. 18, 2022

Solutions

Exam1S22

1. Starting from rest, a car accelerates at $t = 0$ in a positive x-direction from $x = 0$ at 3.50 m/s^2 for 25.0 s . Then it travels at constant speed for 40.0 s . Then it slows down with an acceleration of magnitude 2.00 m/s^2 until it stops.

a. Find the position and velocity of the car after it has traveled for 25.0 s . **10**

$$\begin{aligned}x &= 0 + 0 + \frac{1}{2} (3.50) (25.0)^2 \\ &= 1094 = 1.09 \times 10^3 \text{ m}\end{aligned}$$

$$v = 0 + (3.50)(25.0) = 87.5 \text{ m/s}$$

b. Find the position of the car after it has traveled for an additional 40.0 s . **5**

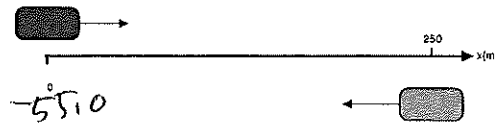
$$\begin{aligned}x &= 1094 + 87.5(40) \\ &= 4594 = 4.59 \times 10^3 \text{ m}\end{aligned}$$

c. Find the total time and final position of the car when it has come to rest. **15**

$$0 = 87.5 - (2.00)t$$

$$t = 43.75 \text{ s} = 43.8 \text{ s} + 65.0 = 109 \text{ s}$$

$$\begin{aligned}x &= 4594 + 87.5(43.8) + \frac{1}{2} (-2.00)(43.8)^2 \\ &= 6.51 \times 10^3 \text{ m}\end{aligned}$$



2. Two trains approach each other on parallel tracks. At $t=0$ the train on the left starts from rest at $x = -55.0$ m and travels with constant acceleration. The train passes the $x=0$ point with a speed of 24.5 m/s. At $t=0$, the train on the right passes the $x = 250$ m position with a constant speed of 19.0 m/s.
- a. Find the (constant) acceleration of train A. **10**

$$(24.5)^2 = 0 + 2a(35.0)$$

$$a = 5.46 \text{ m/s}^2$$

- b. Using the coordinate system depicted above, write an equation of motion (x vs. t) for the train on the left: **10**

$$x_l = -55.0 + \frac{1}{2}(5.46)t^2 = -55.0 + 2.73t^2$$

- c. Using the coordinate system depicted above, write an equation of motion (x vs. t) for the train on the right: **10**

$$x_r = 250 - 19.0t$$

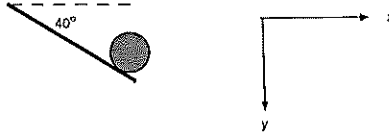
- d. Find the time at which the centers of the trains are side-by-side. **10**

$$-55.0 + 2.73t^2 = 250 - 19.0t$$

$$2.73t^2 + 19.0t - 305 = 0$$

$$t = \frac{-19.0 \pm \sqrt{19.0^2 + 4 \cdot 2.73 \cdot 305}}{5.46}$$

$$= 7.65 \text{ s}$$



3. A ball rolls off a roof that makes an angle of 40.0° with respect to the horizontal. The speed of the ball when it leaves the roof is 12.5 m/s.

a. Find the x- and y-components of the velocity and express the velocity in vector notation using the coordinate system given above. **10**

$$v_{x0} = 12.5 \cos 40.0^\circ = 9.58 \text{ m/s}$$

$$v_{y0} = 12.5 \sin 40.0^\circ = 8.03 \text{ m/s}$$

$$\vec{v}_0 = (9.58 \hat{i} + 8.03 \hat{j}) \text{ m/s}$$

b. The ball takes 1.50 s to hit the ground. Find the height of the edge of the roof. **10**

$$y = H = 0 + 8.03(1.50) + \frac{1}{2}g(1.50)^2$$

$$H = 23.1 \text{ m}$$

c. Find how far from the roof the ball lands in a horizontal direction. **10**

$$x = 9.58(1.50)$$

$$= 14.4 \text{ m}$$

Exam1S22c1+

1. Starting from rest, a car accelerates at $t = 0$ in a positive x-direction from $x = 0$ at 3.00 m/s^2 for 30.0 s . Then it travels at constant speed for 45.0 s . Then it slows down with an acceleration of magnitude 1.75 m/s^2 until it stops.

a. Find the position and velocity of the car after it has traveled for 30.0 s . 10

$$x = 0 + 0 + \frac{1}{2} (3.00) (30.0)^2$$
$$= 1350 = 1.35 \times 10^3 \text{ m}$$

$$v = 0 + (3.00)(30.0) = 90.0 \text{ m/s}$$

b. Find the position of the car after it has traveled for an additional 45.0 s . 5

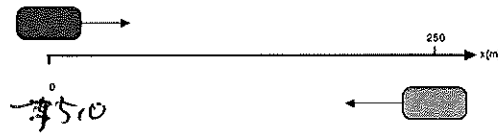
$$x = 1350 + 90.0 (45.0)$$
$$= 5400 = 5.40 \times 10^3 \text{ m}$$

c. Find the total time and final position of the car when it has come to rest. 15

$$0 = 90.0 - (1.75)t$$

$$t = 51.4 \text{ s} + 75.0 = 126 \text{ s}$$

$$x = 5400 + 90 (51.4) + \frac{1}{2} (-1.75) (51.4)^2$$
$$= 7712 \text{ m} = 7.71 \times 10^3 \text{ m}$$



2. Two trains approach each other on parallel tracks. At $t=0$ the train on the left starts from rest at $x = -75.0$ m and travels with constant acceleration. The train passes the $x=0$ point with a speed of 29.5 m/s. At $t=0$, the train on the right passes the $x = 250$ m position with a constant speed of 21.0 m/s.

a. Find the (constant) acceleration of train A. **10**

$$29.5^2 = 0 + 2a(75.0)$$

$$a = 5.80 \text{ m/s}^2$$

b. Using the coordinate system depicted above, write an equation of motion (x vs. t) for the train on the left: **10**

$$x_l = -75.0 + \frac{1}{2}(5.80)t^2 = -75.0 + 2.90t^2$$

c. Using the coordinate system depicted above, write an equation of motion (x vs. t) for the train on the right: **10**

$$x_r = 250 - 21.0t$$

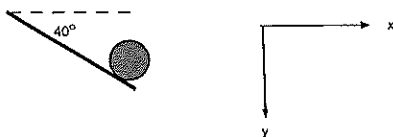
d. Find the time at which the centers of the trains are side-by-side. **10**

$$-75.0 + 2.90t^2 = 250 - 21.0t$$

$$2.90t^2 + 21.0t - 325 = 0$$

$$t = \frac{-21.0 \pm \sqrt{21.0^2 + 4(2.90)(325)}}{5.80}$$

$$= 7.57 \text{ s}$$



3. A ball rolls off a roof that makes an angle of 40.0° with respect to the horizontal. The speed of the ball when it leaves the roof is 15.5 m/s .

a. Find the x- and y-components of the velocity and express the velocity in vector notation using the coordinate system given above. **10**

$$v_{x0} = 15.5 \cos 40.0^\circ = 11.9 \text{ m/s}$$

$$v_{y0} = 15.5 \sin 40.0^\circ = 9.96 \text{ m/s}$$

$$\vec{v}_0 = (11.9\hat{i} + 9.96\hat{j}) \text{ m/s}$$

b. The ball takes 2.00 s to hit the ground. Find the height of the edge of the roof. **10**

$$y = H = 0 + 9.96(2.00) + \frac{1}{2}g(2.00)^2$$

$$= 39.5 \text{ m}$$

c. Find how far from the roof the ball lands in a horizontal direction. **10**

$$x = (11.9)(2.00)$$

$$= 23.8 \text{ m}$$