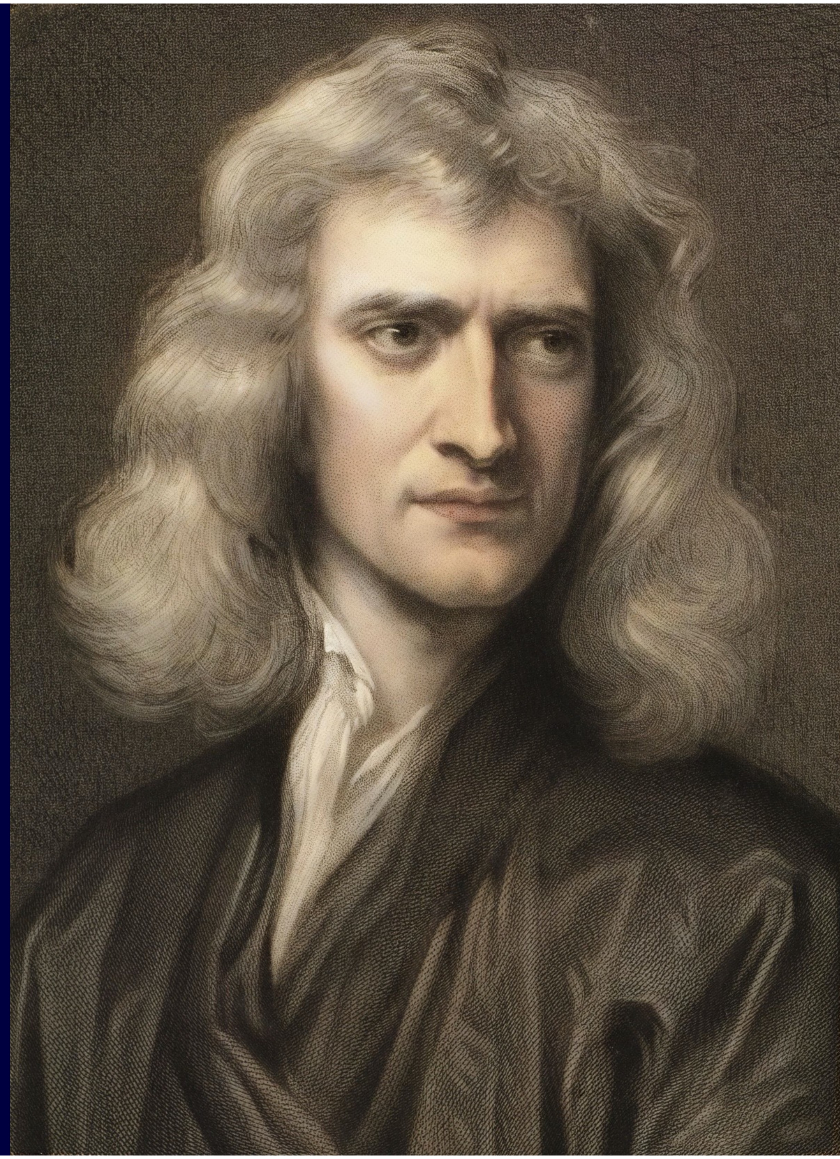
Physics 2A: Lecture 11
Today's Agenda

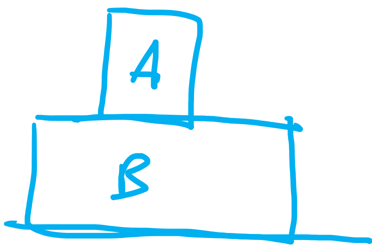
- Review for Quiz 2

Start Recording



Clicker Question 1

The magnitude of the gravitational force exerted by Earth on an object of mass m_1 is $m_1 g$. What is the magnitude of the force exerted by the object on Earth (mass m_E)?

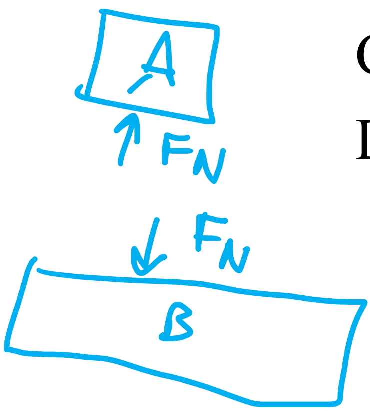


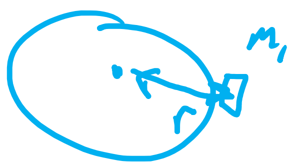
A. $m_1 g$

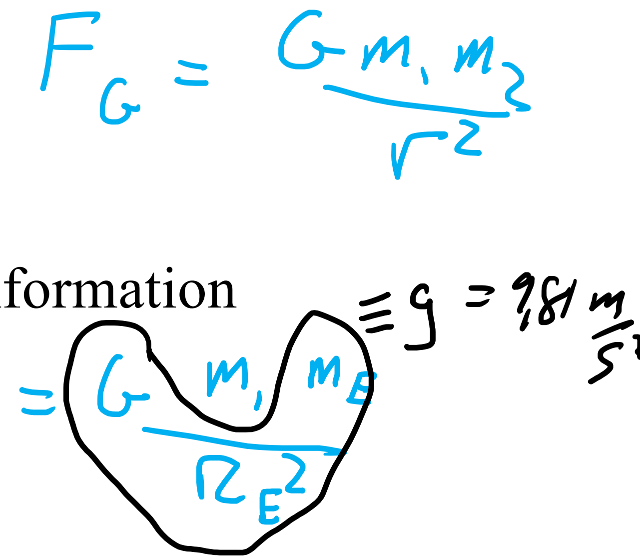
B. $m_E g$

C. 0

D. Cannot be determined from the given information







Clicker Question 1.5:

Assume the block below is pulled by some force, and that there is a force of friction that works on the block in the opposite direction. If the Block moves at constant velocity to the right, which must true? (Note arrows are not drawn to scale)

(a) $|F_{friction}| > |F_{pull}|$

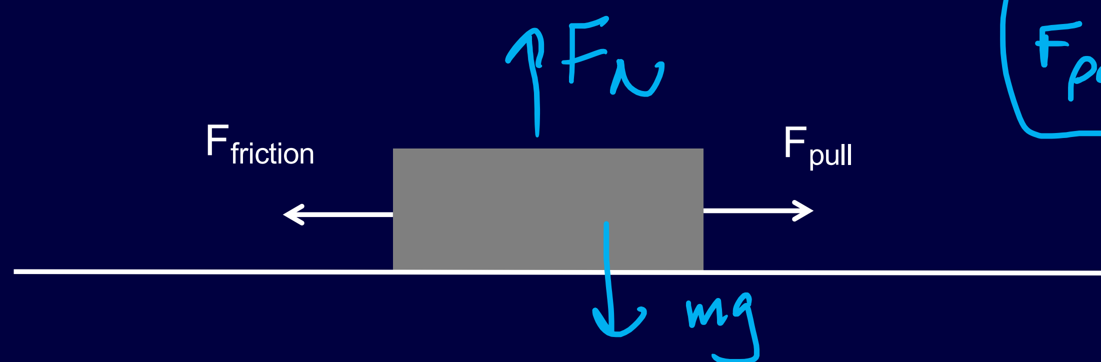
(b) $|F_{friction}| = |F_{pull}|$

(c) $|F_{friction}| < |F_{pull}|$

$$\Sigma F_x = m a_x$$

$$F_{pull} - F_{friction} = 0$$

$$F_{pull} = F_{friction}$$

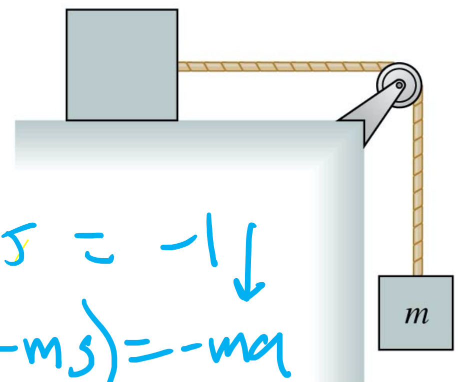


Clicker 2

acceleration constraint

The top block is accelerated across a frictionless table by the falling mass m. The string is massless, and the pulley is both massless and frictionless. The tension in the string is

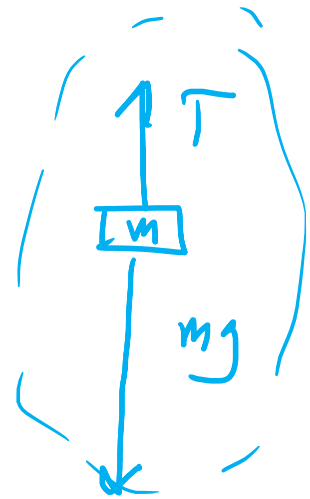
A. $T < mg$
B. $T = mg$
C. $T > mg$



$4 - 5 = -1$

$(T - mg) = -ma$

$T = mg - ma$



Solving Force Problems

Step 1: What forces are acting on our object?

Step 2: Draw a Free Body Diagram for each object.

Step 3: Select coordinate system.

Try to get as many forces in x-y direction

Step 4: Break all forces into x-y components

Step 5: Apply Newton's Second law.

$\Sigma F_X = ma_X$

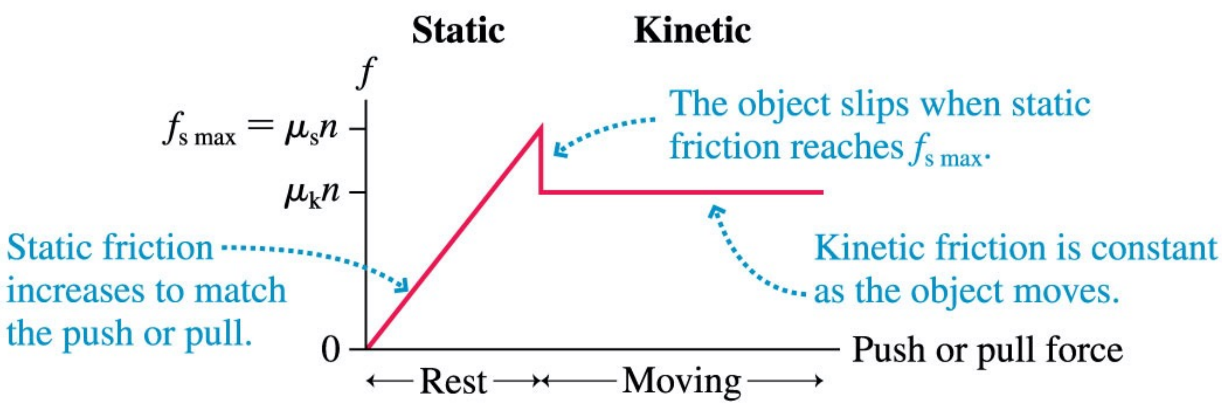
$\Sigma F_Y = ma_Y$

Step 6: Solve for what you need.

A Model of Friction

Student: I am still confused on the difference between Fsmax and Fs. Since there is no formula for Fs, do we ever use anything but Fsmax?

- Graphically:

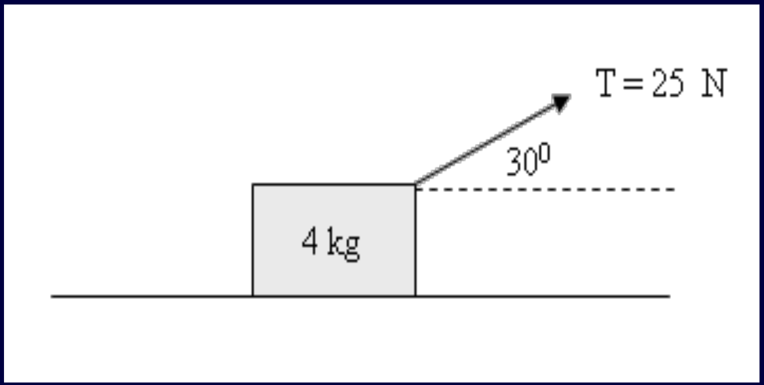


$F_N = ?$

Clicker Question 3:

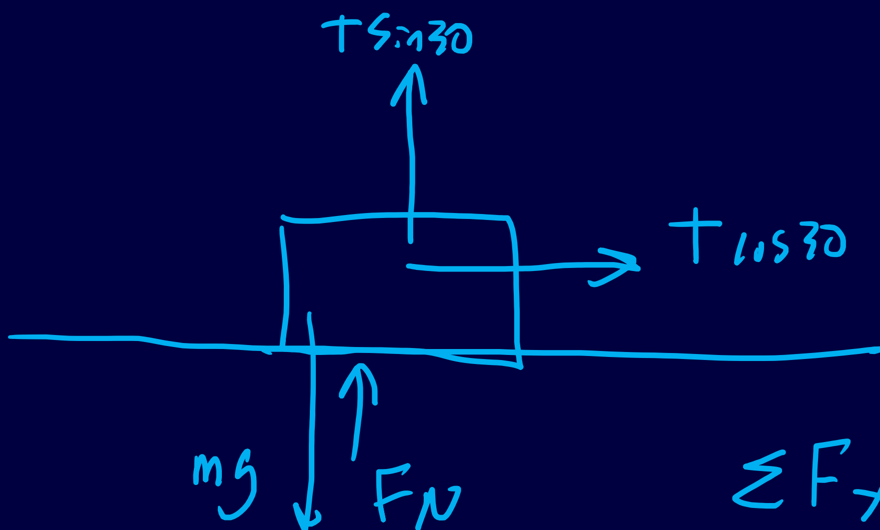
A block of mass M = 4.0 kg is free to move on a horizontal frictionless surface, and is pulled with a rope that makes an angle of 30° with the horizontal as shown in the drawing below. The tension in the rope is 25 N. What is the acceleration of the block?

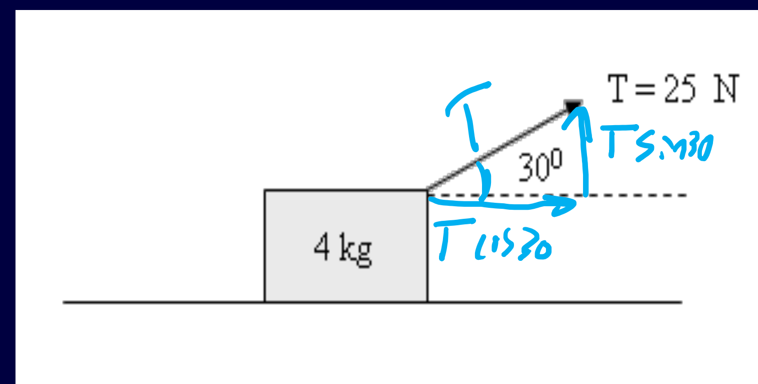
(a) 4.41 m/s^2
(b) 7.81 m/s^2
(c) 2.24 m/s^2
(d) 3.54 m/s^2
(e) 5.41 m/s^2



Clicker Question 3:

A block of mass M = 4.0 kg is free to move on a horizontal frictionless surface, and is pulled with a rope that makes an angle of 30° with the horizontal as shown in the drawing below. The tension in the rope is 25 N. What is the acceleration of the block?





$$\Sigma F_x = m a_x$$

$$T \cos 30 = m a_x$$

$$a = \frac{T \cos 30}{m} = 5.41 \text{ m/s}^2$$

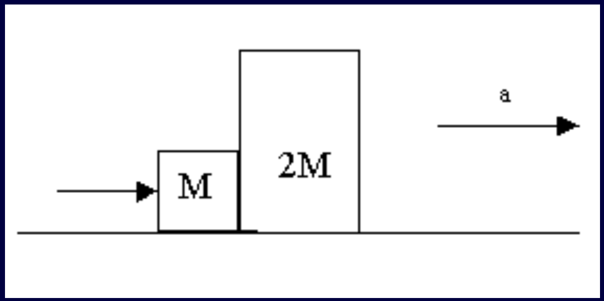
Clicker Question 4:

A small and a large block (mass M and 2M respectively) are arranged on a horizontal frictionless surface as shown below. A student pushes on the left side of the small block with a force of 5N so that the entire system accelerates to the right. How will the accelerations compare?

(A) $a_M > a_{2M}$

(B) $a_M = a_{2M}$

(C) $a_M < a_{2M}$



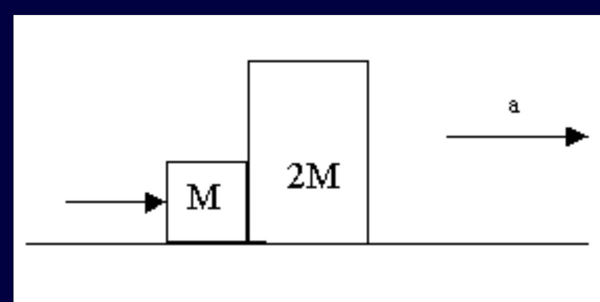
Clicker Question 5:

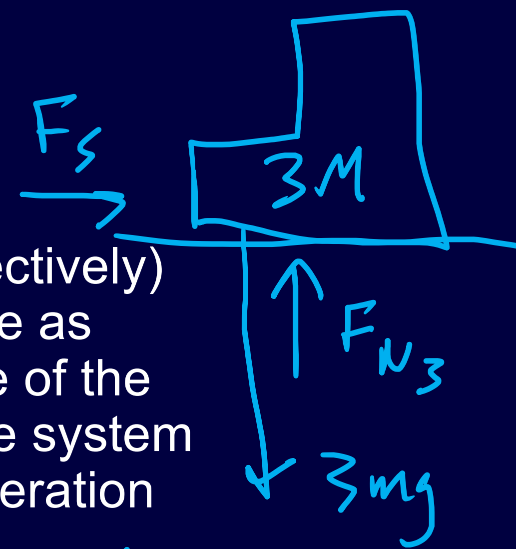
A small and a large block (mass M and 2M respectively) are arranged on a horizontal frictionless surface as shown below. A student pushes on the left side of the small block with a force of 5 N so that the entire system accelerates to the right. If M = 3 kg what acceleration will block M have?

(A) 1.67 m/s^2

(B) 0.55 m/s^2

(C) 0.83 m/s^2





$\Sigma F_s = m_{sys} a$

$F_s = 3m a$

Clicker Question 6:

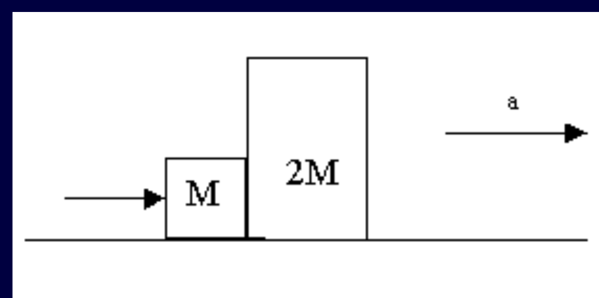
A small and a large block (mass M and 2M respectively) are arranged on a horizontal frictionless surface as shown below. A student pushes on the left side of the small block with a force of 5 N so that the entire system accelerates to the right. How many forces act on block M?

(A) 2

(B) 3

(C) 4

(D) 5



$$F_s - F_{2m,m} = ma$$

$$F_{m,2m} = 2ma$$

$$= 2(3\,kg)(0.55\ m/s^2) = 3.3\,N$$

$$F_s - 2ma = ma$$

$$F_s = 3ma$$

$$a = \frac{F_s}{3m} = 0.55\ m/s^2$$

$$F_{2m,m} = F_s - ma$$

$$= 5N - (3\,kg)(0.55\ m/s^2)$$

$$= 3.3\,N$$

$m = 3\,kg$

$F_s = 5N$

Clicker Question 7:

A small and a large block (mass M and 2M respectively) are arranged on a horizontal surface as shown below. A student pushes on the left side of the small block so that the entire system accelerates to the right. If M = 3 kg, what force does block 2M apply on block M?

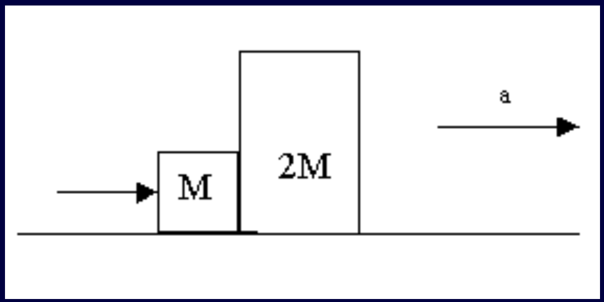
(A) 6.65 N

(B) 5 N

(C) 3.3 N

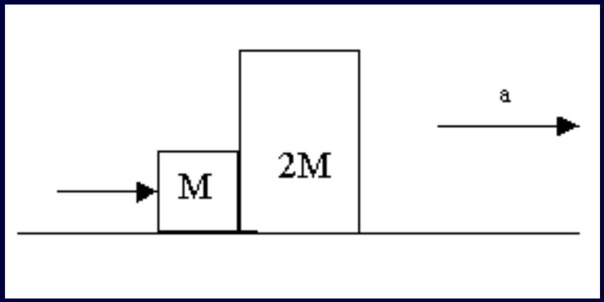
(D) 1.65 N

(E) 0 N



Clicker Question 8:

A small and a large block (mass M and 2M respectively) are arranged on a horizontal surface as shown below. A student pushes on the left side of the small block so that the entire system accelerates to the right. How does the **net force** on the small block F_S compare to the **net force** on the large block F_L? (M = 3 kg)

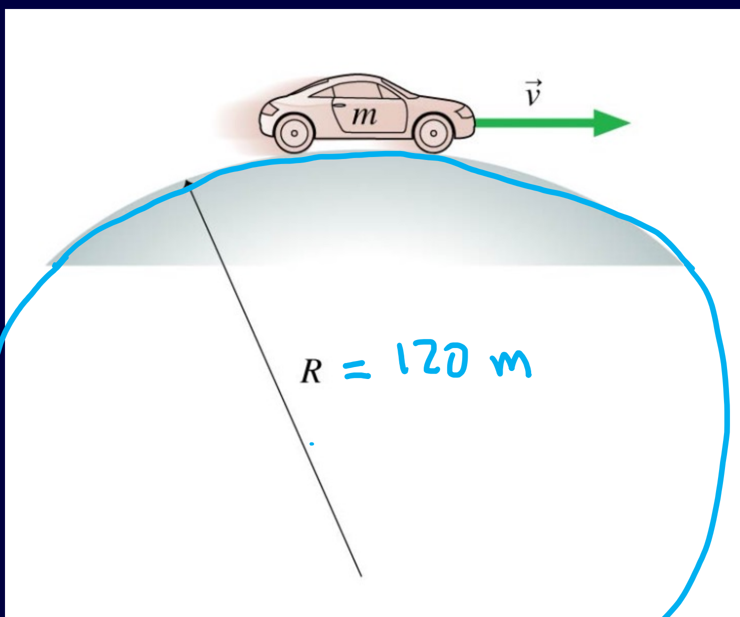


(A) $F_S > F_L$
(B) $F_S = F_L$
(C) $F_S < F_L$

A car of mass m = 1000 kg drives over a hilltop that has a radius of curvature R = 0.120 km travelling at a constant speed of 20 m/s as in the figure below. (a) At this speed, what is the normal force that the ground applies to the car at the very top of the hilltop, as pictured? (b) At what speed would the car be traveling when its tires just barely lose contact with the road when the car is at the top of the hilltop?

↑ +y

$a_c = v^2/r$



↑ F_N

↓ mg

At
B

$$\Sigma F_y = ma_y$$

$$(F_N - mg) = -\frac{mv^2}{r}$$

$$F_N = mg - \frac{mv^2}{r} = m\left(g - \frac{v^2}{r}\right)$$

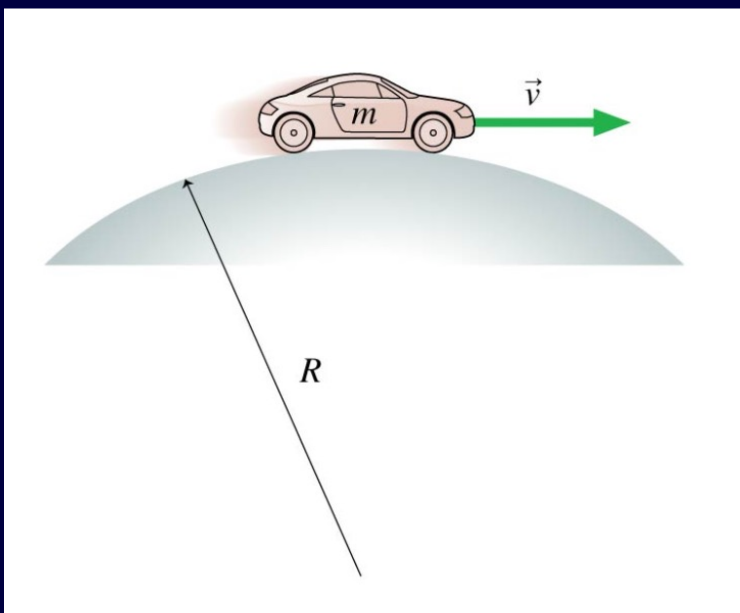
$$= 1000\,kg\left[9.81\,m/s^2 - \frac{(20\,m/s)^2}{120\,m}\right]$$

$$\boxed{= 6476.67\,N}$$

A car of mass m = 1000 kg drives over a hilltop that has a radius of curvature R = 0.120 km travelling at a constant speed of 20 m/s as in the figure below. (a) At this speed, what is the normal force that the ground applies to the car at the very top of the hilltop, as pictured? (b) At what speed would the car be traveling when its tires just barely lose contact with the road when the car is at the top of the hilltop?

(b) 20 m/s $F_N = 0$

$= 0.0001\ N$



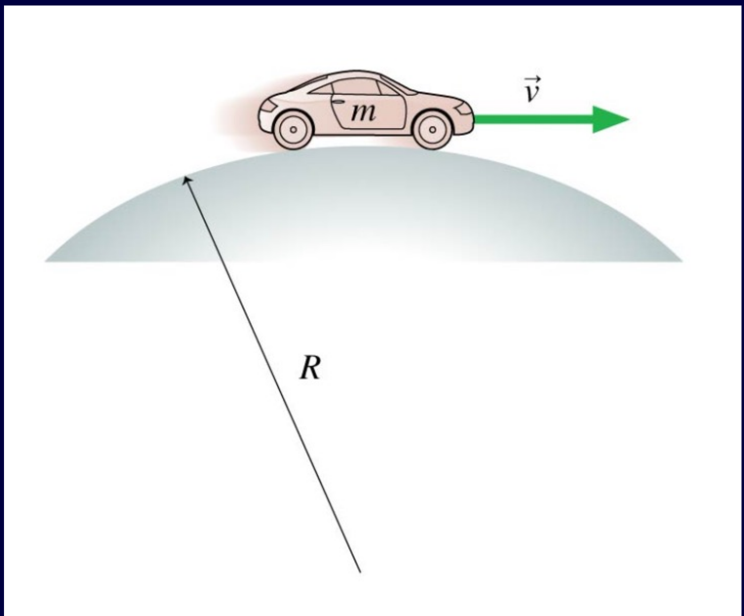
A $v_n > 20$ m/s

B $v_n < 20$ m/s

$$F_N - mg = -m\frac{v^2}{r} \uparrow$$

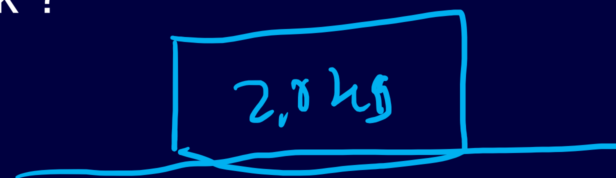
$$v = \sqrt{gr} = 34.3 \text{ m/s}$$

A car of mass m = 1000 kg drives over a hilltop that has a radius of curvature R = 0.120 km travelling at a constant speed of 20 m/s as in the figure below. (a) At this speed, what is the normal force that the ground applies to the car at the very top of the hilltop, as pictured? (b) At what speed would the car be traveling when its tires just barely lose contact with the road when the car is at the top of the hilltop?



Clicker Question 9:

The 1.0 kg block in the figure is tied to the wall with a rope. It sits on top of the 2.0 kg block. The lower block is pulled to the right with a tension force of 20 N. The coefficient of kinetic friction at both the lower and upper surfaces of the 2.0 kg block is $\mu_k = 0.41$. How many forces act on the bottom block ?



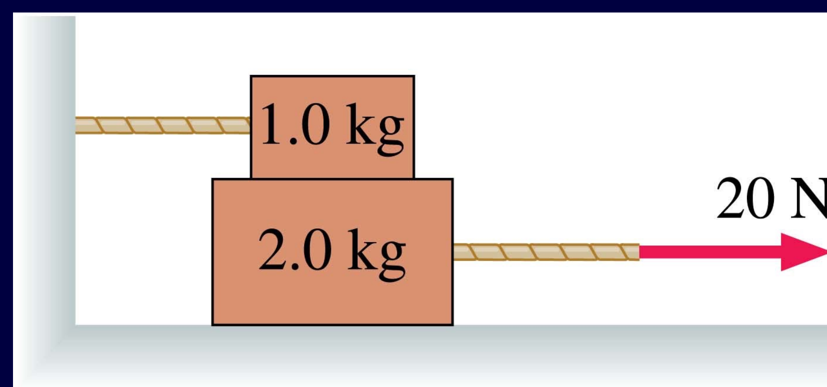
(A) 3

(B) 4

(C) 5

(D) 6

(E) 7



7.24: The 1.0 kg block in the figure is tied to the wall with a rope. It sits on top of the 2.0 kg block. The lower block is pulled to the right with a tension force of 20 N. The coefficient of kinetic friction at both the lower and upper surfaces of the 2.0 kg block is $\mu k = 0.41$. What is the tension in the rope holding the 1.0 kg block to the wall? What is the acceleration of the 2.0 kg block?

$\Sigma F_y = 0$

$F_{N_1} = m_1 g$

$\Sigma F_x = m a_x = 0$

$T_1 = f_{k_1} = \mu_k F_{N_1} = \mu_k m_1 g$

$= 4N$

$(0.41)(1kg)\ 9.81\ m/s$

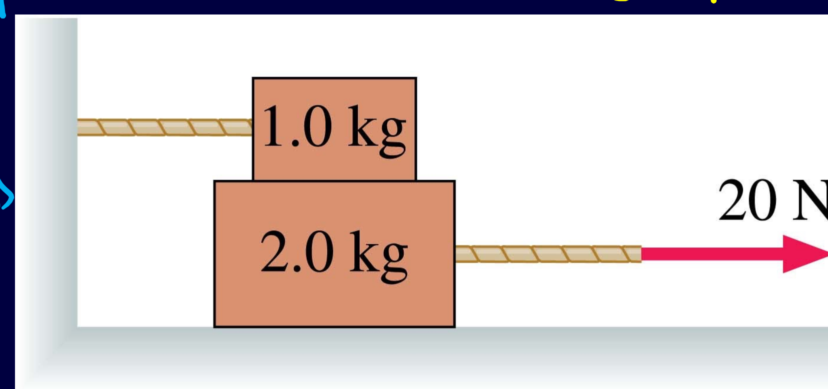
$\Sigma F_y = 0$

$F_{N2} - m_2 g - F_{N1} = 0$

$F_{N2} = m_2 g + F_{N_1}$

$F_{N2} = m_2 g + m_1 g$

$T_2 = 20N$



7.24: The 1.0 kg block in the figure is tied to the wall with a rope. It sits on top of the 2.0 kg block. The lower block is pulled to the right with a tension force of 20 N. The coefficient of kinetic friction at both the lower and upper surfaces of the 2.0 kg block is μk = 0.41. What is the tension in the rope holding the 1.0 kg block to the wall? What is the acceleration of the 2.0 kg block?

$F_{N_2} = (m_1 + m_2)g$

$\Sigma F_x = m a_x$

$T_2 = 20\,N$

$m_1 = 1\,kg$

$m_2 = 2\,kg$

$T_2 - f_{k_2} - f_{k_1} = m_2 a$

$T_2 - \mu F_{N_2} - \mu F_{N_1} = m_2 a$

$a = \frac{T_2 - \mu[m_1 + m_2]g - \mu m_1 g}{m_2}$

$= 2\,m/s^2$