Quiz Average **5.86** **Quiz High Score** **8**

PH 220 **Quiz # 08 (10 pts)** **Name** **Solution**

A hypothetical conservative force is found to have a potential energy function given by:

$$U(x) = 4x^3 - 2x + 6$$

$U(x)$ will be in units of Joules if x is in units of meters. What is the magnitude and direction of the conservative force at $x = 2.00\ m$?

A.	$+34\ N\ (\hat{\imath})$	**C.**	$-34\ N\ (\hat{\imath})$
B.	$+46\ N\ (\hat{\imath})$	**D.**	$\mathbf{-46\ N\ (\hat{\imath})}$

$$\vec{F} = -\vec{\nabla}U(x) = -\frac{\partial}{\partial x}U(x)(\hat{\imath}) - \frac{\partial}{\partial y}U(x)(\hat{\jmath}) - \frac{\partial}{\partial z}U(x)(\hat{k})$$

Since there is no y or z dependence this reduces to

$$\vec{F} = -\frac{\partial}{\partial x}U(x)(\hat{\imath}) = -\frac{\partial}{\partial x}(4x^3 - 2x + 6)(\hat{\imath}) = -(12x^2 - 2)(\hat{\imath})$$

Find at $x = 2.00\ m$

$$\vec{F} = -(12x^2 - 2)(\hat{\imath}) = -(12(2)^2 - 2)(\hat{\imath}) = -(48 - 2)(\hat{\imath}) = -(46)(\hat{\imath}) = -46(\hat{\imath})$$

Since units for U were Joules and x were meters, F is in Newtons

So, the correct answer is D !

A spring has a spring constant of $k = 22.2\ {}^{N}/_{m}$. It is initially compressed a distance of $1.80\ m$. What is the change in the potential energy stored in the spring if the spring is relaxed and now is only compressed a distance of $0.90\ m$?

A. $+27.0\ J$ **B.** $+10.0\ J$ **C.** $\mathbf{-27.0\ J}$ **D.** $-10.0\ J$

$$\Delta U_{Spring} = U_{Spring\ final} - U_{Spring\ initial} = \frac{1}{2}kx_f^2 - \frac{1}{2}kx_0^2 = \frac{1}{2}k\left(x_f^2 - x_0^2\right)$$

$$\Delta U_{Spring} = \frac{1}{2}\left(22.2\ {}^{N}/_{m}\right)\left((0.90\ m)^2 - (1.80\ m)^2\right) = 11.1\ {}^{N}/_{m}\left(0.81\ m^2 - 3.24\ m^2\right)$$

$$\Delta U_{Spring} = 11.1\ {}^{N}/_{m}\left(-2.43\ m^2\right) = -26.97\ J$$

So, the correct answer is C !

A mass $(m = 1.31\ kg)$ is traveling through space with an initial velocity of $\left(\vec{v_0} = 9.84\ {}^{m}/_{s}\ \widehat{(+k)}\right)$. It encounters an unknown force $\vec{F} = 13.0\ N\ \widehat{(-k)}$ which acts on the mass while it makes a displacement of $\vec{S} = 4.33\ m\ \widehat{(+k)}$. What is the final velocity of the mass after it has been displaced by that distance?

A. $\mathbf{3.30\ {}^{m}/_{s}\ \widehat{(+k)}}$

B. $3.30\ {}^{m}/_{s}\ \widehat{(-k)}$

C. $13.5\ {}^{m}/_{s}\ \widehat{(-k)}$

D. $13.5\ {}^{m}/_{s}\ \widehat{(+k)}$

$$W = \Delta K = \frac{1}{2}m\left(v_f^2 - v_0^2\right) = \vec{F}\cdot\vec{S} = \left(13.0\ N\ \widehat{(-k)}\right)\cdot\left(4.33\ m\ \widehat{(k)}\right)$$

$$\frac{1}{2}m\left(v_f^2 - v_0^2\right) = (13.0\ N)(4.33\ m)\widehat{(-k)}\cdot\widehat{(k)} = (13.0\ N)(4.33\ m)(-1)$$

$$v_f^2 = v_0^2 - \frac{2(13.0\ N)(4.33\ m)}{m} = \left(9.84\ {}^{m}/_{s}\right)^2 - \frac{2(13.0\ N)(4.33\ m)}{1.31\ kg}$$

$$v_f^2 = 96.83\ {}^{m^2}/_{s^2} - 85.94\ {}^{m^2}/_{s^2} = 10.89\ {}^{m^2}/_{s^2}$$

$$v_f = \sqrt{10.89\ {}^{m^2}/_{s^2}} = 3.30\ {}^{m}/_{s}\ \widehat{(k)}$$

So, the correct answer is A !

A crate $(\mathrm{m} = 25.0\ \mathrm{kg})$ is dropped at rest from a plane at a height of $(\mathrm{h} = 1500.\ \mathrm{m})$. If we assumed no air resistance the crate would strike the ground with a speed of about $171.5\ ^{\mathrm{m}}/_{\mathrm{s}}$. This likely breaks up anything within the crate. If we attach a parachute and assume air resistance is possible, the crate could land with a speed of $(\mathrm{v_f} = 5.00\ ^{\mathrm{m}}/_{\mathrm{s}})$. How much work must air resistance do for this to happen?

A.	$-3.12 \text{ x } 10^2 \text{ J}$	**C.**	$+3.12 \text{ x } 10^2 \text{ J}$
B.	$\mathbf{-3.67 \text{ x } 10^5 \text{ J}}$	**D.**	$+3.67 \text{ x } 10^5 \text{ J}$

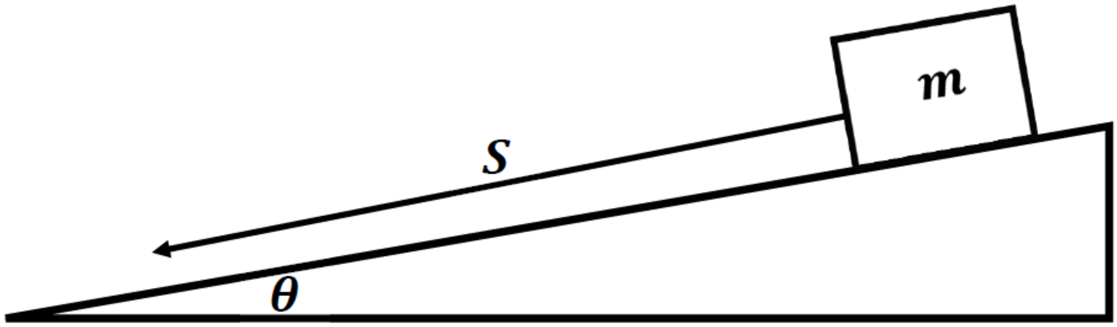
$$\sum \boldsymbol{W_{non\ Cons}} = \boldsymbol{W_{air}} = \Delta \boldsymbol{E} = \Delta \boldsymbol{K} + \Delta \boldsymbol{U} = \frac{1}{2}\boldsymbol{m}\left(\boldsymbol{v_f^2} - \boldsymbol{v_0^2}\right) + (\mathbf{0} - \boldsymbol{mgh})$$

$$\boldsymbol{W_{air}} = \frac{1}{2}\boldsymbol{m}\left(\boldsymbol{v_f^2} - \mathbf{0}\right) + (-\boldsymbol{mgh}) = \frac{1}{2}\boldsymbol{m v_f^2} - \boldsymbol{mgh}$$

$$\boldsymbol{W_{air}} = \frac{1}{2}(\mathbf{25.0}\ \boldsymbol{kg})(\mathbf{5.00}\ ^{\boldsymbol{m}}/_{\boldsymbol{s}})^2 - (\mathbf{25.0}\ \boldsymbol{kg})\left(\mathbf{9.80}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}\right)(\mathbf{1500.}\boldsymbol{m})$$

$$\boldsymbol{W_{air}} = \mathbf{312.5}\ \boldsymbol{J} - \mathbf{3.68}\ \boldsymbol{x}\mathbf{10^5}\ \boldsymbol{J} = -\mathbf{3.67}\ \boldsymbol{x}\ \mathbf{10^5}\ \boldsymbol{J}$$

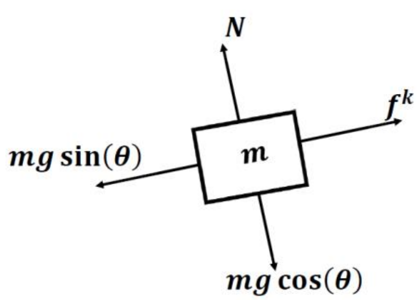
So, the correct answer is B !



A mass $(\mathrm{m} = 3.34\ \mathrm{kg})$ is released from rest and allowed to slide down a plane inclined by an angle $(\theta = 18.0°)$ with the horizontal as shown above. The mass slides a distance $(\mathrm{S} = 4.33\ \mathrm{m})$. There is a coefficient of kinetic friction between the mass and the inclined plane of $(\mu_\mathrm{k} = 0.231)$. After the mass has slid the distance S, the speed of the mass is found to be $(\mathrm{v_f} = 2.75\ {}^{\mathrm{m}}/_{\mathrm{s}})$. How much work was done by the normal force as the mass slid down the plane?

A.	$+43.8\ \mathrm{J}$	**C.**	$-31.1\ \mathrm{J}$
B.	$\mathbf{+0.00\ J}$	**D.**	$-142.\ \mathrm{J}$

Free Body Diagram is on right. N is perpendicular to displacement.



Remember Perpendicular forces do no work!

So, the correct answer is B !

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