PHYS141 OUTLINE QUESTIONS SOLUTIONS

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Exercise 2

Chapter 8, Page 174

Principles of Physics, International Edition
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Solution Verified Answered 2 years ago

Step 1

To solve this problem we are going to use the fact that the work done from the gravitational field is going to be equal to the change in gravitational potential energy so we can write

$$W = mg\Delta y$$

a) Since point A is at the same height as the initial position we have that $\Delta y = 0$ so the total work done by the gravitational force is

$$W_A = \Delta U = 0$$

b) At point B the height is $y = h/2$ so we have that the work done by gravity is equal to

$$W_B = -mg\Delta y = \frac{mgh}{2} = \frac{825 \times 9.8 \times 50}{2}$$

$$W_B = 202 \times 10^3 \mathrm{J}$$

c) A work done by gravity from the initial point to point C is equal to

$$W_C = -mg\Delta y = mgh = 825 \times 9.8 \times 50$$

$$W_C = 404 \times 10^3 \mathrm{J}$$

d) If the point C is taken as a zero potential point we can write that at B

$$U_B = mg\Delta y = \frac{mgh}{2} = \frac{825 \times 9.8 \times 50}{2}$$

$$U_B = 202 \times 10^3 \mathrm{J}$$

e) Whereas at point A the potential is

$$U_A = mg\Delta y = mgh = 825 \times 9.8 \times 50$$

$$U_A = 404 \times 10^3 \mathrm{J}$$

f) If the mass of the car would be doubled the change will increase.

Result

$$\text{a) } W_A = \Delta U = 0$$

$$\text{b) } W_B = 202 \times 10^3 \mathrm{J}$$

$$\text{c) } W_B = 404 \times 10^3 \mathrm{J}$$

$$\text{d) } U_B = 202 \times 10^3 \mathrm{J}$$

$$\text{e) } U_A = 404 \times 10^3 \mathrm{J}$$

$$\text{f) It will increase.}$$

Exercise 1 Exercise 3a

Exercise 5a

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Step 1 1 of 3

Givens:

Mass of the ice flake, $m = 2$ g

Radius of the bowl, $r = 22$ cm.

The flake-bowl contact is friction-less (Friction force is zero).

Step 2 2 of 3

Part a:

The displacement vector of the ice flake from the initial point to the bottom of the bowl can be written as:

$$\vec{d_b} = (-r\hat{i} - r\hat{j})\ \mathrm{m}.$$

Note: it was assumed that the initial position of the ice flake is the origin of the Cartesian coordinates.

The gravitational force vector can also be written as:

$$\vec{F_g} = -mg\hat{j}\ \mathrm{N}.$$

Therefore, the work done on the ice flake by the gravitational force from the initial point to the bottom of the bowl is given by:

$$\begin{aligned} W_{gb} = \vec{F_g} \cdot \vec{d_b} &= (-mg\hat{j}) \cdot (-r\hat{i} - r\hat{j}) \\ &= 0 + mgr \\ &= 0 + 2 \cdot 10^{-3} \cdot 9.8 \cdot 22 \cdot 10^{-2} \\ &= 4.312 \cdot 10^{-3}\ \mathrm{J} \end{aligned}$$

Where W_{gb} is the work done on the ice flake by the gravitational force from the initial point to the bottom of the bowl.

Result 3 of 3

$$(a)\ \ W_{gb} = 4.312 \cdot 10^{-3}\ \mathrm{J}$$

Exercise 5b

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Solution Verified Answered 1 year ago

Step 1

Part b:

Because the ice flake is falling, the change in the gravitational potential energy of the ice flake is equal to the negative work done on it by the gravitational force.

$$\Delta U_b = -W_{gb} = -4.312 \cdot 10^{-3}\ \text{J}.$$

Where ΔU is the change in the gravitational potential energy of the ice flake the flake's descent to the bottom of the bowl .

Result

$$(b)\ \ \Delta U_b = -4.312 \cdot 10^{-3}\ \text{J}$$

Exercise 5c

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Step 1 1 of 2

Part c:

The potential energy is taken to be zero at the bottom of the bowl, then the bottom of the bowl is the reference point.

Therefore, the potential energy of the ice flake when it was released is given by:

$$U_i = mgh_i = mgr = 2 \cdot 10^{-3} \cdot 9.8 \cdot 22 \cdot 10^{-2} = 4.312 \cdot 10^{-3}\ \mathrm{J}$$

Where

U_i is the potential energy of the ice flake when it was released.

h_i is the vertical distance from the the edge of the bowl to the bottom of the bowl.

Result 2 of 2

$$(c)\ \ U_i = 4.312 \cdot 10^{-3}\ \mathrm{J}$$

Exercise 5b

Rate this solution

Exercise 5d

Exercise 5d

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Step 1 1 of 2

Part d:

The potential energy is taken to be zero at the release point, then the release point is the reference point.

Therefore, the potential energy of the ice flake when it reaches the bottom of the bowl is given by:

$$U_f = mgh_f = mg(-r) = -2 \cdot 10^{-3} \cdot 9.8 \cdot 22 \cdot 10^{-2} = -4.312 \cdot 10^{-3}\ \mathrm{J}.$$

Where

U_f is the potential energy of the ice flake when it reaches the bottom of the bowl.

h_f is the vertical distance from the the bottom of the bowl to the release point. h_f is negative because the bottom of the bowl is below the release point.

Result 2 of 2

$$(d)\ \ U_f = -4.312 \cdot 10^{-3}\ \mathrm{J}$$

Exercise 5e

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Solution Verified Answered 1 year ago

Step 1

Part e:

All the magnitudes of the answers to (a) through (d) would be **doubled** if the mass of the ice flake was doubled. All the magnitudes of the answers are directly proportional to the mass of the ice flake.

Result

$$(e)\quad \text{Doubled}$$

Exercise 5d
Rate this solution
Exercise 6

Exercise 6

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Solution Verified Answered 2 years ago

Step 1

1 of 3

In order to solve this problem we will use the fact that the work done on the body by the gravitational field is given

$$W = -mg\Delta h$$

whereas the gravitational potential is given as

$$U = mg\Delta h$$

a) The work that is being done on the the ball from point P till point Q is equal to

$$W_Q = -mg\Delta h = -mg(R-h) = 4mgR$$

After we insert the given values we get that

$$W_Q = 4 \times 0.032 \times 9.8 \times 0.1$$

$$W_Q = 0.13\text{J}$$

b) The work that is being done on the the ball from point P till the tope (T) is equal to

$$W_T = -mg\Delta h = -mg(2R-h) = 3mgR$$

After we insert the given values we get that

$$W_T = 3 \times 0.032 \times 9.8 \times 0.1$$

$$W_T = 0.094\text{J}$$

Step 2

2 of 3

c) If the bottom of the circle is taken as a zero potential than the gravitational potential at point P is equal to

$$U_P = mg\Delta h = mgh$$

After we insert the given values we get that

$$W_P = 0.032 \times 9.8 \times 0.5$$

$$W_P = 0.16\text{J}$$

d) By the same principle, the gravitational potential at point Q is equal to

$$U_Q = mg\Delta h = mgR$$

After we insert the given values we get that

$$U_Q = 0.032 \times 9.8 \times 0.1$$

$$U_Q = 0.031\text{J}$$

e) Finally, the gravitational potential at point top of the circle is equal to

$$U_T = mg\Delta h = 2mgR$$

After we insert the given values we get that

$$U_T = 2 \times 0.032 \times 9.8 \times 0.1$$

$$U_T = 0.062\text{J}$$

f) These results do not depend on the initial velocity but only on the mass and the altitude of the ball so they will remain the same.

Result

3 of 3

$$\text{a) } W_Q = 0.13\text{J}$$

$$\text{a) } W_Q = 0.13\text{J}$$

$$\text{b) } W_Q = 0.0.094\text{J}$$

$$\text{c) } W_Q = 0.16\text{J}$$

$$\text{d) } W_Q = 0.031\text{J}$$

$$\text{e) } W_Q = 0.062\text{J}$$

f) The results will remain the same.

Exercise 20

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Solution Verified Answered 2 years ago

Step 1

To solve this problem we will use the conservation of energy. If we take that the lowest point has zero gravitational potential we can write that $-\Delta U = \Delta K$

$$mgh = \frac{1}{2}v_0^2 - \frac{1}{2}v^2$$

We can solve this expression for v to obtain that

$$v^2 = v_0^2 - 2gh$$

$$v = \sqrt{v_0^2 - 2gh}$$

The height h can be expressed via the length of the string and its angle with the vertical as follows

$$h = R - R\cos\theta = R(1 - \cos\theta)$$

The speed is now given as

$$v = \sqrt{v_0^2 - 2gR(1 - \cos\theta)}$$

a) We can use the expression obtained above to get the speed at $\theta = 60^\circ$

$$v = \sqrt{v_0^2 - 2gR(1 - \cos\theta)} = \sqrt{8^2 - 2 \times 9.8 \times 4.5 \times (1 - \cos 60^\circ)}$$

The speed is then equal to

$$v(60^\circ) = 4.5\text{m/s}$$

b) The greatest angle of the string with the vertical is achieved when the kinetic energy is equal to zero, i.e. when $v = 0$. In that case our expression above becomes

$$v_0^2 - 2gR(1 - \cos\theta) = 0$$

We can solve it for the term with containing the angle and get that

$$\cos\theta = 1 - \frac{v_0^2}{2gR} = 1 - \frac{8^2}{2 \times 9.8 \times 4.5}$$

$$\cos\theta = 0.274$$

So the angle is finally given as

$$\theta = \arccos 0.274 = 74^\circ$$

c) The total mechanical energy of the system is equal to its total energy and in this case, it is equal to its kinetic energy at the lowest point since $U = 0$ there.

$$E_{mec} = K = \frac{1}{2}mv^2 = 0.5 \times 2 \times 8^2$$

$$E_{mec} = 64\text{J}$$

Result

$$\text{a) } v(60^\circ) = 4.5\text{m/s}$$

$$\text{b) } \theta = \arccos 0.274 = 74^\circ$$

$$\text{c) } E_{mec} = 64\text{J}$$

Exercise 19 Rate this solution Exercise 21a

Exercise 23a

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Solutions Verified

Solution A Solution B

Answered 1 year ago

Step 1

1 of 5

We apply the law of conservation of energy between the gravitational potential energy of the ball-Earth system and the kinetic energy of the ball. We set the reference point to be the horizontal; that is, the gravitational potential energy there is equal to 0.

Step 2

2 of 5

The given length of the string is $L = 1.2\ \mathrm{m}$, and the distance between the point of attachment of the string to the peg is $d = 0.75\ \mathrm{m}$.

Step 3

3 of 5

$\mathbf{(a).}$ When the ball is at the \textbf{lowest point}, then the vertical displacement is $-L$ or $-1.2\ \mathrm{m}$. Let m be the mass of the ball, and v_L the speed on the bottom. Therefore, by the law of conservation of kinetic and gravitational potential energy,

$$\begin{aligned} U_i + K_i &= U_f + K_f \\ 0 + 0 &= -mgL + \frac{1}{2}m(v_L)^2 \\ \implies v_L &= \sqrt{2gL} \end{aligned}$$

Step 4

4 of 5

Substituting $L = 1.2\ \mathrm{m}$, we have

$$\begin{aligned} v_L &= \sqrt{2\left(9.81\ \frac{\mathrm{m}}{\mathrm{s}^2}\right)(1.2\ \mathrm{m})} \\ &= \boxed{4.85\ \frac{\mathrm{m}}{\mathrm{s}}} \end{aligned}$$

Result

5 of 5

$$\mathbf{(a).}\ 4.85\ \frac{\mathrm{m}}{\mathrm{s}}$$

Exercise 22
Rate this solution
Exercise 23b

Exercise 23b

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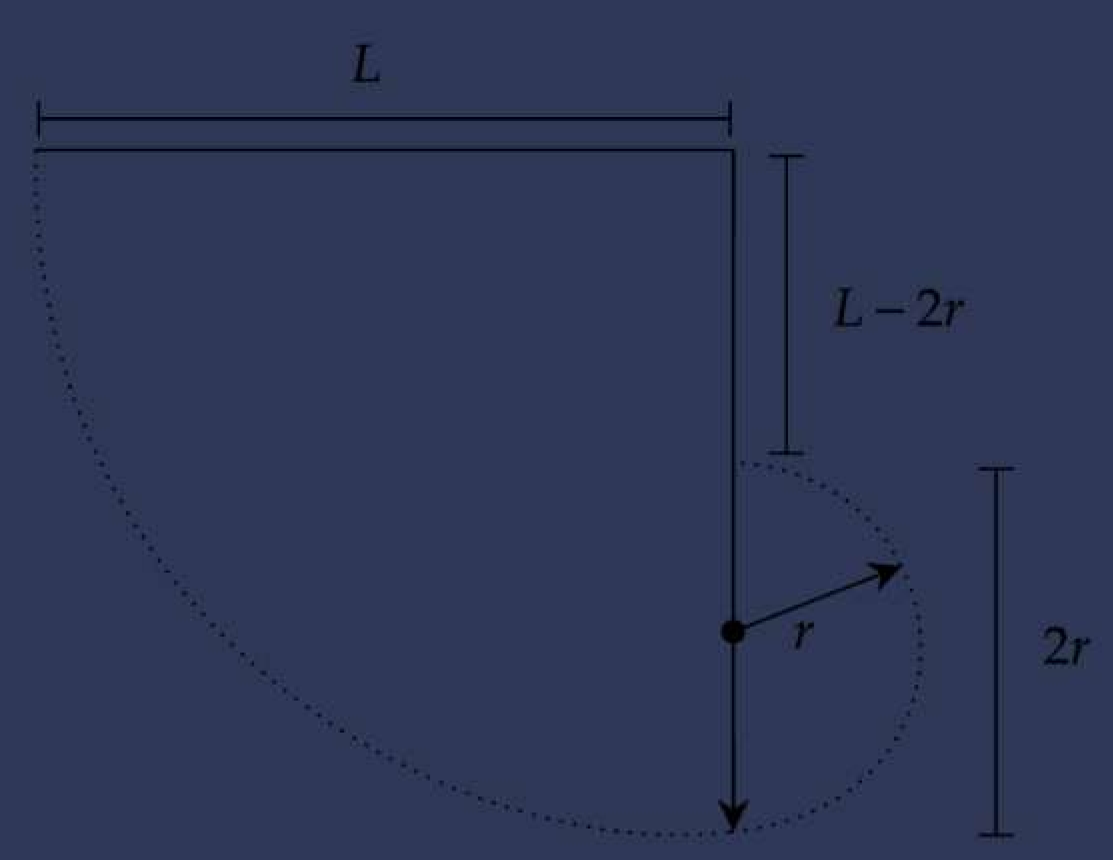
Solution Verified Answered 1 year ago

Step 1 1 of 4

$\textbf{(b).}$ Refer to the figure. We have $d = L - r$, so $d + r = L$. Since $d = 0.750\text{ m}$ and $L = 1.20\text{ m}$, then it follows that $r = 0.450\text{ m}$. Therefore, the vertical displacement of the ball as it reaches the \textbf{top} position is $-(L - 2r) = -0.300\text{ m}$.



Step 2 2 of 4

Applying the law of conservation of energy,

$$\begin{aligned} U_i + K_i &= U_f + K_f \\ 0 + 0 &= -mg(L - 2r) + \frac{1}{2}m(v_T)^2 \\ \implies v_T &= \sqrt{2g(L - 2r)} \end{aligned}$$

Step 3 3 of 4

Substituting $L - 2r = 0.300\text{ m}$, we have

$$\begin{aligned} v_T &= \sqrt{2\left(9.81\ \frac{\text{m}}{\text{s}^2}\right)(0.300\text{ m})} \\ &= \boxed{2.43\ \frac{\text{m}}{\text{s}}} \end{aligned}$$

Result 4 of 4

$$\textbf{(b).}\ 2.43\ \frac{\text{m}}{\text{s}}$$

Exercise 23a Rate this solution Exercise 24

Exercise 24

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Solution Verified Answered 2 years ago

Step 1

1 of 2

In order to solve this problem we will use the conservation of energy law. We have to understand that the system will reach an equilibrium, i.e. the deepest possible compression once the forces on it are equal to zero. Nevertheless, we can approach the problem from another side, we can say that the system will be in an equilibrium once the gravitational potential is fully transformed into the elastic potential. We bare in mind that since the body is in rest at the beginning and at the end, $\Delta K = 0$. If we take that at the position of the maximum compression x we have the gravitational field to be zero it has to hold

$$mg(h+x) = \frac{1}{2}kx^2$$

$$\frac{1}{2}kx^2 - mgx - mgh = 0 | /mg$$

$$\frac{k}{2mg}x^2 - x - h = 0$$

This is a quadratic equation and after we insert the given values it becomes

$$\frac{1960}{2 \times 2 \times 9.8}x^2 - x - 0.5 = 0$$

This equation has two solutions of which only the positive one is physical and has a meaning

$$x = 0.11\text{m}$$

Result

2 of 2

$$x = 0.11\text{m}$$

Exercise 26a

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Solution Verified Answered 1 year ago

Step 1 1 of 3

Givens:

$\vec{F} = (6x - 12)\hat{i}$ N, acting on a particle,

The particle is moving along x axis,

at $x = 0$, the potential energy $U(0) = 27$ J.

Step 2 2 of 3

Part a:

Work done on the particle by force $\vec{F}$ at distance x is:

$$\begin{aligned} W = \int_{r_i}^{r_f} \vec{F} \cdot d\vec{r} &= \int_{r_i}^{r_f} (F_x\hat{i} + F_y\hat{j} + F_z\hat{k}) \cdot (dx\hat{i} + dy\hat{j} + dz\hat{k}) \\ &= \int_{x_i}^{x_f} F_x \, dx + 0 + 0 = \int_0^x (6x - 12) \, dx \\ &= [\frac{6x^2}{2} - 12x]\Big|_0^x = (3x^2 - 12x) - 0 = 3x^2 - 12x \text{ J.} \end{aligned}$$

Where x is the distance of the particle in meters.

The change in the potential energy of the ball is equal to the negative work done on it by force $\vec{F}$.

$$\Delta U = -W = -(3x^2 - 12x) \text{ J.}$$

Where ΔU is the change in the potential energy of the particle at distance x, But ΔU at distance x is also defined as:

$$\begin{aligned} \Delta U &= U(x) - U(0) \\ \therefore \; U(x) &= \Delta U + U(0) = -(3x^2 - 12x) + 27 \\ &= -3x^2 + 12x + 27 \text{ J.} \end{aligned} \tag{1}$$

Where $U(x)$ is the potential energy of the particle at distance x.

Result 3 of 3

(a) $U(x) = -3x^2 + 12x + 27$ J.

Exercise 26b

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Solution Verified Answered 1 year ago

Step 1 1 of 2

Part b:

Differentiating $U(x)$ in equation 1 w.r.t x, and equating the first derivative to zero gives the maximum positive potential energy of the particle with respect to its position.

$$\frac{dU(x)}{dx} = -6x + 12$$

$$\therefore \ -6x + 12 = 0 \text{ Corresponds to the maximum positive potential energy of the particle.}$$

$$-6x = -12$$

$$x = \frac{12}{6} = 2$$

Substitute in equation 1 to get the maximum positive potential energy of the particle with respect to its position

$$U_{max} = -3(2)^2 + 12 \times 2 + 27 = 39 \text{ J.}$$

Result 2 of 2

(b) $U_{max} = 39$ J.

Rate this solution

Exercise 26a Exercise 26c

Exercise 26c

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Solution Verified Answered 1 year ago

Step 1 1 of 2

Part c:

Values of x at which the potential energy of the particle is equal to zero can be found by solving the quadratic equation:

$$-3x^2 + 12x + 27 = 0$$
$$\therefore\ x = \frac{-12 \pm \sqrt{12^2 - 4 \times -3 \times 27}}{-2 \times 3}$$

Therefore, the negative value of x at which the potential energy equal to zero is:

$$x_{-ve} = \frac{-12 + \sqrt{12^2 - 4 \times -3 \times 27}}{-2 \times 3} = -1.6 \text{ m.}$$

Result 2 of 2

(c) $x_{-ve} = -1.6$ m.

Exercise 26b Rate this solution Exercise 26d

Exercise 26d

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Solution Verified Answered 1 year ago

Step 1

Part d:

Therefore, the positive value of x at which the potential energy equal to zero is:

$$x_{+ve} = \frac{-12 - \sqrt{12^2 - 4 \times -3 \times 27}}{-2 \times 3} = 5.6 \text{ m.}$$

Result

(d) $x_{+ve} = 5.6$ m.

Exercise 26c

Rate this solution

Exercise 27a

Exercise 31

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Solution Verified Answered 2 years ago

Step 1 1 of 2

To solve this problem we will fully utilize the conservation of energy principle.

a) If we know that the maximum height that the block reaches is equal to 5m we can use the conservation of energy to write that

$$\frac{1}{2}kx^2 = mgh$$

This is the expression we will use the find the spring constant k

$$k = \frac{2mgh}{x^2} = \frac{2 \times 1 \times 9.8 \times 5}{0.25^2}$$

This gives us that

$$k = 1568\text{N} = 1.6\text{kN}$$

b) Now, we can take a look at the situation when the block is between the spring and the incline, sliding on the horizontal surface. In this case, the entire potential elastic energy has transformed into the kinetic energy of the block

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$$

This can be solved for v to give that

$$v^2 = \frac{kx^2}{m} = \frac{1568 \times 0.25^2}{1}$$

$$v = 9.9\text{m/s}$$

c) In order to deduce what will happen if the angle of the incline would increase we have to take a look at the equation given in part a

$$\frac{1}{2}kx^2 = mgh$$

which can be solved for h

$$h = \frac{kx^2}{2mg}$$

where we can see that it doesn't depend on the angle of the incline whatsoever. So, it will be the same.

Result 2 of 2

$$\text{a) } k = 1.6\text{kN}$$

$$\text{b) } v = 9.9\text{m/s}$$

$$\text{c) Same}$$

Exercise 34

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Solution Verified Answered 2 years ago

Step 1

In order to solve this problem, we will use the conservation of energy and Newton's second law. At the moment when the boy loses contact with the mound the kinetic energy of the boy is equal to

$$\frac{1}{2}mv^2 = mg\Delta h$$

where $\Delta h = R - R\cos\theta = R(1-\cos\theta)$ with angle θ being the angle between the vertical and the boy's current position on the sphere.

$$\frac{1}{2}mv^2 = mgR(1-\cos\theta)$$

At the same moment, the centripetal force is equal to the gravitational force

$$\frac{mv^2}{R} = mg\cos\theta$$

since the normal force is equal to zero. We can now express v^2 from the first equation and plug it in the second.

$$v^2 = 2gR(1-\cos\theta)$$

so after inserting it into the second equation we have that

$$\frac{2gR(1-\cos\theta)}{R} = g\cos\theta$$

$$2(1-\cos\theta) = \cos\theta$$

After we solve this equation for $\cos\theta$ we have that

$$\cos\theta = \frac{2}{3}$$

Now, the height is given as

$$h = R\cos\theta = 12.8 \times 0.66$$

Finally, we have that the height is

$$h = 8.5\mathrm{m}$$

Result

$$h = 8.5\mathrm{m}$$

Exercise 38a

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Solutions Verified

Solution A Solution B

Answered 1 year ago

Step 1 1 of 6

Given Information

- Particle mass: $m_p = 0.2\ \mathrm{kg}$
- Potential energy at the point A: $U_A = 9.0\ \mathrm{J}$
- Potential energy at the point C: $U_C = 20.0\ \mathrm{J}$
- Potential energy at the point D: $U_D = 24.0\ \mathrm{J}$
- Potential energy at the point B: $U_B = 12.0\ \mathrm{J}$
- Initial kinetic energy: $T_i = 4.0\ \mathrm{J}$

Objective

- $\mathbf{a)}$ Find the particle's speed at the point $x_1 = 3.5\ \mathrm{m}$
- $\mathbf{b)}$ Find the particle's speed at the point $x_2 = 6.5\ \mathrm{m}$
- $\mathbf{c)}$ Find the place of turning point for the right side x_R
- $\mathbf{d)}$ Find the place of turning point for the left side x_L

Step 2 2 of 6

$\mathbf{a)}$

To find the particle's speed at a certain point after the release, we can consider the law of conservation of energy, which states that the total energy must remain the same for the same system in two different time instances.

Since the force in our problem is conservative, we can write the total energy of the particle E as:

$$E = T + P \tag{1}$$

Where T is the kinetic energy of the particle and P is the potential energy of the particle.

Step 3 3 of 6

Using the conservation of energy, we can say that the system in the first instance, where $P = U_B$ and $T = T_i$, has the same total energy as the system in the other instance at the point x_1:

$$E_1 = U_B + T_i = E_{x_1} = P_{x_1} + T_{x_1} \tag{2}$$

Where, from the graph we can read that at x_1 potential energy is $P_{x_1} = U_A$. Using this, from (2) we can express the kinetic energy at the point x_1 as:

$$\begin{aligned} T_{x_1} &= U_B + T_i - P_{x_1} \\ &= U_B + T_i - U_A \end{aligned} \tag{3}$$

Step 4 4 of 6

Since we know the kinetic energy at the point x_1, we can easily find the speed at the point x_1 by using the definition of kinetic energy T, for a particle of mass m and velocity v:

$$T = \frac{m \cdot v^2}{2} \rightarrow T_{x_1} = \frac{m_p \cdot v_{x_1}^2}{2} \tag{4}$$

Combining (4) into (3), we get:

$$\frac{m_p \cdot v_{x_1}^2}{2} = U_B + T_i - U_A$$

$$v_{x_1} = \sqrt{\frac{2}{m_p} \cdot (U_B + T_i - U_A)} \tag{5}$$

Step 5 5 of 6

Using equation (5), we can finally calculate the speed at the point x_1:

$$\begin{aligned} v_{x_1} &= \sqrt{\frac{2}{m_p} \cdot (U_B + T_i - U_A)} \\ &= \sqrt{\frac{2}{0.2} \cdot (12 + 4 - 9)} \\ &= \boxed{8.47\ \frac{\mathrm{m}}{\mathrm{s}}} \end{aligned}$$

Result 6 of 6

$$\mathbf{a)}\ v_{x_1} = 8.47\ \frac{\mathrm{m}}{\mathrm{s}}$$

Exercise 38b

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Solution Verified Answered 1 year ago

Step 1

b)

We can solve this part of the problem with the same method used in part **a**). Thus, to find the velocity at point x_2, we use the equation (5), where instead of using potential energy U_A, we use the potential energy at the point $P_{x_2} = 0$, which is the potential energy at the point x_2 that we can read from the graph.

Step 2

Writing down the equation (5) for this case:

$$\begin{aligned} v_{x_2} &= \sqrt{\frac{2}{m_p} \cdot (U_B + T_i - P_{x_2})} \\ &= \sqrt{\frac{2}{0.2} \cdot (12 + 4 - 0)} \\ &= \boxed{12.65\ \frac{\text{m}}{\text{s}}} \end{aligned}$$

Result

$$\textbf{b)}\ v_{x_2} = 12.65\ \frac{\text{m}}{\text{s}}$$

Exercise 38c

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Step 1 1 of 7

c)

As the particle starts to climb hill that is positioned between $x = 7$ m and $x = 8$ m, it will reach a point where it's velocity becomes zero — turning point x_{tp}.

This will happen at the point where all the kinetic energy particle has had has turned into potential energy. So, all the energy the particle had in the beginning (Kinetic T_i and potential U_B) has turned into potential energy at the turning point, thus the potential energy at the turning point U_{tp} is equal to:

$$U_{tp} = T_i + U_B \tag{1}$$

Step 2 2 of 7

Now we know at what value of the y axis (potential energy) does the particle reach the turning point.

To find the position of the turning point, we can simply look at the graph and find the corresponding x axis value for a given y value. But, we are not given enough resolution to do this — we can only see that the value lies somewhere between the values 7 m and 8 m.

So, we will have to find a method for finding the corresponding x value.

Step 3 3 of 7

To find the corresponding x value for a given y value (potential energy U_{tp}, we can see that the change of potential energy U is linear with the change of position x between $x = 7$ m and $x = 8$ m. This means that the ratio of potential energy change ΔU with the change in position Δx stays constant in this interval:

$$\frac{\Delta U}{\Delta x} = C \tag{2}$$

Where C is a constant (or the slope of the graph) at this interval.

Step 4 4 of 7

Since C is the slope of the graph, it is equal to the rise over run (As stated in (7)), and since the slope is constant for this interval, we can write the equation (7) for two cases:

- Between point $x = 7$ m and the turning point x_{tp}:

$$\frac{\Delta U}{\Delta x} = \frac{(U_{tp} - 0)}{x_{tp} - 7} = C \tag{3}$$

- Between point $x = 8$ m and the turning point x_{tp}:

$$\frac{\Delta U}{\Delta x} = \frac{(U_D - U_{tp})}{8 - x_{tp}} = C \tag{4}$$

Where we took into account that potential energy U at the point $x = 7$ m is $U = 0$ and $U = U_D$ at the point $x = 8$ m.

Step 5 5 of 7

Since the equations (8) and (9) are equal to the same constant, we can just equate them and express x_{tp}:

$$\begin{aligned}\frac{(U_{tp} - 0)}{x_{tp} - 7} &= \frac{(U_D - U_{tp})}{8 - x_{tp}} \\ \frac{U_{tp}}{x_{tp} - 7} &= \frac{U_D - U_{tp}}{8 - x_{tp}} \\ (8 - x_{tp}) \cdot U_{tp} &= (x_{tp} - 7) \cdot (U_D - U_{tp}) \\ 8 \cdot U_{tp} - x_{tp} \cdot \cancel{U_{tp}} &= x_{tp} \cdot (U_D - \cancel{U_{tp}}) - 7 \cdot (U_D - U_{tp}) \\ -x_{tp} \cdot U_D &= -1 \cdot U_{tp} - 7 \cdot U_D \\ x_{tp} &= \frac{U_{tp} + 7 \cdot U_D}{U_D} \end{aligned} \tag{5}$$

Now we have everything to calculate the turning point x_{tp}.

Step 6 6 of 7

Using (6) and equation (10), we finally calculate the turning point x_{tp}:

$$\begin{aligned} x_{tp} &= \frac{U_{tp} + 7 \cdot U_D}{U_D} \\ &= \frac{(U_B + T_i) + 7 \cdot U_D}{U_D} \\ &= \frac{(12 + 4) + 7 \cdot 24}{24} \\ &= \boxed{7.6 \text{ m}} \end{aligned}$$

Result 7 of 7

c) $x_{tp} = 7.6$ m

Exercise 38d

Chapter 8, Page 178

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Solution Verified Answered 1 year ago

Step 1

1 of 3

$\mathbf{d)}$

To find the turning point for the left side (Between $x = 1\ \mathrm{m}$ and $x = 3\ \mathrm{m}$) we use the same method as in part $\mathbf{c)}$ of the problem.

So, we again use the equation (7) for two cases:

- Between $x = 3\ \mathrm{m}$ and the turning point x_{tp}:

$$\frac{\Delta U}{\Delta x} = \frac{U_{tp} - U_C}{x_{tp} - 1} = C \tag{1}$$

- Between the turning point x_{tp} and $x = 1\ \mathrm{m}$:

$$\frac{\Delta U}{\Delta x} = \frac{U_A - U_{tp}}{3 - x_{tp}} = C \tag{2}$$

Where we noticed from the graph that the potential energy at $x = 3\ \mathrm{m}$ is $U = U_A$, and the potential energy at $x = 1\ \mathrm{m}$ is $U = U_C$.

Step 2

2 of 3

Again, we can equate equations (11) and (12):

$$\frac{U_{tp} - U_C}{x_{tp} - 1} = \frac{U_A - U_{tp}}{3 - x_{tp}}$$

After doing the same algebra as in part $\mathbf{c)}$ of the problem, we get:

$$x_{tp} = \boxed{1.73\ \mathrm{m}}$$

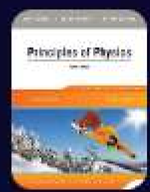
Result

3 of 3

$$\mathbf{d)}\ x_{tp} = 1.73\ \mathrm{m}$$

Exercise 60

Chapter 8, Page 180



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Solution

Verified Answered 2 years ago

Step 1

In order to solve this problem we are going to use the conservation of energy principle and work-energy relation. Let's write the conservation of energy relation when initially the bundle is at the given position with the given kinetic energy and once it reaches its final destination.

$$K_1 + U_1 = U_2 + f_k \cdot xx$$

$$K_1 = \Delta U + f_k \cdot x = mg \sin\theta \cdot x + \mu mg \cos\theta \cdot x$$

Using the kinetic energy formula we have that

$$x = \frac{K_1}{mg(\sin\theta + \mu\cos\theta)} = \frac{150}{4 \times 9.8 \times (\sin 30^\circ + 0.36 \times \cos 30^\circ)}$$

Finally, the bundle will slide for additional

$$x = 4.7\text{m}$$

Result

$$x = 4.7\text{m}$$

Exercise 65

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Solutions Verified

Solution A Solution B

Answered 2 years ago

Step 1 1 of 10

Denote n as the number of passes the block makes to the flat region. That is, when $n = 1$, it moves from its initial position A to the right, passing through the flat region once. When $n = 2$, it moves from the right to the left, again passing through the flat region.

Step 2 2 of 10

Likewise, denote d as the distance it travels in the flat region. We are given that the length is L, and $h = \frac{L}{2}$ so that $L = 2h$. This means that $0 \leq d \leq 2h$. Furthermore, we know that $d = rh$, where $0 \leq r \leq 2$. Physically, r denotes the fractional component of the length of the region $L = 2h$.

Step 3 3 of 10

During the first pass to the flat region ($n = 1$), the increase in thermal energy of the system is

$$\Delta E_{\text{th},1} = f_k d = \mu_k mgd$$

Note that we don't say that it passes through with distance L, as we do not know if the block will stop moving $\textbf{during}$ the first pass.

Step 4 4 of 10

If the block stops moving $\textbf{during}$ the second pass ($n = 2$), then the increase in thermal energy is.

$$\Delta E_{\text{th},2} = \mu_k mg(d + L)$$

Step 5 5 of 10

Generalizing to n passes, we have

$$\Delta E_{\text{th},n} = \mu_k mg(d + (n-1)L)$$

Step 6 6 of 10

The block will stop if all of its associated initial gravitational potential energy is converted to thermal energy. That is,

$$\begin{aligned} mgh &= E_{\text{th},n} = \mu_k mg(d + (n-1)L) \\ \implies h &= \mu_k(d + (n-1)L) \end{aligned}$$

Step 7 7 of 10

We've set $d = rh$ and $L = 2h$, so that

$$\begin{aligned} h &= \mu_k(rh + 2(n-1)h) \\ \implies 1 &= \mu_k(r + 2n - 2) \end{aligned}$$

We need to solve for r such that $0 \leq r \leq 2$ and n, which is a positive integer.

Step 8 8 of 10

Substituting the given $\mu_k = 0.2$

$$\begin{aligned} 0.2(r + 2n - 2) &= 1 \\ r + 2n &= 7 \end{aligned}$$

When $n = 1$, $r = 5$ which cannot be the case since $0 \leq r \leq 2$. Similarly, when $n = 2$, $r = 3$, also not possible. When $n = 3$, $r = 1$, which is a solution. When $n \geq 4$, r will give negative values so this is not possible.

Step 9 9 of 10

Therefore, it must be the case that the block stops $\textbf{during}$ the $n = 3$ pass. Specifically, the block stops on a distance $d = h = \frac{L}{2}$ or halfway through the flat region.

Result 10 of 10

$\frac{L}{2}$, during the third pass.