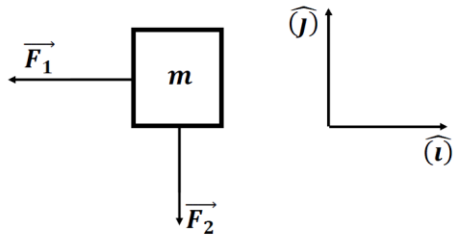
Exam Average **66.8** Exam High Score **85**

PH 220 **Exam # 02 (100 pts)** **Name** **Solution**

1

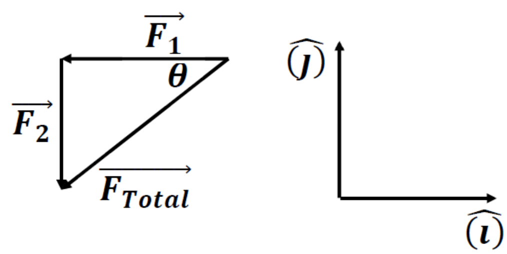


As shown on the left a mass($m = 1.93$ kg) is acted upon by two forces: $\vec{F_1} = 13.8\text{ N }\widehat{(-\imath)}$ and $\vec{F_2} = 15.1\text{ N }\widehat{(-\jmath)}$. What is the magnitude and direction of the acceleration that results from these two forces acting on the mass?

A. $\mathbf{10.6\ {}^{m}/_{s^2}\ @\ 47.6°\ below\ \widehat{(-\imath)}}$ **C.** $10.6\ {}^{m}/_{s^2}\ @\ 47.6°\text{ above }\widehat{(-\imath)}$

B. $10.6\ {}^{m}/_{s^2}\ @\ 47.6°\text{ below }\widehat{(+\imath)}$ **D.** $10.6\ {}^{m}/_{s^2}\ @\ 47.6°\text{ above }\widehat{(+\imath)}$

Since the two forces act perpendicularly, we can use the Pythagorean theorem to find the net force and then use that to find the acceleration. We can see



$$F_{Total} = \sqrt{F_1^2 + F_2^2} = \sqrt{(13.8\ N)^2 + (15.1\ N)^2} = \sqrt{190.4\ N^2 + 228.0\ N^2} = \sqrt{418.4\ N^2}$$

$$F_{Total} = 20.5\ N$$

$$\theta = \tan^{-1}\left(\frac{F_2}{F_1}\right) = \tan^{-1}\left(\frac{15.1\ N}{13.8\ N}\right) = \tan^{-1}(1.094) = 47.6°$$

So,

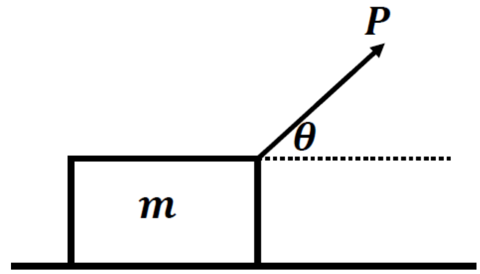
$$\overrightarrow{F_{Total}} = 20.5\ N\ @\ 47.6°\ below\ \widehat{(-\imath)}$$

$$\vec{a} = \frac{\overrightarrow{F_{Total}}}{m} = \frac{20.5\ N\ @\ 47.6°\ below\ \widehat{(-\imath)}}{1.93\ kg} = 10.6\ {}^{m}/_{s^2}\ @\ 47.6°\ below\ \widehat{(-\imath)}$$

So, the correct answer is A !

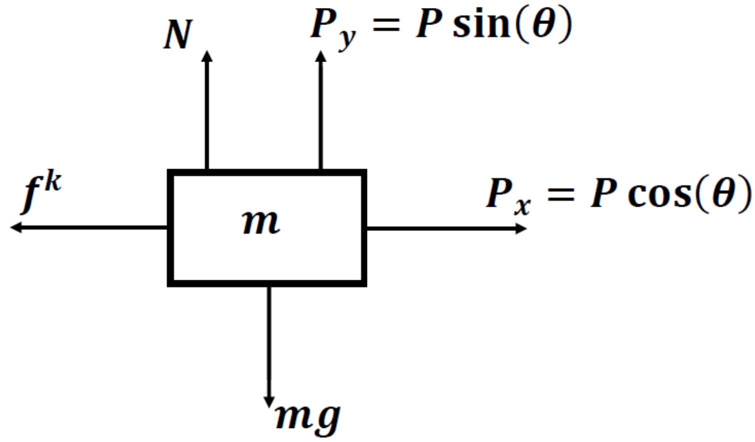
2

A mass $(\mathrm{m} = 2.61\ \mathrm{kg})$ is being pulled to the right by a force P $(\mathrm{P} = 95.0\ \mathrm{N})$ which is at an angle $(\theta = 14.0°)$ above the horizontal as shown in the diagram on the right. The coefficient of kinetic friction between the mass and the horizontal surface is $(\mu_k = 0.362)$. The coefficient of static friction is $(\mu_s = 0.524)$ What is the magnitude of the normal force between the mass and the horizontal surface?



A. 25.6 N **B.** **2.60 N** **C.** 23.0 N **D.** 48.6 N

Free Body Diagram is:



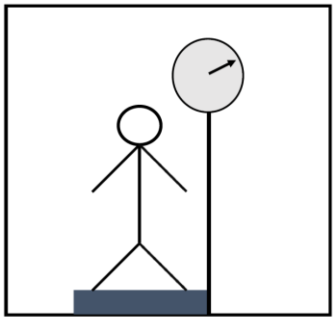
$$\sum F_y = N + P\sin(\theta) - mg = ma_y = 0$$

$$N = mg - P\sin(\theta) = (2.61\ kg)\left(9.80\ {}^{m}/_{s^2}\right) - (95.0\ N)\sin(14.0°)$$

$$N = 25.58\ N - 22.98\ N = 2.60\ N$$

So, the correct answer is B !

3



A man ($m = 75.3\ kg$) is standing on a scale which is inside an elevator. While the elevator is accelerating the scale provides a reading of $497.\ N$ for his weight. What is the magnitude and direction of the acceleration of the elevator?

A. $9.80\ ^{m}/_{s^2}\ (\widehat{Down})$

B. $6.60\ ^{m}/_{s^2}\ (\widehat{Up})$

C. $\mathbf{3.20}\ ^{\mathbf{m}}/_{\mathbf{s^2}}\ (\widehat{\mathbf{Down}})$

D. $16.4\ ^{m}/_{s^2}\ (\widehat{Up})$

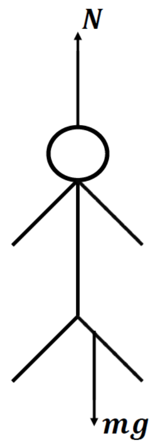
Free Body Diagram on the right, Sum of forces equations below:

$$\sum \boldsymbol{F_y} = \boldsymbol{N - mg = ma}$$

$$\boldsymbol{a = \frac{N}{m} - g = \frac{497.\,N}{75.3\ kg} - 9.80\ ^{m}/_{s^2}}$$

$$\boldsymbol{a = 6.60\ ^{m}/_{s^2} - 9.80\ ^{m}/_{s^2}}$$

$$\boldsymbol{a = -3.20\ ^{m}/_{s^2}}$$

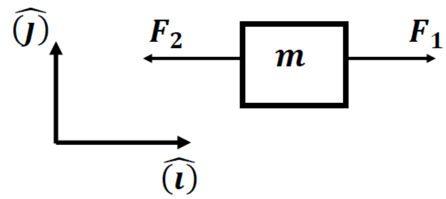


- sign indicates the acceleration is downward!

So, the correct answer is C !

4

A mass $(\mathrm{m} = 23.7\ \mathrm{kg})$ is at rest when two forces begin to act on it. $\overrightarrow{\mathrm{F}_1} = 43.2\ \mathrm{N}\ \widehat{(+\imath)}$ and $\overrightarrow{\mathrm{F}_2} = 129.\ \mathrm{N}\ \widehat{(-\imath)}$. What is the magnitude and direction of the velocity of the mass after the forces have acted for a time of $2.71\ \mathrm{s}$?



A. $16.7\ ^{\mathrm{m}}/_{\mathrm{s}}\ \widehat{(+\imath)}$ **B.** $13.3\ ^{\mathrm{m}}/_{\mathrm{s}}\ \widehat{(+\imath)}$ **C.** $3.62\ ^{\mathrm{m}}/_{\mathrm{s}}\ \widehat{(-\imath)}$ **D.** $\mathbf{9.81\ ^{m}/_{s}\ \widehat{(-\imath)}}$

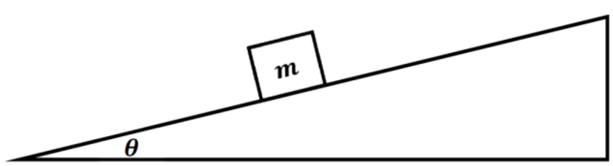
$$\sum \boldsymbol{F_x} = \overrightarrow{\boldsymbol{F_1}} - \overrightarrow{\boldsymbol{F_2}} = \mathbf{43.2\ N}\ \widehat{(+\imath)} + \mathbf{129.\ N}\ \widehat{(-\imath)} = -\mathbf{43.2\ N}\ \widehat{(-\imath)} + \mathbf{129.\ N}\ \widehat{(-\imath)} = \mathbf{85.8}\ \boldsymbol{N}\widehat{(-\imath)} = \boldsymbol{m}\vec{\boldsymbol{a}}$$

$$\vec{\boldsymbol{a}} = \frac{\mathbf{85.8}\ \boldsymbol{N}\widehat{(-\imath)}}{\boldsymbol{m}} = \frac{\mathbf{85.8}\ \boldsymbol{N}\widehat{(-\imath)}}{\mathbf{23.7}\ \boldsymbol{kg}} = \mathbf{3.62}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}\ \widehat{(-\imath)}$$

$$\overrightarrow{\boldsymbol{v_f}} = \overrightarrow{\boldsymbol{v_0}} + \vec{\boldsymbol{a}}\boldsymbol{t} = \mathbf{0} + \vec{\boldsymbol{a}}\boldsymbol{t} = \left(\mathbf{3.62}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}\ \widehat{(-\imath)}\right)(\mathbf{2.71}\ \boldsymbol{s}) = \mathbf{9.81}\ ^{\boldsymbol{m}}/_{\boldsymbol{s}}\ \widehat{(-\imath)}$$

So, the correct answer is D !

5



A mass $(\mathrm{m} = 3.17\ \mathrm{kg})$ is at rest on a plane inclined an angle $(\theta = 37.0°)$ to the horizontal. The coefficient of static friction is $\mu_s = 0.946$, while the coefficient of kinetic friction is $\mu_k = 0.882$. What is the magnitude of the friction force acting on the mass?

A. $24.8\ \mathrm{N}$ **C.** $23.5\ \mathrm{N}$

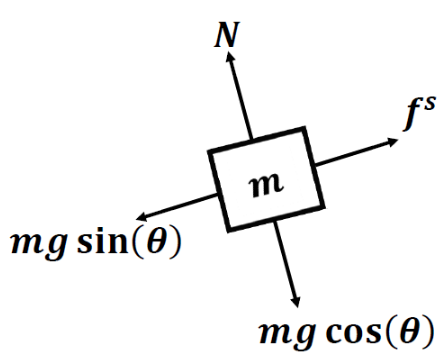
B. $21.9\ \mathrm{N}$ **D.** $\mathbf{18.7\ N}$

$$\sum \boldsymbol{F}_{\parallel} = \boldsymbol{f^s} - \boldsymbol{mg}\sin(\boldsymbol{\theta}) = \boldsymbol{ma}_{\parallel} = \mathbf{0}$$

$$\boldsymbol{f^s} = \boldsymbol{mg}\sin(\boldsymbol{\theta})$$

$$\boldsymbol{f^s} = (\mathbf{3.17}\ \boldsymbol{kg})\left(\mathbf{9.80}\ ^{\boldsymbol{m}}/_{\boldsymbol{s^2}}\right)\sin(\mathbf{37.0°})$$

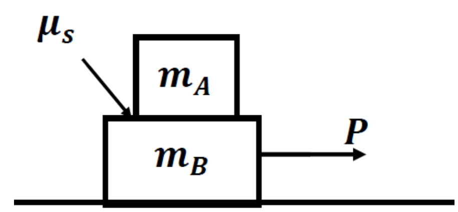
$$\boldsymbol{f^s} = \mathbf{18.7}\ \boldsymbol{N}$$



So, the correct answer is D !

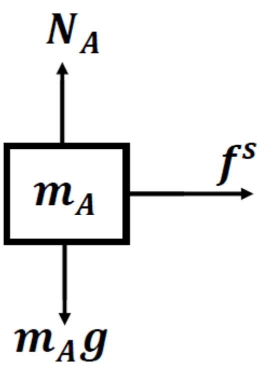
6

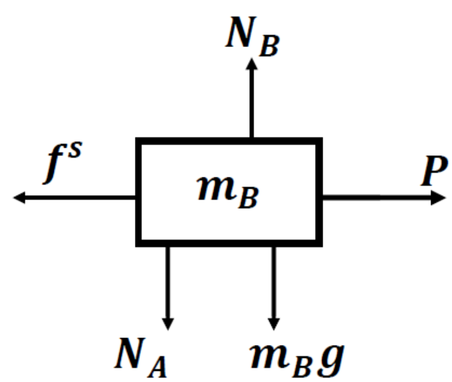
Mass A ($m_A = 4.26\ \mathrm{kg}$) is at rest relative to mass B ($m_B = 7.11\ \mathrm{kg}$). A pulling force ($P = 55.5\ \mathrm{N}$) causes both masses to slide along a frictionless surface with an acceleration of $\left(a = 4.88\ \mathrm{m}/\mathrm{s}^2\right)$. What is the minimum coefficient of static friction (μ_s) needed to keep mass A at rest relative to mass B?



A. 0.599 **B.** 0.797 **C.** $\mathbf{0.498}$ **D.** 0.000

Free Body Diagrams are:





Consider only mass A

$$\sum F_{Ax} = f^s = f^{s,max} = \mu_s N_A = m_A a$$

$$\sum F_{Ay} = N_A - m_A g = m_A a_y = 0$$

$$N_A = m_A g$$

$$\mu_s N_A = \mu_s m_A g = m_A a$$

$$\mu_s = \frac{a}{g} = \frac{4.88\ m/s^2}{9.80\ m/s^2} = 0.498$$

So, the correct answer is C !

7

A ball has a mass of $0.414\ \mathrm{kg}$ is attached to a cord which is massless and stretchless, but the cord will break if the tension in the cord exceeds a value of $15.8\ \mathrm{N}$. If the ball is now swung in a nearly horizontal circle of radius $0.750\ \mathrm{m}$ at what tangential speed will the cord snap?

A. $28.62\ \mathrm{m}/\mathrm{s}$ **B.** $\mathbf{5.35\ m/s}$ **C.** $7.57\ \mathrm{m}/\mathrm{s}$ **D.** $4.61\ \mathrm{m}/\mathrm{s}$

$$\sum \boldsymbol{F_R} = \boldsymbol{T} = \boldsymbol{m a_c} = \boldsymbol{m}\frac{\boldsymbol{v^2}}{\boldsymbol{R}}$$

$$\boldsymbol{v^2} = \frac{\boldsymbol{RT}}{\boldsymbol{m}}$$

$$\boldsymbol{v} = \sqrt{\frac{\boldsymbol{RT}}{\boldsymbol{m}}} = \sqrt{\frac{(\mathbf{0.750}\ \boldsymbol{m})(\mathbf{15.8}\ \boldsymbol{N})}{\mathbf{0.414}\ \boldsymbol{kg}}} = \sqrt{\frac{\mathbf{11.85}\ \boldsymbol{m\ N}}{\mathbf{0.414}\ \boldsymbol{kg}}} = \sqrt{\mathbf{28.62}\ \boldsymbol{m^2}/\boldsymbol{s^2}} = \mathbf{5.35}\ \boldsymbol{m}/\boldsymbol{s}$$

So, the correct answer is B !

8

A driver navigating a circular path has a speed which is described by:

$$\mathrm{v(t)} = (1.71\mathrm{t}^2 - 2.49)\ \mathrm{m}/\mathrm{s}$$

Time is assumed to have units of seconds. The circular path has a radius of $84.0\ \mathrm{m}$. What is the radial acceleration at a time of $\mathrm{t} = 3.00\ \mathrm{s}$?

A. $\mathbf{1.98\ m/s^2}$ **C.** $0.15\ \mathrm{m}/\mathrm{s}^2$

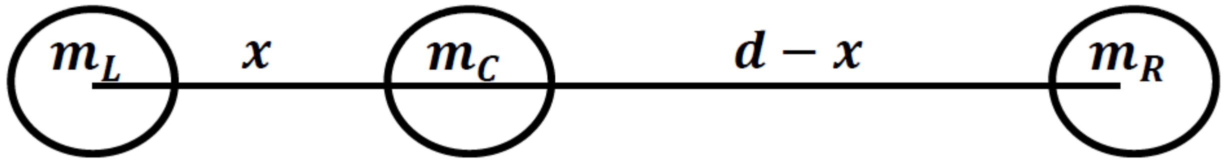
B. $9.80\ \mathrm{m}/\mathrm{s}^2$ **D.** $1.03\ \mathrm{m}/\mathrm{s}^2$

$$\boldsymbol{a_R} = \boldsymbol{a_c} = \frac{\boldsymbol{v^2}}{\boldsymbol{R}} = \frac{\left((\mathbf{1.71}\boldsymbol{t^2} - \mathbf{2.49})\ \boldsymbol{m}/\boldsymbol{s}\right)^{\mathbf{2}}}{\mathbf{84.0}\ \boldsymbol{m}} = \frac{\left((\mathbf{1.71}(\mathbf{3.00}\ \boldsymbol{s})^2 - \mathbf{2.49})\ \boldsymbol{m}/\boldsymbol{s}\right)^{\mathbf{2}}}{\mathbf{84.0}\ \boldsymbol{m}} = \frac{(\mathbf{12.9}\ \boldsymbol{m}/\boldsymbol{s})^2}{\mathbf{84.0}\ \boldsymbol{m}}$$

$$\boldsymbol{a_R} = \mathbf{1.98}\ \boldsymbol{m}/\boldsymbol{s^2}$$

So, the correct answer is A !

9



Shown above three masses lie along a horizontal line. The distance between the center of the left mass ($m_L = 2.54$ kg) and the right mass ($m_R = 6.49$ kg) is ($d = 12.0$ m). At what distance x, from the left mass should a third mass ($m_C = 9.27$ kg) be placed where the net gravitational force from the other two masses would cancel and result in $\overrightarrow{F_{Net \to m_C}} = 0.00$ N?

A. $\mathbf{4.62\ m}$ **B.** 7.38 m **C.** 3.38 m **D.** 8.62 m

$$\overrightarrow{F_{Net \to m_C}} = \overrightarrow{F_{M_L \to m_C}} + \overrightarrow{F_{M_R \to m_C}} = 0.00\ N$$

$$\overrightarrow{F_{M_L \to m_C}} = \frac{G m_L m_C}{x^2} \widehat{(-\imath)}$$

$$\overrightarrow{F_{M_R \to m_C}} = \frac{G m_R m_C}{(d - x)^2} \widehat{(+\imath)}$$

$$\overrightarrow{F_{Net \to m_C}} = \overrightarrow{F_{M_L \to m_C}} + \overrightarrow{F_{M_R \to m_C}} = \frac{G m_L m_C}{x^2} \widehat{(-\imath)} + \frac{G m_R m_C}{(d - x)^2} \widehat{(+\imath)} = 0.00\ N$$

$$\overrightarrow{F_{Net \to m_C}} = -\frac{G m_L m_C}{x^2} \widehat{(+\imath)} + \frac{G m_R m_C}{(d - x)^2} \widehat{(+\imath)} = 0.00\ N$$

So,

$$\frac{G m_L m_C}{x^2} \widehat{(+\imath)} = \frac{G m_R m_C}{(d - x)^2} \widehat{(+\imath)}$$

Cancel common terms

$$\frac{m_L}{x^2} = \frac{m_R}{(d - x)^2}$$

$$(d - x)^2 = \frac{m_R}{m_L} x^2$$

$$(d - x) = x \sqrt{\frac{m_R}{m_L}}$$

$$d = x + x \sqrt{\frac{m_R}{m_L}} = x \left(1 + \sqrt{\frac{m_R}{m_L}} \right)$$

$$x = \frac{d}{\left(1 + \sqrt{\frac{m_R}{m_L}}\right)} = \frac{12.0\ m}{\left(1 + \sqrt{\frac{6.49\ kg}{2.54\ kg}}\right)} = \frac{12.0\ m}{(1 + 1.60)} = 4.62\ m$$

So, the correct answer is A !

10

The Moon has a mass of $7.34 \text{ x } 10^{22}$ kg. How far from the center of the Moon would you need to be in orbit to measure an acceleration of gravity equal to one tenth the Earth's acceleration of gravity? In other words, at what distance is $g_{\text{Moon}} = 0.980\ ^{\text{m}}/_{\text{s}^2}$?

A.	$5.00 \text{ x } 10^{12}$ m	**C.**	$1.74 \text{ x } 10^{6}$ m
B.	$\mathbf{2.24 \text{ x } 10^{6}}$ **m**	**D.**	$8.57 \text{ x } 10^{11}$ m

$$g = \frac{Gm}{r^2}$$

$$g_{Moon} = \frac{Gm_{Moon}}{r^2}$$

Solve for distance

$$r = \sqrt{\frac{Gm_{Moon}}{g_{Moon}}} = \sqrt{\frac{\left(6.67\ x\ 10^{-11}\ ^{Nm^2}/_{kg^2}\right)(7.34\ x\ 10^{22}\ kg)}{0.980\ ^{m}/_{s^2}}} = \sqrt{\frac{4.896\ x\ 10^{12}\ ^{m^3}/_{s^2}}{0.980\ ^{m}/_{s^2}}}$$

$$r = \sqrt{4.996\ x\ 10^{12}\ m^2} = 2.24\ x\ 10^{6}\ m$$

So, the correct answer is B !

11

How far from the Earth's center would you need to place a satellite that goes over you twice a day? In other words, how far away is a satellite that has a period of 12.0 h? The mass of the Earth is 5.98×10^{24} kg.

A. 1.13×10^{5} m

B. 1.37×10^{11} m

C. $\mathbf{2.66 \times 10^{7}}$ **m**

D. 1.89×10^{22} m

$$\frac{G m_E m_s}{r^2} = m_s \frac{v^2}{r} = \frac{m_s}{r}\left(\frac{2\pi r}{T}\right)^2$$

$$r = \left[\frac{G m_E}{4\pi^2} T^2\right]^{1/3} = \left[\frac{\left(6.67 \times 10^{-11}\ N\,m^2/kg^2\right)(5.98 \times 10^{24}\ kg)}{4\pi^2}(12.0\ h)^2 \times \left(\frac{3600\ s}{h}\right)^2\right]^{1/3}$$

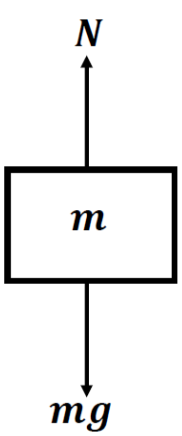
$$r = \left[\frac{3.989 \times 10^{14}\ m^3/s^2}{4\pi^2} \times 1.866 \times 10^{9}\ s^2\right]^{1/3} = [1.885 \times 10^{22}\ m^3]^{1/3} = 2.66 \times 10^{7}\ m$$

So, the correct answer is C !

12

Joel ($m = 65.0$ kg) is riding a Ferris wheel which has a radius of 20.0 m. When the Ferris wheel is rotating at a constant speed of 14.0 m/s, Joel's apparent weight at the top of the wheel is zero (0.00 N). What is his apparent weight at the bottom of the wheel?

A. 637.0 N **B.** 0.000 N **C.** 1911. N **D.** **1274. N**



$$\sum F_R = N - mg = m\frac{v^2}{R}$$

Apparent weight is Normal force N

$$N = mg + m\frac{v^2}{R} = m\left(g + \frac{v^2}{R}\right)$$

$$N = (65.0\ kg)\left(9.80\ m/s^2 + \frac{(14.0\ m/s)^2}{20.0\ m}\right)$$

$$N = (65.0\ kg)\left(9.80\ m/s^2 + 9.80\ m/s^2\right)$$

$$N = 1274.\ N$$

So, the correct answer is D !

13

Vector A is $\vec{A} = 5.00\text{ m}\ \widehat{(+\imath)} + 12.0\text{ m}\ \widehat{(-\jmath)}$, and Vector B is $\vec{B} = 7.00\text{ m}\ \widehat{(-\imath)} + 24.0\text{ m}\ \widehat{(-\jmath)}$. What is the angle between the two vectors?

A. $51.1°$ **B.** $6.36°$ **C.** $83.6°$ **D.** $\mathbf{38.9°}$

$$\vec{A}\cdot\vec{B} = A_xB_x\left(\widehat{(+\imath)}\cdot\widehat{(-\imath)}\right) + A_yB_y\left(\widehat{(-\jmath)}\cdot\widehat{(-\jmath)}\right) = -A_xB_x + A_yB_y = |\vec{A}||\vec{B}|\cos(\theta_{AB})$$

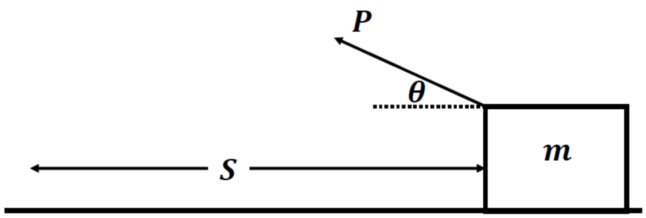
$$\cos(\theta_{AB}) = \frac{-A_xB_x + A_yB_y}{\sqrt{A_x^2 + A_y^2}\sqrt{B_x^2 + B_y^2}} = \frac{-(5.00\ m)(7.00\ m) + (12.0\ m)(24.0\ m)}{\sqrt{(5.00\ m)^2 + (12.0\ m)^2}\sqrt{(7.00\ m)^2 + (24.0\ m)^2}}$$

$$\cos(\theta_{AB}) = \frac{253.\ m^2}{(13.0\ m)(25.0\ m)} = 0.7784$$

$$\theta_{AB} = \cos^{-1}(0.7784) = 38.9°$$

So, the correct answer is D !

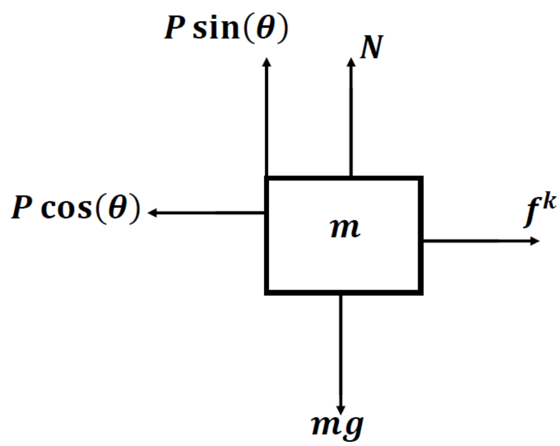
14



A box has a mass $(m = 12.3\ kg)$ is being dragged across the floor by a pulling force $(P = 58.7\ N)$ which is attached to the box such that it makes an angle $(\theta = 27.6°)$. The coefficient of static friction is $\mu_s = 0.678$, while the coefficient of kinetic friction is $\mu_k = 0.467$. How much work is done by the friction force on the box if the displacement of the box is $S = 11.9\ m$?

A. $+518.\,J$ **B.** $+753.\,J$ **C.** $\mathbf{-518.\,J}$ **D.** $-753.\,J$

Free Body Diagram and Sum of Forces Equations



$$\sum F_y = N + P\sin(\theta) - mg = ma_y = 0$$

$$N = mg - P\sin(\theta)$$

$$\sum F_x = P\cos(\theta) - f^k = ma_x$$

$$f^k = \mu_k N = \mu_k(mg - P\sin(\theta))$$

$$W_{f^k} = -\mu_k(mg - P\sin(\theta))S$$

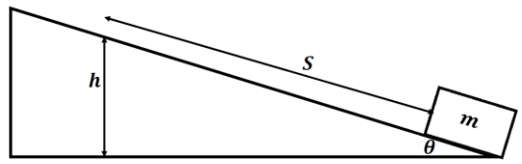
$$W_{f^k} = -(0.467)\left((12.3\ kg)\left(9.80\ {}^{m}/_{s^2}\right) - (58.7\ N)\sin(27.6°)\right)(11.9\ m)$$

$$W_{f^k} = -(0.467)(120.5\ N - 27.2\ N)(11.9\ m) = -(0.467)(93.3N)(11.9\ m) = -518.J$$

So, the correct answer is C !

15

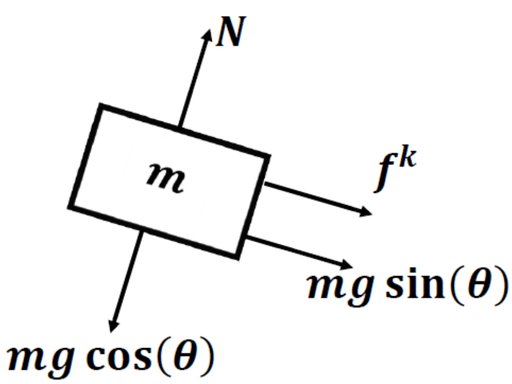
A crate with a mass $(\mathrm{m} = 8.54\ \mathrm{kg})$is traveling with a speed $(\mathrm{v}_0 = 11.3\ \mathrm{m}/_{\mathrm{s}})$ when it reaches the bottom of the inclined plane which makes an angle $(\theta = 34.8°)$ with respect to the horizontal. The coefficient of static friction between the crate and inclined plane surface is $\mu_s = 0.705$, while the coefficient of kinetic friction is $\mu_k = 0.565$. How much work is done by gravity as the crate travels a distance $\mathrm{S} = 7.23\ \mathrm{m}$ up the incline?



A. $-545.\,\mathrm{J}$ **C.** $+281.\,\mathrm{J}$

B. $\mathbf{-345.\,J}$ **D.** $+350.\,\mathrm{J}$

Free Body Diagram and Sum of the Forces Equations



$$\sum F_{\perp} = N - mg\cos(\theta) = ma_{\perp} = 0$$

$$N = mg\cos(\theta)$$

$$\sum F_{\parallel} = mg\sin(\theta) + f^k = ma_{\parallel}$$

$$W_{Grav} = -mg\sin(\theta)\,S$$

Alternatively,

$$W_{Grav} = -mgh = -mgS\sin(\theta)$$

$$W_{Grav} = -mg\sin(\theta)\,S = -(8.54\ kg)\left(9.80\ {}^{m}/_{s^2}\right)\sin(34.8°)\,(7.23\ m) = -345.J$$

So, the correct answer is B !

16

An object has a mass $(13.9\ \mathrm{kg})$ is acted upon by a force given by $\vec{\mathrm{F}} = 29.5\ \mathrm{N}\ \widehat{(+\imath)} + 22.3\ \mathrm{N}\ \widehat{(+\jmath)}$. The object undergoes a displacement described by $\vec{\mathrm{S}} = 12.7\ \mathrm{m}\ \widehat{(+\imath)} - 2.92\ \mathrm{m}\ \widehat{(+\jmath)}$. What is the work done by this force displacing the object along that displacement?

A. $\mathbf{+310.\,J}$ **B.** $+440.\,\mathrm{J}$ **C.** $-809.\,\mathrm{J}$ **D.** $-507.\,\mathrm{J}$

$$W = \vec{F}\cdot\vec{S} = F_xS_x\left(\widehat{(+\imath)}\cdot\widehat{(+\imath)}\right) + F_yS_y\left(\widehat{(+\jmath)}\cdot\widehat{(+\jmath)}\right) = (29.5\ N)(12.7\ m) + (22.3\ N)(-2.92\ m)$$

$$W = 374.7\,J - 65.1\,J = +309.6\,J$$

So, the correct answer is A !

17

Approximately $1.40 \times 10^7\ \text{kg}/_\text{s}$ of water flows through the Hoover Dam. The water then falls about $221.\text{m}$. If you had a pump to move the water in reverse (in other words you would raise $1.40 \times 10^7\ \text{kg}/_\text{s}$ of water up a height of $221.\text{m}$), what power would the pump need?

A. $\mathbf{3.03 \times 10^{10}\ W}$ **C.** $3.09 \times 10^9\ \text{W}$

B. $1.37 \times 10^8\ \text{W}$ **D.** $6.21 \times 10^5\ \text{W}$

$$P = \frac{W}{t} = \frac{FS}{t} = \frac{mgh}{t} = \left(\frac{m}{t}\right) gh = \left(1.40\ x\ 10^7\ {}^{kg}/_{s}\right)\left(9.80\ {}^{m}/_{s^2}\right)(221.m) = 3.03\ x\ 10^{10}\ W$$

So, the correct answer is A !

18

A basketball has a mass ($\text{m} = 0.624\ \text{kg}$) is released from rest from a height of $1.22\ \text{m}$ above the floor. After the ball bounces off the floor, it rebounds to a height of $0.690\ \text{m}$. To dribble the ball, a player applies a force with their hand. Assuming the hand is in contact with the ball for a distance of $0.130\ \text{m}$. What is the average force the hand exerts so that the ball does rebound back to the starting height of $1.22\ \text{m}$? Ignore air resistance.

A. $3.24\ \text{N}$ **B.** $\mathbf{24.9\ N}$ **C.** $57.4\ \text{N}$ **D.** $32.4\ \text{N}$

$$\sum W_{NonCons} = W_{Hand} = F_{ave}S = \Delta E = \Delta K + \Delta U = 0 + \Delta U = mg\Delta h = mg(h_f - h_0)$$

$$F_{ave} = \frac{mg(h_f - h_0)}{S} = \frac{(0.624\ kg)\left(9.80\ {}^{m}/_{s^2}\right)(1.22\ m - 0.690\ m)}{0.130\ n} = \frac{3.24\ N\ m}{0.130\ m} = 24.9\ N$$

So, the correct answer is B !

19

A mass ($\mathrm{m} = 9.73\ \mathrm{kg}$) is sliding on a frictionless horizontal surface with an initial speed of $2.04\ ^{\mathrm{m}}/_{\mathrm{s}}$ when it strikes a spring which is horizontal. The spring has a spring constant of $173.\ ^{\mathrm{N}}/_{\mathrm{m}}$. The mass is brought to rest as it compresses the spring. How much is the spring compressed when the mass has come to rest?

A. $0.110\ \mathrm{m}$ **B.** $0.332\ \mathrm{m}$ **C.** $\mathbf{0.475\ m}$ **D.** $0.117\ \mathrm{m}$

$$\sum \boldsymbol{W_{NonCons}} = \mathbf{0} = \Delta \boldsymbol{E}$$

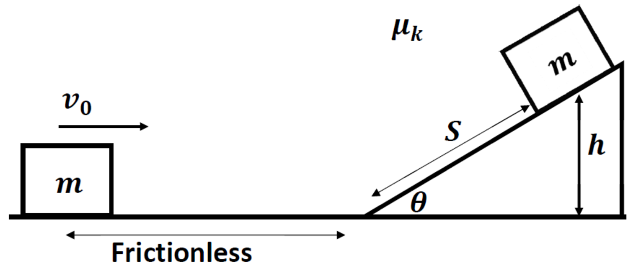
$$\boldsymbol{E_{Before}} = \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{m v_0^2} = \boldsymbol{E_{After}} = \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{k x^2}$$

$$\boldsymbol{x^2} = \frac{\frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{m v_0^2}}{\frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{k}} = \frac{\boldsymbol{m v_0^2}}{\boldsymbol{k}}$$

$$\boldsymbol{x} = \sqrt{\frac{\boldsymbol{m}}{\boldsymbol{k}}}\boldsymbol{v_0} = \sqrt{\frac{\mathbf{9.37}\ \boldsymbol{kg}}{\mathbf{173.}\ ^{\boldsymbol{N}}/_{\boldsymbol{m}}}}(\mathbf{2.04}\ ^{\boldsymbol{m}}/_{\boldsymbol{s}}) = \mathbf{0.233}\ \boldsymbol{s}(\mathbf{2.04}\ ^{\boldsymbol{m}}/_{\boldsymbol{s}}) = \mathbf{0.475}\ \boldsymbol{m}$$

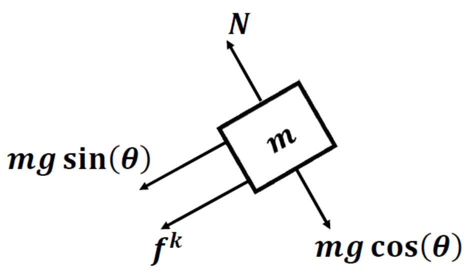
So, the correct answer is C !

A box ($m = 13.9\ kg$) is sliding along a frictionless horizontal surface with a speed ($v_0 = 12.2\ ^m/_s$) begins to slide up a plane inclined by an angle ($\theta = 24.0°$) above the horizontal. The coefficient of static friction between the box and inclined plane is $\mu_s = 0.894$ and a coefficient of kinetic friction $\mu_k = 0.371$. How far along the incline (S) will the box travel before it momentarily comes to rest?



A. $224.\ m$ **B.** $20.4\ m$ **C.** $112.\ m$ **D.** $\mathbf{10.2\ m}$

Free Body Diagram and Sum of Forces Equations



$$\sum F_\perp = N - mg\cos(\theta) = ma_\perp = 0$$

$$N = mg\cos(\theta)$$

$$\sum F_\parallel = f^k + mg\sin(\theta) = ma_\parallel$$

$$\sum W_{NonCons} = W_{Friction} = \Delta E = \Delta K + \Delta U$$

Note: $h = S\sin(\theta)$

$$W_{Friction} = -f^k S = -\mu_k N S = -\mu_k(mg\cos(\theta))S = \Delta E = \Delta K + \Delta U = \frac{1}{2}m\left(v_f^2 - v_0^2\right) + mg\left(h_f - h_0\right)$$

$$-\mu_k(mg\cos(\theta))S = \frac{1}{2}m\left(0 - v_0^2\right) + mg\left(h_f - 0\right) = -\frac{1}{2}mv_0^2 + mgS\sin(\theta)$$

$$\mu_k(mg\cos(\theta))S = \frac{1}{2}mv_0^2 - mgS\sin(\theta)$$

$$mgS\sin(\theta) + \mu_k(mg\cos(\theta))S = mgS(\sin(\theta) + \mu_k\cos(\theta)) = \frac{1}{2}mv_0^2$$

$$S = \frac{v_0^2}{2g(\sin(\theta) + \mu_k\cos(\theta))} = \frac{(12.2\ ^m/_s)^2}{2\left(9.80\ ^m/_{s^2}\right)(\sin(24.0°) + (0.371)\cos(24.0°))}$$

$$S = \frac{148.8\ ^{m^2}/_{s^2}}{19.6\ ^m/_{s^2}\,(0.746)} = 10.2\ m$$

So, the correct answer is D !

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