# PHYS141 OUTLINE QUESTIONS SOLUTIONS

BY AHMAD HAMDAN

## Exercise 2

Chapter 2, Page 29

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 

To solve this problem, in each case we will first find the total time spent and then, we will find the average velocity.

a) The average velocity is given as

$$v_{avg} = \frac{\Delta x_{tot}}{\Delta t_{tot}}$$

where the total time is given as $\Delta t_{tot} = t_1 + t_2$ and each time we obtain through

$$t_1 = \frac{\Delta x_1}{v_1} = \frac{73.2}{1.22} = 60\text{s}$$

$$t_2 = \frac{\Delta x_2}{v_2} = \frac{73.2}{2.85} = 25.7\text{s}$$

$$\Delta t_{tot} = 60 + 25.7 = 85.7\text{s}$$

Let's now find the total distances covered in the same manner as we did with the time

$$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = 73.2 + 73.2 = 146.4\text{m}$$

Now the average speed is simply

$$v_{avg} = \frac{\Delta x_{tot}}{\Delta t_{tot}} = \frac{146.4}{85.7} = 1.71\text{m/s}$$

**Step 2** 

b) To find the the average velocity in this case, we have to find the total distance covered first. We do so for both segments, one by one

$$\Delta x_1 = v_1 \cdot \Delta t_1 = 1.22 \times 60 = 73.2\text{m}$$

$$\Delta x_2 = v_2 \cdot \Delta t_2 = 3.05 \times 60 = 183\text{m}$$

$$\Delta x_{tot} = 73.2 + 183 = 256.2\text{m}$$

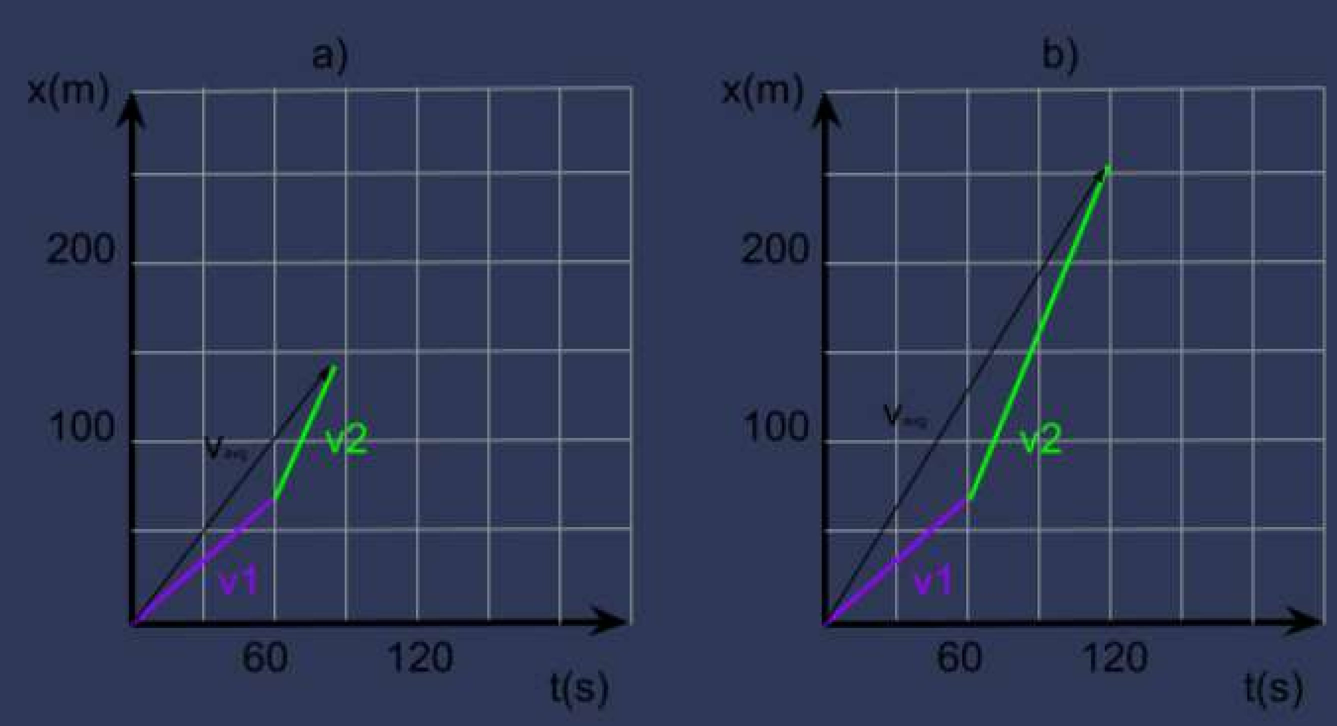
Now, the average speed is given as

$$v_{avg} = \frac{\Delta x_{tot}}{\Delta t_{tot}} = \frac{\Delta x_{tot}}{\Delta t_1 + \Delta t_2}$$

$$v_{avg} = \frac{256.2}{120} = 2.135\text{m/s}$$

**Step 3** 

The slope of the arrows denoted as $v_{avg}$ give the value of the average velocities.




**Result** 

$$\text{a) } v_{avg} = 1.71\text{m/s}$$

$$\text{b) } v_{avg} = 2.135\text{m/s}$$

## Exercise 3

Chapter 2, Page 29

Principles of Physics, International Edition

ISBN: 9781118230749

Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 3

To solve this problem we will have to determine the exact time Rachel needs to get to school. Let's denote it as $t_1$

$$t_1 = \frac{x}{v_1} = \frac{2.8}{6 \times \frac{1}{60}} = 28\text{min}$$

Now, $t_2$ is equal to

$$t_2 = t - t_1 = 35 - 28 = 7\text{min}$$

a) To find the average magnitude of the velocity during this period of time we have to understand that the direction of Rachel's motion has changed so we have the velocities in opposite direction. To get the average we have to subtract the paths from each other and divide with time

$$v_{avg} = \frac{28 \times 6 - 7 \times 7.7}{35} = 3.26\text{m/s}$$

**Step 2** 2 of 3

b) Now, to get the average speed, we will sum the pats up and then divide with time

$$v_{avg} = \frac{28 \times 6 + 7 \times 7.7}{35} = 6.34\text{m/s}$$

**Result** 3 of 3

$$\text{a) } v_{avg} = 3.26\text{m/s}$$

$$\text{b) } v_{avg} = 6.34\text{m/s}$$

Exercise 2
Rate this solution
Exercise 4

# Exercise 5

Chapter 2, Page 29

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 8

To solve this problem, we will use the given position function and insert the values of time. Let's do it.

a) The function is given as

$$x(t) = 3t - 4t^2 + t^3$$

Let's set time to be $t = 1\text{s}$

$$x(1) = 3 \cdot 1 - 4 \cdot 1^2 + 1^3 = 0\text{m}$$

**Step 2** 2 of 8

b) The function is given as

$$x(t) = 3t - 4t^2 + t^3$$

Let's set time to be $t = 2\text{s}$

$$x(2) = 3 \cdot 2 - 4 \cdot 2^2 + 2^3 = -2\text{m}$$

**Step 3** 3 of 8

c) The function is given as

$$x(t) = 3t - 4t^2 + t^3$$

Let's set time to be $t = 3\text{s}$

$$x(3) = 3 \cdot 3 - 4 \cdot 3^2 + 3^3 = 0\text{m}$$

**Step 4** 4 of 8

d) The function is given as

$$x(t) = 3t - 4t^2 + t^3$$

Let's set time to be $t = 4\text{s}$

$$x(4) = 3 \cdot 4 - 4 \cdot 4^2 + 4^3 = 12\text{m}$$

**Step 5** 5 of 8

e) We find a displacement between $t = 0\text{s}$ and $t = 4\text{s}$ as follows

$$\Delta x = x(4) - x(0) = 12 - 0 = 12\text{m}$$

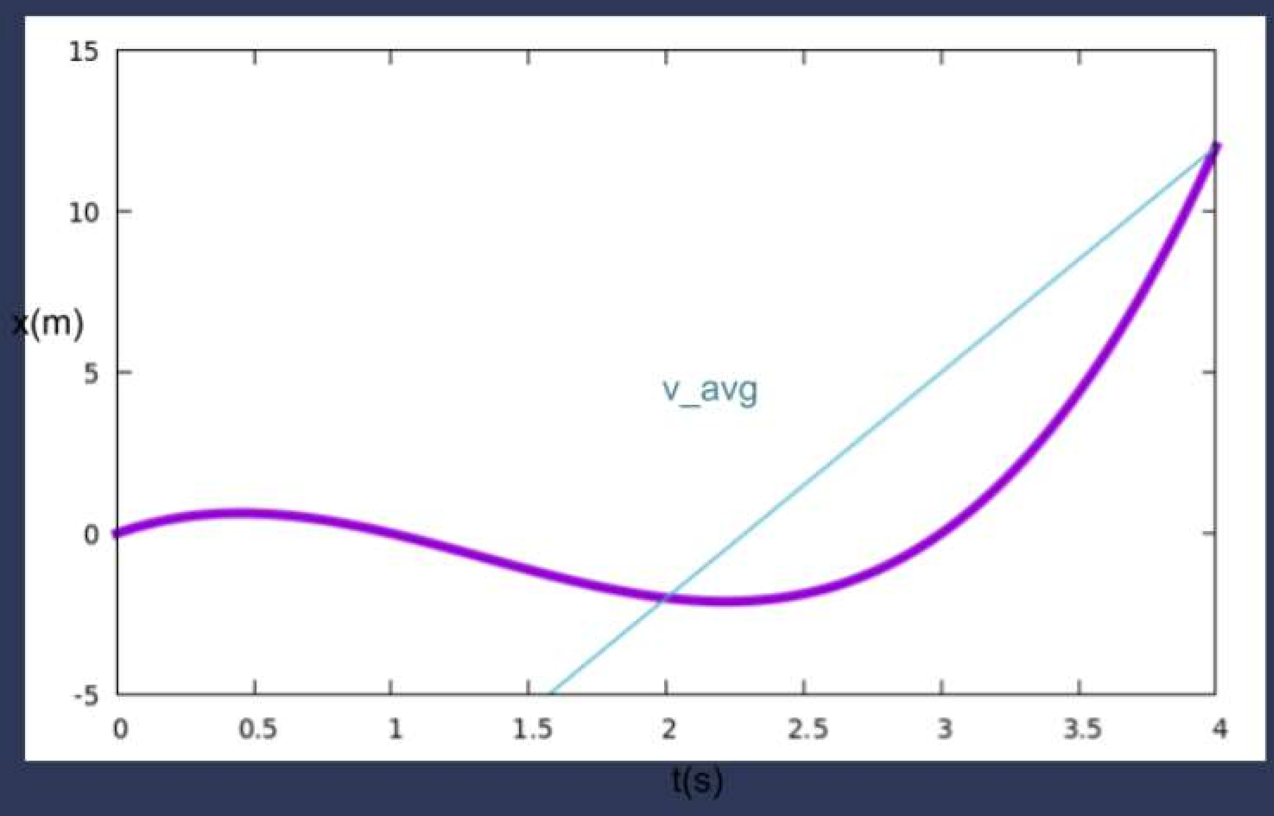
**Step 6** 6 of 8

f) We find the average velocity as given in its definition

$$v_{avg} = \frac{x(4) - x(2)}{4 - 2} = \frac{12 - (-2)}{2} = 7\text{m/s}$$

**Step 7** 7 of 8

g) The average velocity between the points $t = 2$ and $t = 4$ is found as slope of cyan linear function as shown bellow.






**Result** 8 of 8

a) $x(1) = 0\text{m}$

b) $x(2) = -2\text{m}$

c) $x(3) = 0\text{m}$

d) $x(4) = 12\text{m}$

e) $\Delta x = 12\text{m}$

f) $v_{avg} = 7\text{m/s}$

# Exercise 14

Chapter 2, Page 30

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 3

**Givens:**

$x = 16te^{-t}$ m

is the position function of the moving electron.

**Step 2** 2 of 3

To know when the electron stops we set the velocity equal to zero, taking into our consideration that the velocity is the time derivative of the displacement, and solve for the value of t:

$$v = \frac{dx}{dt} = 16(1-t)e^{-t} = 0$$

$$\text{(The product Rule)}$$

The value of the previous equation is zero when t=1 s, since the exponential function can't be zero.

This means that after 1 s the electron stops.

To find the position of the electron when it stops, we put the value of t we obtained in the given function $x = 16te^{-t}$ as following:

$$x = 16e^{-1} = 5.88 \text{ m}$$

**Result** 3 of 3

$$x = 5.88 \text{ m}$$

# Exercise 15

Chapter 2, Page 30

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 3

a) To solve this problem we will have to differentiate the function describing the position as follows

$$x = 18t + 5 \cdot t^2$$

$$v_{inst} = \frac{dx}{dt} = 18 + 10 \cdot t$$

Now we can insert $t = 2$s to obtain that

$$v_{inst} = 18 + 10 \cdot 2 = 38\text{m/s}$$

**Step 2** 2 of 3

b) The average velocity is given by its definition as following

$$v_{avg} = \frac{x_2 - x_1}{\Delta t}$$

where

$$x_2 = x(3) = 18 \cdot 3 + 5 \cdot 3^2 = 99\text{m}$$

$$x_1 = x(2) = 18 \cdot 2 + 5 \cdot 2^2 = 56\text{m}$$

So we have that

$$v_{avg} = \frac{43}{1} = 43\text{m/s}$$

**Result** 3 of 3

$$\text{a) } v_{inst} = 38\text{m/s}$$

$$\text{b) } v_{avg} = 43\text{m/s}$$

Exercise 14
Rate this solution
Exercise 16a

# Exercise 21

Chapter 2, Page 30

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 3

a) To solve this problem we will use the kinematic formula that connects the distance, velocity and acceleration and it is given as

$$v^2 = v_0^2 + 2a(x - x_0)$$

If we solve it for the acceleration we obtain that

$$a = \frac{v^2 - v_0^2}{2(x - x_0)}$$

If we now note that $v = 0$ and if transfer the initial velocity to $m/s$ we get

$$v_0 = 130\frac{km}{h} \times \frac{1000}{3600} = 36.11\mathrm{m/s}$$

Now, we obtain that

$$a = \frac{-36.11^2}{2 \times 210} = 3.1\mathrm{m/s}^2$$

**Step 2** 2 of 3

b) In order to find the stopping time, we can take several approaches but let's achieve it with the most basic one $v = v_0 - at$ which boils down to

$$v_0 = at$$

$$t = \frac{v_a}{a} = \frac{36.11}{3.1} = 11.65\mathrm{s}$$

**Result** 3 of 3

$$a = 3.1\mathrm{m/s}^2$$

$$t = 11.65\mathrm{s}$$

Exercise 20 Rate this solution Exercise 22

# Exercise 23

Chapter 2, Page 30

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

## Solution

Verified Answered 2 years ago

### Step 1

1 of 2

To solve this problem we will use the kinematic equation that connects the acceleration and distance covered

$$s = \frac{1}{2}at^2$$

Now, the distance covered at the fifth second is given as

$$s_{45} = \frac{1}{2}a(5^2 - 4^2) = \frac{1}{2}9a$$

and the distance covered in first five seconds is

$$s_{05} = \frac{1}{2}a5^2 = \frac{1}{2}25a$$

Their ratio now becomes

$$\frac{s_{45}}{s_{05}} = \frac{9}{25} = 0.36$$

### Result

2 of 2

$$\frac{s_{45}}{s_{05}} = 0.36$$

Exercise 22

Rate this solution

Exercise 24a

# Exercise 33

Chapter 2, Page 31

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 2

Apart from the initial velocity, another contribution to the total velocity is the one due to the gravitational acceleration, $g$. To solve this problem we will use the kinematic expression that relates the distance covered, the acceleration and the velocity:

$$x = v_0 t + \frac{1}{2} g t^2$$

Which is a quadratic formula

$$\frac{1}{2} g t^2 + v_0 t - x = 0$$

$$0.5 \times 9.81 \times t^2 + 20t - 60 = 0$$

After we solve it using the well-known formula

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Which gives us two solutions, but only one is physical

$$t = 2\text{s}$$

**Result** 2 of 2

$$t = 2\text{s}$$

Exercise 32
Rate this solution
Exercise 34

# Exercise 39

Chapter 2, Page 31

Principles of Physics, International Edition

ISBN: 9781118230749

Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 2

To solve this problem we have to understand that at the moment when the policeman starts chasing the car. the distance between them is

$$x = v_{car}t = 46 \cdot 1 = 46\text{m}$$

This gives us the equation as follows

$$v_{car}t + x = \frac{1}{2}a_{police}t^2$$

which makes a quadratic equation which after we insert all the values states that

$$46 + 46t = 0.5 \times 4 \times t^2$$

$$2t^2 - -46t - 46 = 0$$

This quadratic equation has two solutions from which we can neglect the negative one so we have that

$$t = 24\text{s}$$

**Result** 2 of 2

$$t = 24\text{s}$$

Exercise 38 Rate this solution Exercise 40a

# Exercise 43a

Chapter 2, Page 31

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified Answered 1 year ago

## Step 1

1 of 3

**Given:**

$$D = 676\text{ m}$$
$$v_{i_t} = 161\text{ km/h} = 44.7\text{ m/s}$$
$$v_{i_l} = 29\text{ km/h} = 8.05\text{ m/s}$$

## Step 2

2 of 3

To know the required acceleration so that a collision is just avoided we set the final position of the train and the locomotive equal to each other and solve for the time at which collision occurs.

We should also note that the final velocity of the train should be equal to the velocity of the locomotive $v_{f_t} = v_l$

If the collision is barely avoided and also we set the initial position of the train as our origin so the initial position of the locomotive is $D$.

$$x_{f_t} = x_{f_l}$$
$$x_{i_t} + \frac{1}{2}(v_{i_t} + v_{f_t})t = x_{i_l} + v_l t$$
$$0 + \frac{1}{2}(v_{i_t} + v_l)t = D + v_l t$$

$$t = \frac{D}{\frac{1}{2}(v_{i_t} - v_l)} = \frac{676\text{ m}}{\frac{1}{2}((44.7\text{ m/s}) - (8.05\text{ m/s}))} = 36.8\text{ s}$$

Now calculating the acceleration required to avoid a collision :

$$a = \frac{v_{f_t} - v_{i_t}}{t} = \frac{(8.05\text{ m/s}) - (44.7\text{ m/s})}{36.8\text{ s}} = -0.99\text{ m/s}^2$$

## Result

3 of 3

$$a = -0.99\text{ m/s}^2$$



# Exercise 43b

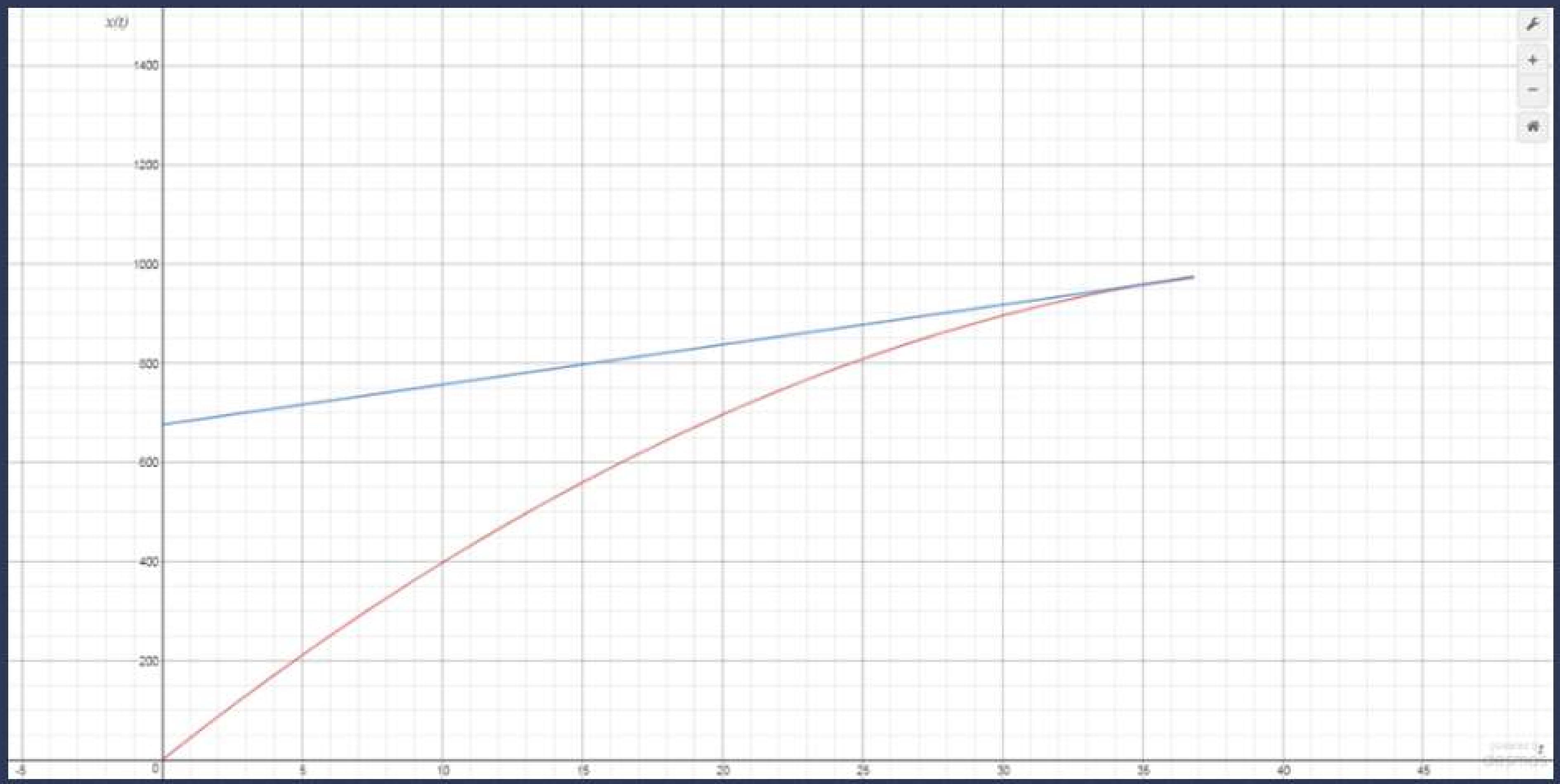
Chapter 2, Page 31

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 1 year ago

### Step 1

1 of 2



The plot of the position as a function of time for the train and the locomotive when the collision is barely avoided is as follows :(where red line represents the train and the blue line represents the locomotive.)

### Step 2

2 of 2

In the case where the collision is not avoided,the graph would look the same except that the slope of the curve of the train would be greater than this because the train would come in contact with the locomotive with a greater velocity than when the collision is barely avoided.

# Exercise 45

Chapter 2, Page 32

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1** 1 of 2

To solve this rather interesting problem we have to understand how to represent the given displacements. The entire height of the tower is covered in a total time of the free fall.

$$H = \frac{1}{2}gt^2$$

Whereas just in the last second we have that the $9/25H$ is covered

$$\frac{9}{25}H = \frac{1}{2}gt^2 - \frac{1}{2}g(t-1)^2$$

If we develop the second equation we get that

$$\frac{9}{25}H = \frac{1}{2}gt^2 - \frac{1}{2}gt^2 + gt - \frac{g}{2}$$
$$\frac{9}{25}H + \frac{g}{2} = gt$$

Which finally gives that time relates to H as

$$t = \frac{\frac{9}{25}H + \frac{g}{2}}{g}$$

Now, we can insert the obtained relation into the first expression given here to get that

$$H = \frac{1}{2}g \times (\frac{\frac{9}{25}H + \frac{g}{2}}{g})^2$$

Which is a quadratic equation for $H$ and it can be written as

$$\frac{81}{625}H + (\frac{9}{25} - 2)gH + \frac{g^2}{4} = 0$$

The coefficients of this equation are

$$A = \frac{81}{625} = 0.13$$
$$B = (\frac{9}{25} - 2)g = -16.1$$
$$C = \frac{g^2}{4} = 24.1$$

and after solving it we obtain two solutions $H = 122.33; 1.52$ Where second is physically impossible since the body in a free fall is going the cover much larger distance than 1.52m in one second and from the problem we know that the last part of the journey is one second long. So we conclude that

$$H = 122\text{m}$$

**Result** 2 of 2

$$H = 122\text{m}$$

## Exercise 47

Chapter 2, Page 32

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

**Solution** Verified Answered 2 years ago

**Step 1**



Note: Because of the convenience, we will take that the direction down is the positive direction of the coordinate h.

a) To solve this problem we will us a kinematic relation that connects the initial velocity, final velocity, acceleration and the displacement

$$v^2 = v_0^2 + 2gh$$

$$v = \sqrt{v_0^2 + 2gh} = \sqrt{14^2 + 2 \times 9.81 \times 98}$$

Which gives that

$$v = 46\mathrm{m/s}$$

b) Now, we can grasp the time but again, we have to take care of the directions of motion

$$v = -v_0 + gt$$

After solving for $t$ we have that

$$t = \frac{v + v_0}{g} = \frac{46 + 14}{9.81}$$

$$t = 6.11\mathrm{s}$$

**Result**



$$\text{a) } v = 46\mathrm{m/s}$$

$$\text{b) } t = 6.11\mathrm{s}$$

Exercise 46 Rate this solution Exercise 48

## Exercise 69

Chapter 2, Page 33

Principles of Physics, International Edition
ISBN: 9781118230749
Table of contents

Solution Verified

**Step 1** 1 of 8

The vertical axis of the graph is divided into 4 squares, each square is set to be a velocity equivalent to 2 m/s, since the maximum point on the graph is set to be 8 m/s. Regarding the horizontal axis, each square is set to be equivalent to 2 s.

**Step 2** 2 of 8

We have here a graph of the velocity versus time. Since the velocity is the derivative of the displacement, the displacement could be obtained by integrating the velocity over time. And we know that the integral of a function is the area under the curve of that function. So, in order to find the displacement we just need to find the area under the curve. Which is easily obtained by finding the areas of the triangles and rectangles and add them together.

**Step 3** 3 of 8

We can divide the graph into 4 regions as following:

$\underline{\textbf{The first region}}$:

It's a triangle of a 2-unit base and an 8-unit height. Hence its area is:

$$A = \frac{1}{2} \times 2 \times 8 = 8 \text{ unit squared.}$$

**Step 4** 4 of 8

$\underline{\textbf{The second region}}$:

It's a rectangle of an 8-unit base and an 8-unit height. Hence its area is:

$$A = 8 \times 8 = 64 \text{ unit squared.}$$

**Step 5** 5 of 8

$\underline{\textbf{The third region}}$:

It's a trapezoid with bases of 4 and 8 units and a 2-unit height. The area of the trapezoid is the arithmetic average of the 2 bases multipled by its height. Hence its area is:

$$A = \frac{4+8}{2} \times 2 = 12 \text{ unit squared.}$$

**Step 6** 6 of 8

$\underline{\textbf{The fourth region}}$:

It's a rectangle of a 4-unit base and a 4-unit height. Hence its area is:

$$A = 4 \times 4 = 16 \text{ unit squared.}$$

**Step 7** 7 of 8

Hence, the total area under the curve is the total displacement as following:

$$\Delta x = 8 + 64 + 12 + 16 = 100 \text{ m}$$

**Result** 8 of 8

$$\Delta x = 100 \text{ m}$$

< Exercise 68
Rate this solution
Exercise 70 >