SOLUTIONS

Closed book and closed notes. No work needs to be shown.

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1. Which of the following statements is correct?

C

a. An object at rest could have a nonzero net force

b. An object in motion must have a net force on it

c. A nonzero net force on an object implies that it will move

d. A zero net force implies that an object will come to rest

e. None of the above

2. Block A is stacked on top of block B. What is the third law pair of the normal force on block A?

D

a. The force of gravity on block A

b. The normal force on block B

c. The friction force of block B on block A

d. The weight of block A on block B

e. There is no third law pair for this force.

3. Three forces act on an object with mass 1kg that is moving North with an acceleration of 2.00 m/s^2 . $\vec{F_1}$ = 6.00 N and it points West. $\vec{F_2}$ = 6.00 N and it points South. What is the magnitude and direction of the third force?

A

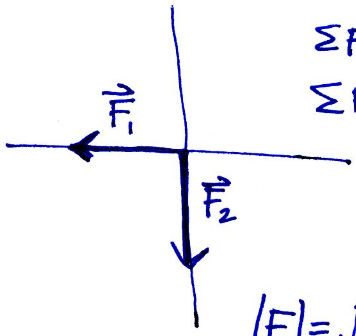
a. $\vec{F_3}$ = 10.0 N and it points 53^o North of East

b. $\vec{F_3}$ = 10.0 N and it points 53^o South of West

c. $\vec{F_3}$ = 7.21 N and it points 34^o South of East

d. $\vec{F_3}$ = 7.21 N and it points 34^o North of East

e. $\vec{F_3}$ = 7.21 N and it points 56^o South of East



$\Sigma F_x = -6N + F_{3x} = 0$

$\Sigma F_y = -6N + F_{3y} = 2$

$F_{3x} = 6N$

$F_{3y} = 8N$

$|F| = \sqrt{6^2 + 8^2}$ $\theta = \tan^{-1}\left(\frac{8}{6}\right)$

4. A football is kicked into the air at an angle θ to the horizontal. What can be said about the net force on the football when it reaches its maximum height? Neglect air resistance.

E

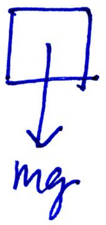
a. The net force is zero.

b. The net force points horizontally.

c. The net force points upwards.

d. The net force is in the direction of the kick.

e. The net force points downwards.

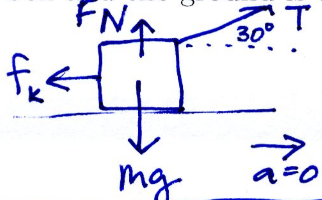


only gravity acts on object

5. You drag a 20.0 N box horizontally at a constant velocity with a rope that makes a 30° angle above the horizontal. What is the tension in the rope if the coefficient of kinetic friction between the box and the ground is 0.500?

B

a. 16.2 N
b. 8.96 N
c. 11.5 N
d. 17.9 N
e. 40 N



$\Sigma F_x = T\cos\theta - f_k = 0$

$\Sigma F_y = T\sin\theta + F_N - mg = 0$

$F_N = mg - T\sin\theta$

$f_k = \mu_k F_N = \mu_k mg - \mu_k T\sin\theta$

$T\cos\theta - \mu_k mg + \mu_k T\sin\theta = 0$

$T(\cos\theta + \mu_k \sin\theta) = \mu_k mg$

$T = \frac{\mu_k mg}{\cos\theta + \mu_k \sin\theta} = \frac{(0.5)(20)}{(\sqrt{3}/2 + 0.5(1/2))} = 8.96$

6. Given that the mass of the moon is 7.36×10^{22} kg and the radius of the moon is 1737 km, how much would someone weigh on the moon if they weigh 600 N on Earth?

D

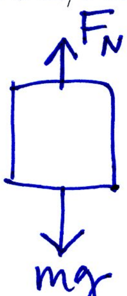
a. 170 N
b. 1700 N
c. 600 N
d. 99.6 N
e. 976 N

$F_g = G\frac{Mm}{r^2} = \frac{(6.67\times10^{-11})(7.36\times10^{22})\left(\frac{600N}{9.8 m/s^2}\right)}{(1.737\times10^{3} m)^2}$

7. A person who weighs 600 N on the ground is standing on a scale in an elevator that is descending with a velocity of 5 m/s and slowing down at 2 m/s². What is the reading on the scale?

C

a. 600 N
b. 122 N
c. 722 N
d. 2400 N
e. 1200 N



a ↑

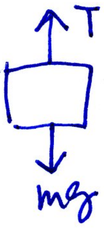
$F_N - mg = ma$

$F_N = \left(\frac{600N}{9.8 m/s^2}\right)(2 m/s^2) + 600N$

8. A 5-kg concrete block is lowered with a downward acceleration of 2.8 m/s² by means of a rope. The force of the block on the rope is:

D

a. 14 N, up
b. 14 N, down
c. 35 N, up
d. 35 N, down
e. 49 N, up



↓ 2.8 m/s²

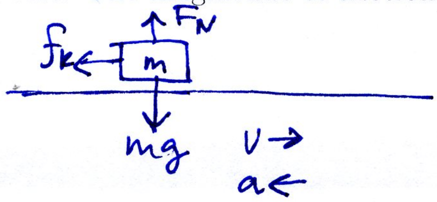
$T - (5)(9.8) = (-2.8)(5)$

$T = 35N$

9. A 10 kg block with an initial velocity of 10 m/s slides 10 meters across a horizontal surface and comes to rest. The magnitude of friction force of the surface acting on the block is:

a. 5 N
b. 10 N
c. 25 N
d. 50 N
e. 98 N

D



$\Sigma F_y = F_N - mg = 0$

$\Sigma F_x = -f_k = -ma$

$v_f^2 = v_0^2 - 2a\Delta x$, $v_f = 0$

$a = \frac{v_0^2}{2\Delta x} = \frac{(10\,m/s)^2}{2(10\,m)} = 5\,m/s^2$

$f_k = (10\,kg)(5\,m/s^2) = 50\,N$

10. A horizontal force of 12 N pushes a 0.50 kg book against a vertical wall. The book is initially at rest. If $\mu_s = 0.60$ and $\mu_k = 0.25$ which *one* of the following is true for this situation?

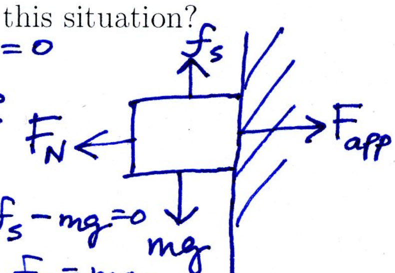
a. The magnitude of the frictional force is 4.9 N.
b. The magnitude of the frictional force is 7.2 N.
c. The normal force of the wall on the book is 7.2 N.
d. The book will start moving downward and accelerate.
e. The book will start moving downward with a constant speed.

A

$\Sigma F_x = F_{app} - F_N = 0$

$F_N = F_{app}$

$f_s \leq \mu_s F_N$



$\Sigma F_y = f_s - mg = 0$

$f_s = mg$

① check to see if $\mu_s F_N > mg$: $(0.6)(12N) = 7.2N$

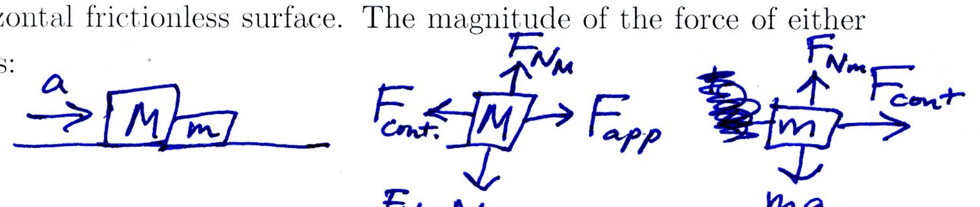
$(0.5\,kg)(9.8\,m/s^2) = 4.9N$

it is! But the friction force has to ballance the weight!

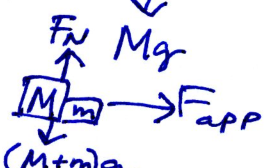
11. A horizontal applied force F pushes on mass M which is placed next to a mass m such that they both move along a horizontal frictionless surface. The magnitude of the force of either of these blocks on the other is:

a. $mF/(m+M)$
b. mF/M
c. $mF/(M-m)$
d. $MF/(M+m)$
e. MF/m

A



both masses:



$F = (M+m)a$

on mass m:

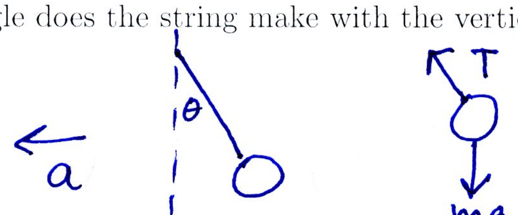
$F_{cont} = ma$

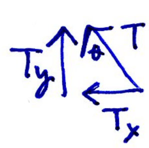
↑ Solve for F_{cont}

12. A car moves horizontally with a constant acceleration of 3 m/s². A ball is suspended by a string from the ceiling of the car. The ball does not swing, being at rest with respect to the car. What angle does the string make with the vertical.

a. 17°
b. 35°
c. 52°
d. 73°
e. Cannot be found without knowing the length of the string

A





$T_x = T\sin\theta$

$T_y = T\cos\theta$

$\Sigma F_x = -T\sin\theta = -ma$

$\Sigma F_y = T\cos\theta - mg = 0$

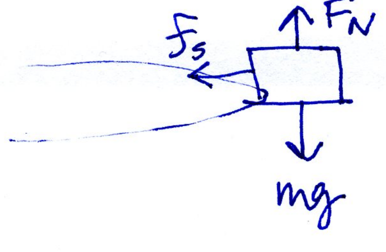
divide eqn ① by eqn ②:

$\tan\theta = \frac{a}{g}$, $\theta = \tan^{-1}\left(\frac{3}{9.8}\right)$

13. A 1000 kg car drives around a flat curve with a radius of 30 m. If the coefficient of static friction between the tires and the ground is $\mu_s = 0.60$, what is the maximum speed that the car can drive before the wheels start slipping? [*Approximate the car as a point mass, i.e. don't worry about the number of wheels it has or how it is shaped.*]

E

a. 1.33 m/s
b.1.76 m/s
c. 176 m/s
d. 420 m/s
e. 13.3 m/s



$f_s = \mu_s F_N = m a_c = m\frac{v^2}{R}$

$\Sigma F_y = F_N - mg = 0, \; F_N = mg$

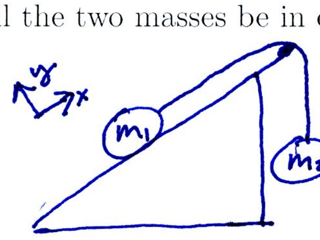
$\frac{m v^2}{R} = \mu_s m g$

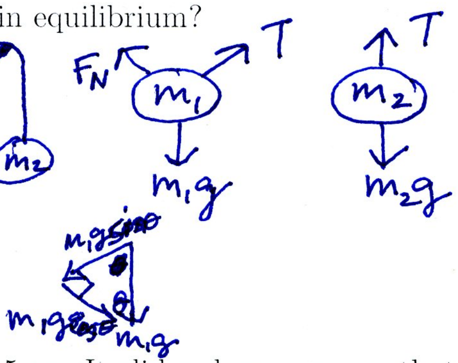
$v = \sqrt{\mu_s g R}$

14. A mass $m_1 = 20$ kg is on a frictionless incline and is connected by a rope and pulley to a mass $m_2 = 10$ kg that is hanging vertically down the other side of the incline. At what angle of incline will the two masses be in equilibrium?

A

a. 30^o
b. 45^0
c. 0^o
d. 90^o
e. 60^o





$\Sigma F_{1y} = T - m_2 g = 0$

$\Sigma F_{2x} = T - m_1 g\cos\theta = 0$

$\Sigma F_{2y} = F_N - m_1 g\sin\theta = 0$

$T = m_2 g$

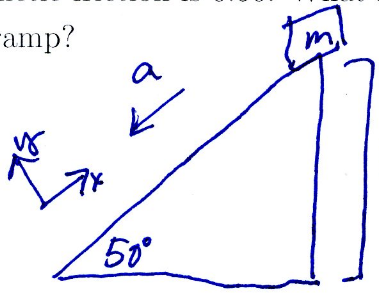
$T = m_1 g\cos\theta$

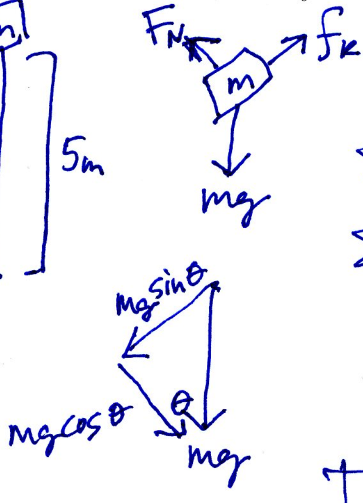
$\rightarrow \cos\theta = \frac{m_2}{m_1}$

15. A 100 kg box is at a height of 5 m. It slides down a ramp that is at an incline of 50^o. The coefficient of kinetic friction is 0.50. What is the final velocity of the box when it reaches the bottom of the ramp?

D

a. 7.89 m/s
b. 6.29 m/s
c. 5.76 m/s
d. 7.53 m/s
e. 8.24 m/s





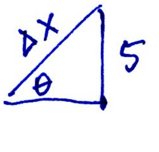
$\Sigma F_x = f_k - mg\sin\theta = ma$

$\Sigma F_y = F_N - mg\cos\theta = 0$

$F_N = mg\cos\theta$

$f_k = \mu mg\cos\theta$

$a = \mu g\cos\theta - g\sin\theta$



$\frac{5m}{\Delta x} = \sin\theta$

$\Delta x = \frac{5m}{\sin\theta} = 6.53m$

$v_f^2 = v_i^2 + 2a\Delta x$

$v_f = \sqrt{2 a \Delta x}$