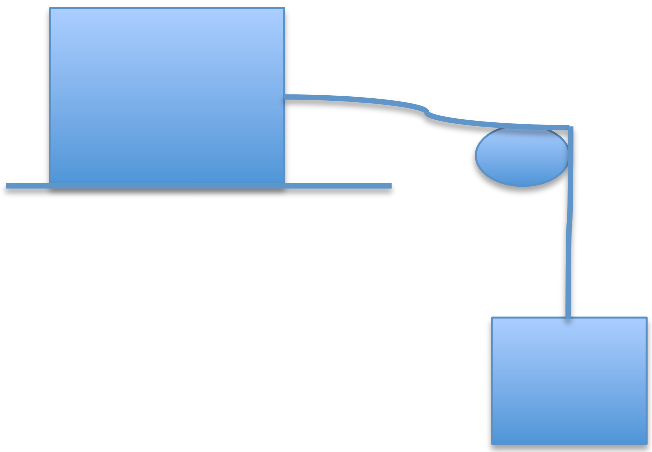
Homework Solutions

PROBLEMS INVOLVING TENSION WILL BE DISCUSSED IN CLASS TOMORROW TO MAKE CORRECTIONS

1. A 4.0 kg mass is attached to a 10. kg mass on a horizontal table via a pulley. The 4.0 kg mass hangs off the edge of the table. Find the acceleration and tension forces involved. Assume there is NO friction.



- $W = mg$
- $W = mg$

$F_{net} = ma$

$a = F/m = 39.24/(4+10)$

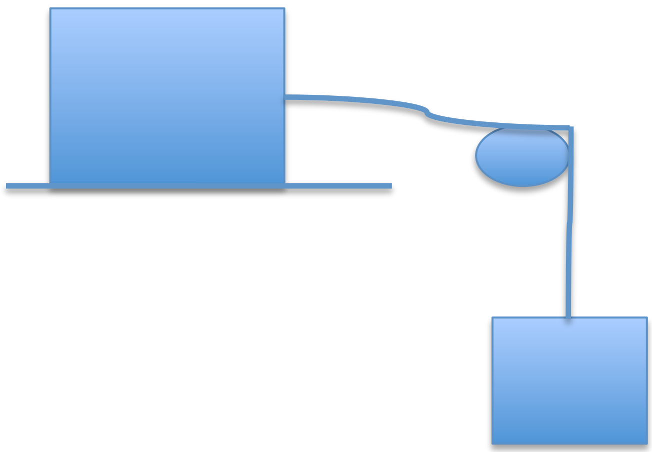
$a = 2.80\ ms^{-2} = 2.8\ ms^{-2}$

$T = mg - ma$

$T = 4kg(9.81ms^{-2}) - 4kg(2.80ms^{-2})$

$T = 28.04\ N = 28\ N$

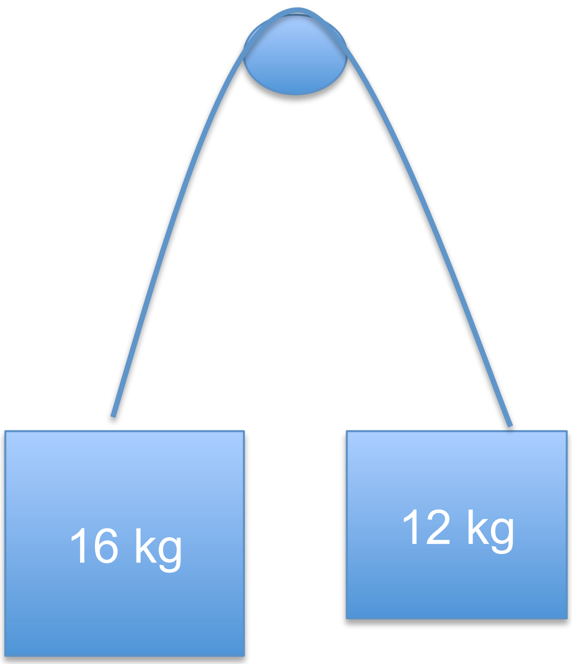
2. Repeat question #1 using a friction coefficient of 0.102 between the 10. kg mass and the horizontal surface.



- $W = mg$
  $W = 4\ kg\ (9.81\ ms^{-2})$
  $W = 39.24\ N = 39\ N$
- $F_{net} = W – F$
  $F = \mu mg = (.102)(10kg)(9.81ms^{-2})$
  $F = 10.0062$
  $F_{net} = 29.2338\ N = ma$
  $a = F/m = 29.2338\ N/(4+10\ kg)$
  $a = 2.088\ ms^{-2} = 2.1\ ms^{-2}$

  $T = mg – ma$
  $T = 4kg(9.81ms^{-2}) –$
  $4kg(2.088ms^{-2})$
  $T = 30.88\ N = 31\ N$

3) A 16 kg mass is attached to another 12 kg mass by string. Both masses hang off a frictionless pulley. (This is called Atwood's machine). Determine the acceleration of the masses and the tension force in the string.



- $T = m_{16}g + m_{16}a$

  $T = 12kg(9.81\ ms^{-2}) + 12kg(1.4ms^{-2})$

  $T = 134.54\ N = 130\ N$

- $F_{net} = m_{16}g - m_{12}g$
- $F_{net} = 4\ kg\ (9.81\ ms^{-2}) = 39.24\ N$

  $F_{net} = ma$

  $a = F/m = 39.24\ N / (16 + 12\ kg)$

  $a = 1.4\ ms^{-2}$

4) Use the following diagram to determine the tension force between mass A and B. A = 4.0 kg, B = 2.0 kg and C = 5.0 kg. There is no friction.

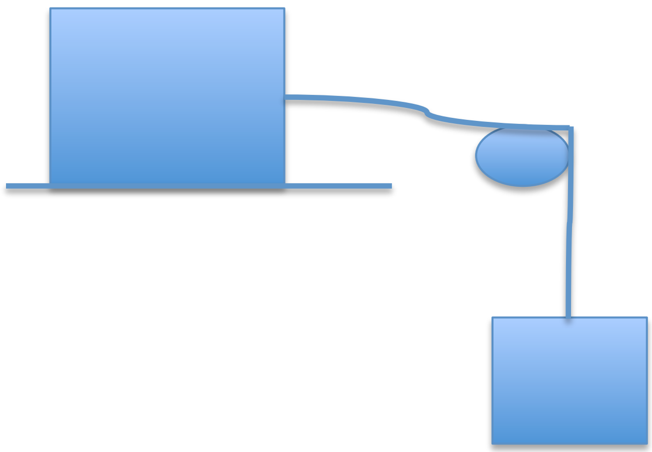
- $T_{AB} = m_A g – m_a a$
  $T_{AB} = 5kg(9.81ms^{-2}) – 5kg(4.45ms^{-2}) =$
26.8 N
- $T_{BC} = T_{AB} – m_B a$
  $T_{BC} = 26.8\ N – 2kg(4.45ms^{-2})$
  $T_{BC} = 17.9\ N = 18\ N$

- $F_{net} = ma$
  $a = F_{net}/m = 49\ N / (4+2+5\ kg) = 4.45\ ms^{-2}$

5) A 10.0 kg block lies on a frictionless horizontal table. To the right of the block is a frictionless pulley. A 25.0 kg mass is hanging off the table connected to the 10.0 kg mass and pulley via some string.

a) Find the acceleration of the system.

b) Find the tension in the string.



b) $T = mg - ma$

$T = 25\ kg\ (9.81\ ms^{-2}) - 25kg(7.01ms^{-2})$

$T = 70.1\ N$

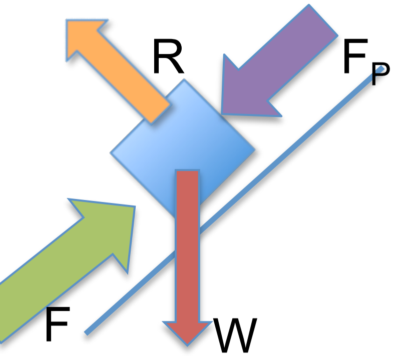
a) $F_{net} = mg = 25kg(9.81\ ms^{-2})$

$F_{net} = ma$

$a = F/m = 245.25\ N/(25+10kg)$

$a = 7.01\ ms^{-2}$

6) A 52.0 N block rests on an inclined plane at an angle of 25.0 [N of E]. If the block is pushed with 10.0 N of force down the ramp and μ = 0.556, what's the block's initial acceleration?



- $W = 52\text{ N} = mg \quad m = 52\text{ N}/9.81\text{ms}^{-2}$
- $F_{net} = F_p + mg\sin\Theta - \mu mg\cos\Theta$

  $= 10\text{N} + 52\sin25 - (0.556)52\cos25$

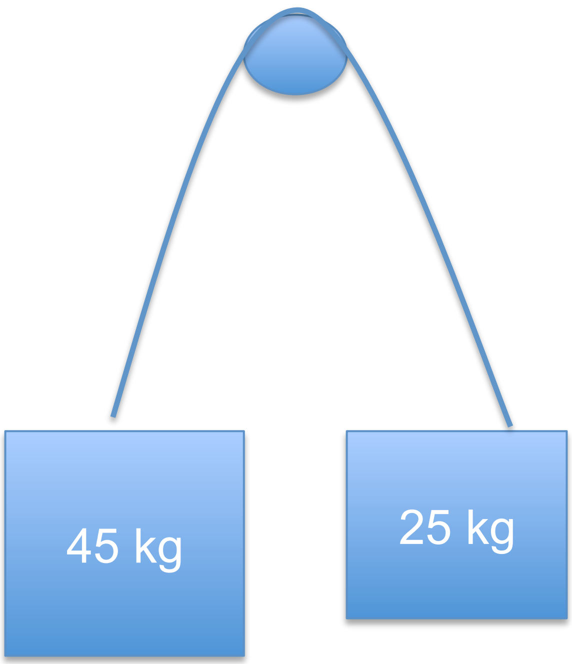
  $= 5.773\text{ N}$

$F_{net} = ma$

$a = F_{net}/m = 5.773 / (52\text{ N}/9.81\text{ms}^{-2})$

$a = 1.09\text{ ms}^{-2}$

7) Two bodies, 1 and 2, have masses m1 = 25 kg and m2 = 45 kg respectively and are attached by a massless inextensible cord which is passed over a frictionless pulley. This set-up is called an Atwood's machine. Determine the acceleration of the bodies.



- $F_{net} = m_{45}g – m_{25}g$

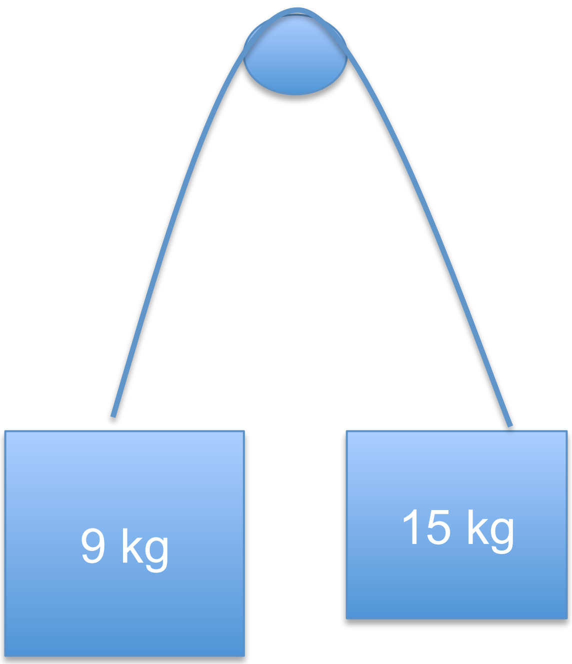
  $F_{net} = 20\ kg\ (9.81\ ms^{-2}) = 196.2N$

  $F = ma$

  $a = F/m = 196.2N / (25+45\ kg)$

  $a = 2.8\ ms^{-2}$

8) A pulley has two suspended masses hanging down on each side in a classic Atwood's machine. If 15.0 kg is on the right and 9.00 kg is on the left, what is the tension force and acceleration of the system?



- $T = F_{net}$

  $T = m_{15}g – m_{15}a$

  $T=15kg(9.81\ ms^{-2})– 15kg(2.45ms^{-2})$

  $T = 110.3625\ N = 110\ N$

- $F_{net} = m_{15}g – m_9g$

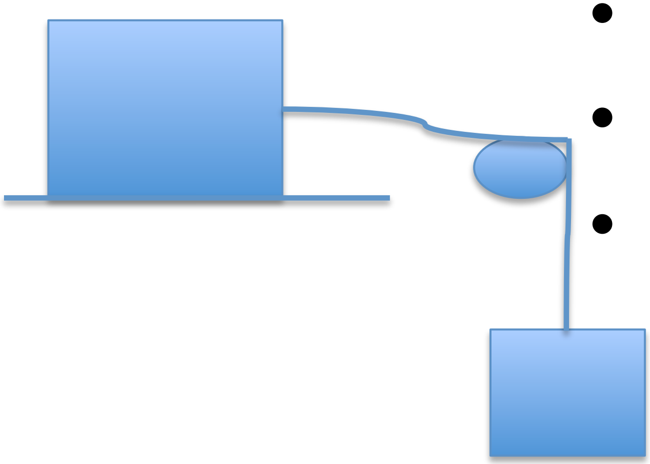
  $F_{net} = (6kg)(9.81ms^{-2}) = 58.86\ N$

  $F_{net} = ma$

  $a = F/m = 58.86\ N/\ (15+9\ kg)$

  $a = 2.4525\ ms^{-2} = 2.45\ ms^{-2}$

9) An object sits at the edge of a table top with a mass of 143 kg. It is connected by a fine strong thread to a mass via a pulley which is hanging in the air below the edge of the table top. The friction coefficient between the 143 kg mass and the table is 0.300 and the tension in the thread is 890. N, find the acceleration of the system and the mass of the other block!!



- $T = m_u g - m_u a = 890\ N$
- $F_{net} = T - \mu mg$
- $F_{net} = 890 - 0.3(143kg)(9.81ms^{-2})$

$F_{net} = 469.151\ N$

$a = F_{net}/m = 469.151\ N / 143\ kg$

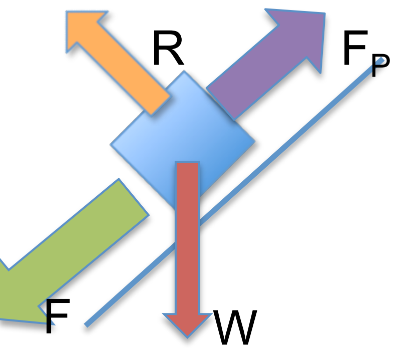
$a = 3.28\ ms^{-2}$

$T / (g-a) = m_u$

$890\ N / (9.81 - 3.28\ ms^{-2}) = m_u$

$m_u = 136\ kg$

15) A block of mass 7 kg is being pulled up an incline of 35° at constant velocity. The applied force is 65 N up the plane. What is the coefficient of friction for the surface?



- $F_{net} = 0$

  $F_P = F_F$

  $F_P = mg\sin\Theta + \mu mg\cos\Theta$

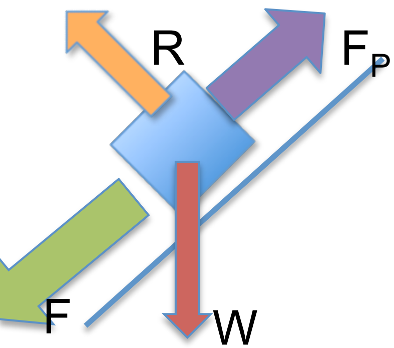
  $(F_P - mg\sin\Theta) / (mg\cos\Theta) = \mu$

  $\mu = [65\text{ N} - 7\text{kg}(9.81\text{ms}^{-2})(\sin 35)] / [7\text{kg}(9.81\text{ms}^{-2})(\cos 35)]$

  $\mu = 25.6125\text{ N} / 56.2512\text{ N}$

  $\mu = 0.455 = 0.5$

16) A block of mass 20 kg is being pulled up an incline of 40º at constant velocity. The applied force is 175 N up the plane. What is the coefficient of friction for the surface?



- $F_{net} = 0$

  $F_P = F_F$

  $F_P = mg\sin\Theta + \mu mg\cos\Theta$

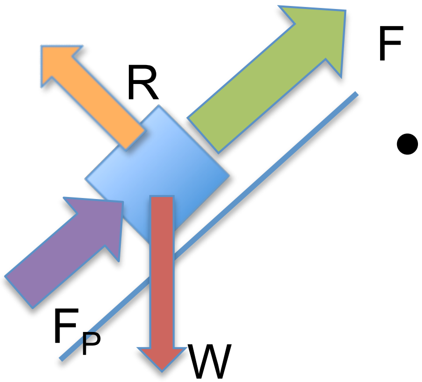
  $(F_P - mg\sin\Theta) / (mg\cos\Theta) = \mu$

  $\mu = [175\ N - 20kg(9.81ms^{-2})(\sin 40)] / [20kg(9.81ms^{-2})(\cos 40)]$

  $\mu = 48.8851\ N / 150.2979\ N$

  $\mu = 0.3253 = 0.3$

17) A block of mass 8 kg is sliding down an incline of 25º at constant velocity. The applied force is 5 N up the plane. What is the coefficient of friction for the surface?



- $F_{net} = 0$

  $F_P = F_F$

  $F_P + \mu mg\cos\Theta = mg\sin\Theta$

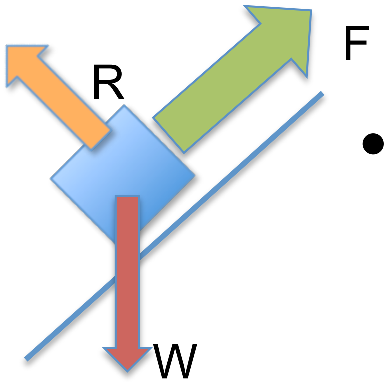
  $(mg\sin\Theta - F_P) / (mg\cos\Theta) = \mu$

  $\mu = [15\ N – 8kg(9.81ms^{-2})(\sin 25)]/ [8kg(9.81ms^{-2})(\cos 25)]$

  $\mu = 18.1671\ N / 71.1270\ N$

  $\mu = 0.2554 = 0.3$

18) A block of mass 35 kg is sliding down an incline of 35° at constant velocity. What is the coefficient of friction for the surface?



- $F_{net} = 0$

  μmgcosΘ = mgsinΘ

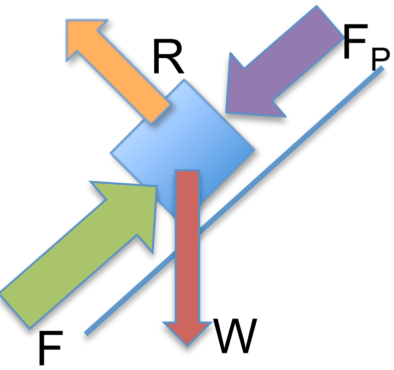
  (mgsinΘ) / (mgcosΘ) = μ

  μ = [35kg(9.81ms^{-2})(sin35)]/[35kg(9.81ms^{-2})(cos35)]

  μ = 196.9375 N / 281.2559 N

  μ = 0.7002 = 0.70

19) A block of mass 15 kg is sliding down an incline of 15º at constant velocity. The applied force is 45 N down the plane. What is the coefficient of friction for the surface?



- $F_{net} = 0$

  $F_P = F_F$

  $F_P + mg\sin\Theta = \mu mg\cos\Theta$

  $(F_P + mg\sin\Theta) / (mg\cos\Theta) = \mu$

  $\mu = [45\ N + 15kg(9.81ms^{-2})(\sin 15)] / [15kg(9.81ms^{-2})(\cos 15)]$

  $\mu = 83.0852\ N / 142.1360\ N$

  $\mu = 0.5845 = 0.58$