Problem 1

The floor of a railroad flatcar is loaded with loose crates having a coefficient of static friction of 0.25 with the floor. If the train is initially moving at a speed of $48km/h$, in how short a distance can the train be stopped at constant acceleration without causing the crates to slide over the floor?

01: **ANS:=36**

$$v = 48km/h = \frac{48 * 10^3 m}{3600s} = 13.3m/s$$

$$a = \frac{f_{s,max}}{m} = \mu_s g = (0.25)(9.8m/s^2) = 2.45m/s^2$$

$$|\Delta x| = \frac{v^2}{2a} = \frac{(13.3m/s)^2}{2(2.45m/s^2)} = 36m$$

Problem 2

In a pickup game of dorm shuffleboard, students crazed by final exams use a broom to propel a calculus book along the dorm hallway. If the $3.5kg$ book is pushed from rest through a distance of $1.20m$ by the horizontal $25N$ force from the broom and then has a speed of $1.75m/s$, what is the coefficient of kinetic friction between the book and floor?

μ_k=_______

$$v^2 = 2a\Delta x$$

02: **ANS:=<u>0.6</u>**

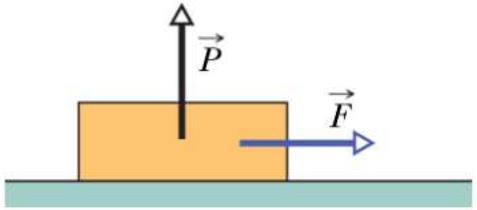
$$a = \frac{v^2}{2\Delta x} = \frac{(1.75m/s)^2}{2(1.2m)} = 1.28m/s^2$$

$$F - \mu_k mg = ma$$

$$\mu_k = \frac{F - ma}{mg} = \frac{25N - (3.5kg)(1.28m/s^2)}{(3.5kg)(9.8m/s^2)} = 0.6$$

Problem 3

A $2.5kg$ block is initially at rest on a horizontal surface. A horizontal force $\vec{F}$ of magnitude $6N$ and a vertical force are $\vec{P}$ are then applied to the block (in the Fig). The coefficients of friction for the block and surface are $\mu_s = 0.4$ and $\mu_k = 0.25$. Determine the magnitude of the frictional force acting on the block if the magnitude of $\vec{P}$ is (a) 8N, (b) 10N, and (c) 12N.



(a)f=_______N

03: **ANS:=6**

(b)f=_______N

04: **ANS:=3.6**

(c)f=_______N

05: **ANS:=3.1**

$F - f = ma$

$F_N = mg - P$

$f_{s,max} = \mu_s F_N$

(a)$P = 8N$

$F_N = mg - P = (2.5)(9.8) - 8 = 16.5N$

$f_{s,max} = \mu_s F_N = (0.4)(16.5) = 6.6N > 6N$

$f = F = 6N$

(b)$P = 10N$

$F_N = mg - P = (2.5)(9.8) - 10 = 14.5N$

$f_{s,max} = \mu_s F_N = (0.4)(14.5) = 5.8N$

最大淨摩擦$f_{s,max} = 5.8N$小於$F = 6N$，
因此積木開始移動

$f_k = \mu_k F_N = (0.4)(14.5) = 3.6N$

(c)$P = 12N$

$F_N = mg - P = (2.5)(9.8) - 12 = 12.5$

$f_{s,max} = \mu_s F_N = (0.4)(12.5) = 5N$

最大淨摩擦$f_{s,max} = 5.8N$小於$F = 6N$，
因此積木已經移動

$f_k = \mu_k F_N = (0.25)(12.5) = 3.1N$

Problem 4

A baseball player with mass $m = 83kg$, sliding into second base, is retarded by a frictional force of magnitude $485N$. What is the coefficient of kinetic friction μ_k between the player and the ground?

μ_k=________

06: **ANS:=0.6**

$$f = \mu_k mg$$

$$\mu_k = \frac{f}{mg} = \frac{485N}{(83kg)(9.8m/s^2)} = 0.6$$

Problem 5

A $12N$ horizontal force $\vec{F}$ pushes a block weighing 5N against a vertical wall (see the figure). The coef?cient of static friction between the wall and the block is 0.6, and the coef?cient of kinetic friction is 0.4. Assume that the block is not moving initially. (a) Will the block move? (b) In unit-vector notation, what is the force on the block from the wall?

(a)yes=1, no=2

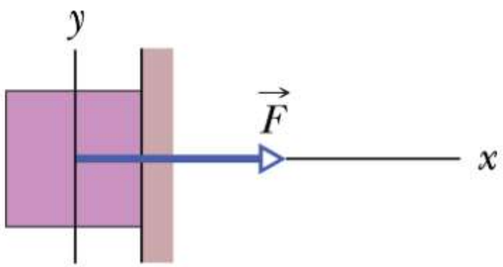
07: **ANS:=2**

(b)$\vec{F} = a\hat{i} + b\hat{j}$, a=___

08: **ANS:=-12**

b=_______

09: **ANS:=5**



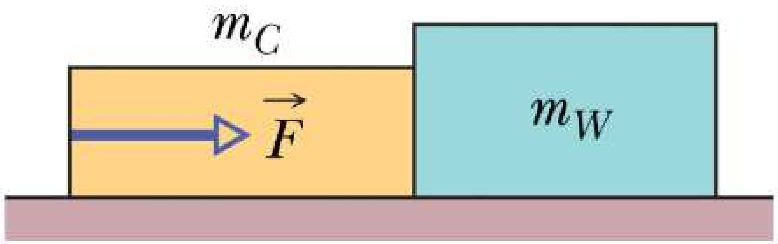
$$(a)\vec{F} = \vec{F}_N = 12$$

$$f_{s,max} = \mu_s F_N = (0.6)(12) = 7.2N < 5N$$，積木不會移動

$$(b)\vec{F}_{wall} = -F_N\hat{i} + f\hat{j} = -12\hat{i} + 5\hat{j}$$

Problem 6

In the figure, a box of Cheerios (mass $m_C = 1kg$) and a box of Wheaties (mass $m_W = 3kg$) are accelerated across a horizontal surface by a horizontal force $\vec{F}$ applied to the Cheerios box. The magnitude of the frictional force on the Cheerios box is $2.0N$, and the magnitude of the frictional force on the Wheaties box is $3.5N$. If the magnitude of $\vec{F}$ is $12N$, what is the magnitude of the force on the Wheaties box from the Cheerios box?



$$m_C + m_W = 1kg + 3kg = 4kg$$

$$f_{total} = 2N + 3.5N = 5.5N$$

$$F - f = ma$$

$$a = \frac{12N - 5.5N}{1kg + 3kg} = 1.6m/s^2$$

$$F' - f_W = m_W a$$

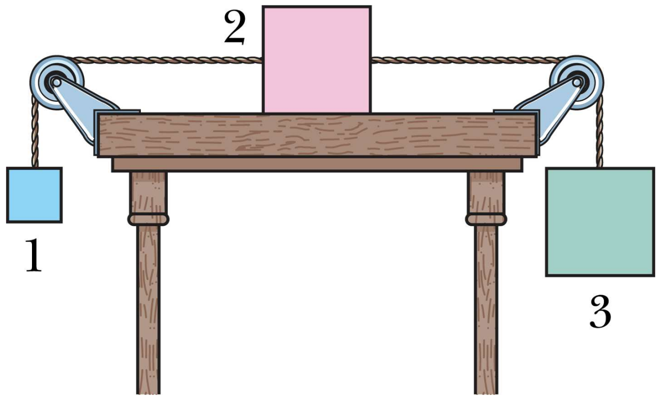
$$F' = m_W a + f_W = (3kg)(1.6m/s^2) + 3.5N = 8.3N$$

F'=_______N

10: **ANS:=8.3**

Problem 7

When the three blocks in the figure are released from rest, they accelerate with a magnitude of $0.5m/s^2$. Block 1 has mass M, block 2 has 2M, and block 3 has 2M.What is the coef?cient of kinetic friction between block 2 and the table?



$$m_3g - \mu_k m_2 g - m_1 g = (m_1 + m_2 + m_3)a$$

$$2Mg - \mu_k(2Mg) - Mg = (M + 2M + 2M)(0.5m/s^2)$$

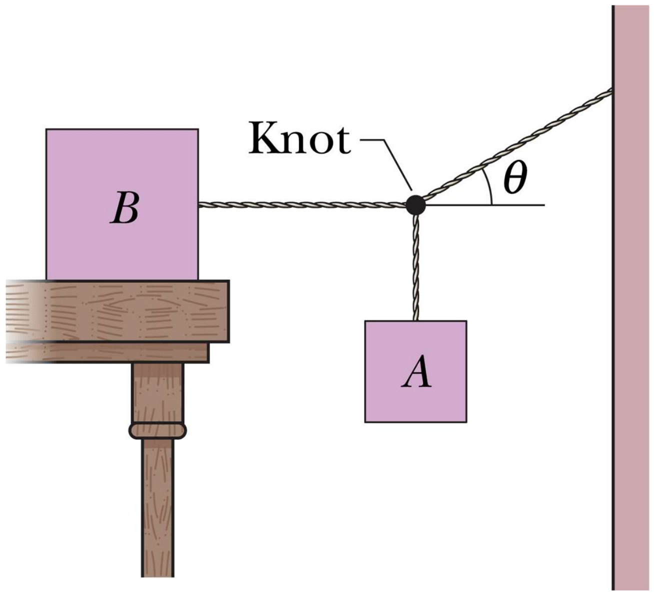
$$\mu_k = \frac{M(9.8 - 2.5)}{2M(9.8)} = 0.372$$

μ_k=_______

11: **ANS:=0.372**

Problem 8

Block B in the figure weighs $711N$. The coefficient of static friction between block and table is 0.25; angle θ is 30^0; assume that the cord between B and the knot is horizontal. Find the maximum weight of block A for which the system will be stationary. 圖中木塊B重711N。木塊與桌面的靜摩擦係數為0.25。角度為30度。假設木塊B與繩結之間的繩子是水平的。問系統靜止條件下木塊A的最大重量為何？



$$T_1 = f_{s,max} = \mu_k W_B$$

$$T_2 cos\theta - T_1 = 0$$

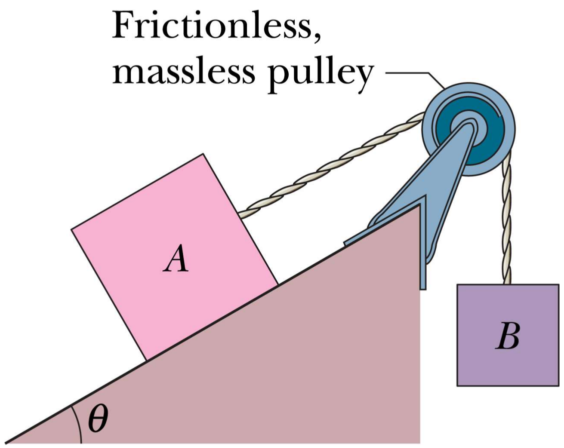
$$W_A = T_2 sin\theta = \frac{T_1}{cos\theta} sin\theta = \mu_k W_B \frac{sin\theta}{\cos\theta}$$

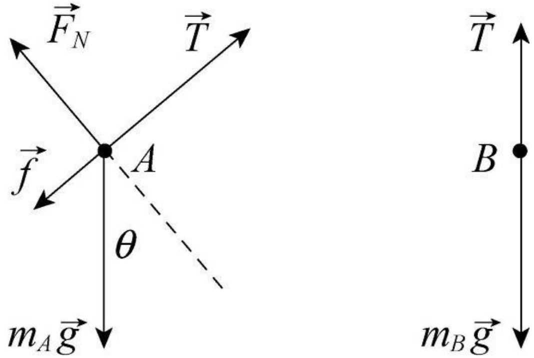
$$W_A = (0.25)(711N)\left(\frac{sin30^0}{cos30^0}\right) = 103N$$

12: **ANS:=103**

Problem 9

Body A in the figure weighs $102N$, and body B weighs $32N$. The coefficients of friction between A and the incline are $\mu_s = 0.56$ and $\mu_k = 0.25$. Angle θ is 40°. Let the positive direction of an x axis be up the incline. In unit-vector notation, what is the acceleration of A if A is initially (a) at rest, (b) moving up the incline, and (c) moving down the incline?





(a)a=_______ m/s^2

13: **ANS:=0**

(b)a=_______ m/s^2

14: **ANS:=-3.9**

(c)a=_______ m/s^2

15: **ANS:=-1**

(a)A靜止，所以$a = 0$

(b)$T - f_k - W_A sin\theta = m_A a$

$f_k = \mu_k F_N$

$f_k = \mu_k F_N$

$F_N = W_A cos\theta$

$W_B - T = m_B a$

$$a = \frac{W_B - W_A sin\theta - \mu_k W_A cos\theta}{m_B + m_A}$$

$$= \frac{32 - 102 * sin40^0 - 0.25 * 102 - cos40^0}{\frac{32 + 102}{9.8}} = -3.9m/s^2$$

(c)$T + f_k - W_A sin\theta = m_A a$ $\quad a = \frac{W_B - W_A sin\theta + \mu_k W_A cos\theta}{m_B + m_A} = -1m/s^2$

Problem 10

What is the smallest radius of an unbanked (flat) track around which a bicyclist can travel if her speed is $29km/h$ and the μ_s between tires and track is 0.32?

$$29km/h = (29km/h)(\frac{1000m}{1km})(\frac{1h}{3600s}) = 8.06m/s$$

摩擦力$f_{s,max} = \mu_s F_N = \mu_s mg$

向心力$f = \dfrac{mv^2}{R}$ $\quad f \leq f_{s,max} \quad \dfrac{mv^2}{R} \leq \mu_s mg$

$$R \geq \frac{v^2}{\mu_s g} = \frac{(8.06m/s)^2}{(0.32)(9.8m/s^2)} = 20.7m$$