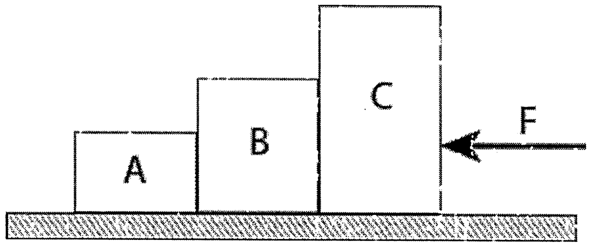
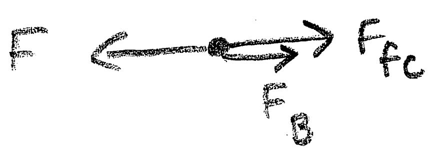
2 Body Problems

Example #1



Three blocks are sliding at a constant velocity across a rough surface as shown. Block A has a mass of 1.0 kg, block B has a mass of 2.0 kg and block C has a mass of 3.0 kg. The coefficient of friction between each block and the surface is 0.30. What is the force between blocks B and C?

Block C



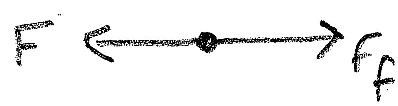
$\Sigma F = ma$

(left +)

$F - F_f - F_B = ma = 0$

$F - \mu m_c g - F_B = 0$

All Blocks



$\Sigma F = ma$

(left +)

$F - F_f = ma = 0$

$F - \mu m_{ABC} g = 0$

$F = \mu m_{abc} g$

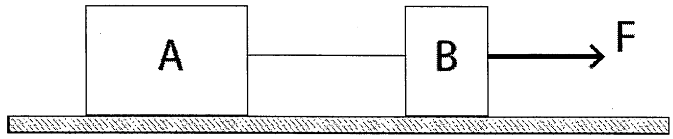
$\mu m_{ABC} g - \mu m_c g = F_B$

$F_B = (.3)(1+2+3)(10) - .3(3)10$

$F_B = -9N$

(or 9N to the right)

Example #2



Two blocks are connected by a string. Block A has a mass of 2.0 kg and block B has a mass of 1.0 kg. A force of 5.0 N accelerates the blocks across a frictionless surface. Calculate the tension in the string between the blocks.

Block A

• → F_T

$\Sigma F = ma$

$F_T = m_A a$

$F_T = (2)(1.67)$

$F_T = 3.3\ N$

or

Block B

F_T ← • → F

$\Sigma F = ma$

$F - F_T = m_B a$

$F_T = F - m_B a$

$= 5 - 1(1.67)$

$F_T = 3.3\ N$

All Blocks

• → F

$\Sigma F = ma$

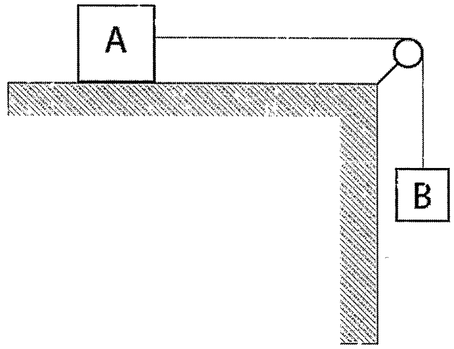
$F = m_{AB} a$

$a = \frac{F}{m_{AB}}$

$= \frac{5}{(2+1)}$

$a = 1.67$

Example #3



A 20 kg block (A) rests on a frictionless table; a cord attached to the block extends horizontally to a pulley at the edge of the table. A 10 kg mass (B) hangs at the end of the cord. Calculate the acceleration of block A and the force of tension in the string.

Block A

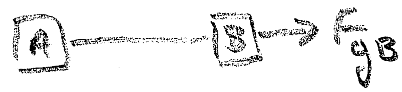
$\Sigma F = ma$

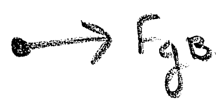
$F_T = m_A a$

$F_T = 20(3.33)$

$F_T = 67N$

All Blocks





$\Sigma F = ma$

$F_{gB} = m_{AB} a$

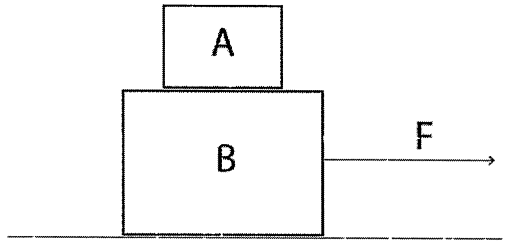
$m_B g = m_{AB} a$

$a = \frac{m_B g}{m_{AB}}$

$a = \frac{10(10)}{(20+10)}$

$a = 3.33 \ m/s^2$

Example #4



Block A (1.0 kg) is placed on top of block B (2 kg) as shown. A force of 12.0 N applied to block B causes the system of both boxes to accelerate to the right (block A remains on top of block B). If the coefficient of friction between all surfaces is 0.30, what is the magnitude of the force that is accelerating block A?

Block A

$\bullet \rightarrow F_A$

$\Sigma F = ma$

$F_A = m_A a$

$F_A = (1)(1)$

$F_A = 1\,N$

All Blocks

$F_{fB} \leftarrow \circ \rightarrow F$

$\Sigma F = ma$

$F - F_{fB} = m_{AB}\, a$

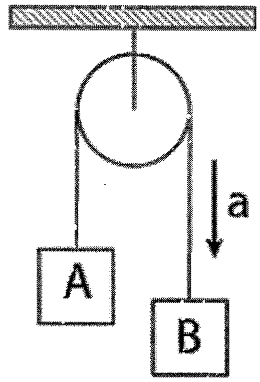
$F - \mu m_{AB} g = m_{AB}\, a$

$a = \dfrac{F - \mu m_{AB} g}{m_{AB}}$

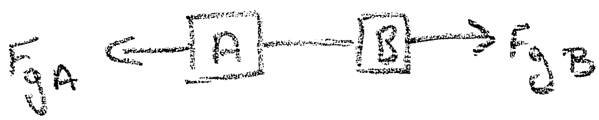
$= \dfrac{12 - .3(1+2)10}{(1+2)}$

$a = 1\ m/s^2$

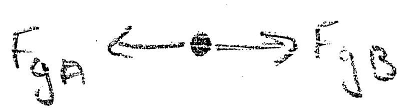
Example #5



An Atwood's Machine consists of masses attached to a frictionless, massless pulley as shown above. The mass of block A is 2.0 kg, and the mass of B is 5.0 kg. Calculate the acceleration of the system when the blocks are released from rest.



All Blocks



$$\Sigma F = ma$$

$$-F_{gA} + F_{gB} = m_{AB}a$$

$$-m_A g + m_B g = m_{AB} a$$

$$a = \frac{(m_B - m_A)g}{(m_A + m_B)}$$

$$= \frac{(5 - 2)10}{(2 + 5)}$$

$$a = 4.3 \ m/s^2$$