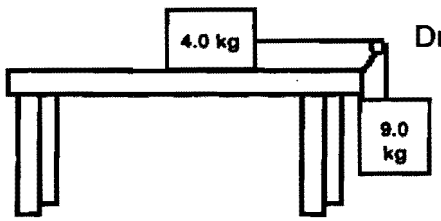
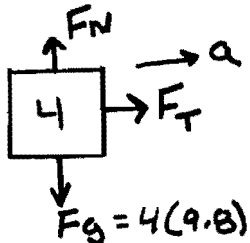
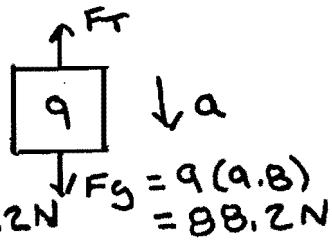
Two Body Problems - Box on Flat Surface with Hanging Mass

1. A 4.0 kg cart is connected by a string to a 9.0 kg mass hanging over the desk as shown below.



Draw your FBD for each mass and write your Fnet equations.





Calculate the force of tension and the acceleration of the system if $\mu = 0.0$

m_1

$F_{NET_x} = ma$

$F_t = ma$

$F_t = 4a$

m_2

$F_{NET_y} = ma$

$F_t - F_g = ma$

$F_t - 88.2 = -9a$

$4a - 88.2 = -9a$

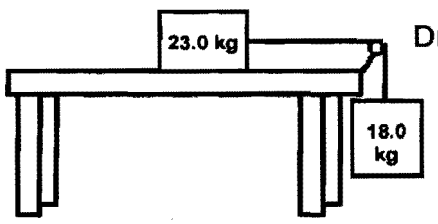
$13a = 88.2$

$a = \frac{88.2}{13} = \boxed{6.78 m/s^2}$

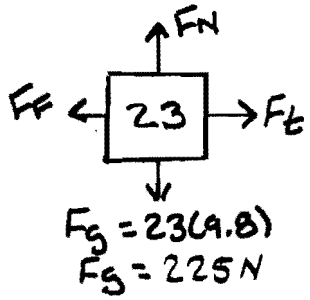
$F_t = 4a$

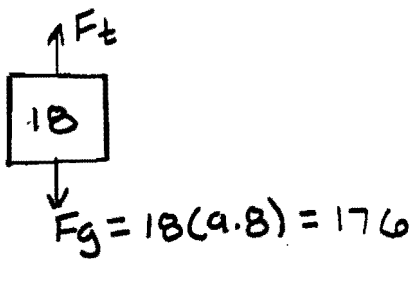
$F_t = 4(6.78) = \boxed{27.1 N}$

2. A 23.0 kg cart is connected by a string to an 18.0 kg mass hanging over the desk as shown below.



Draw your FBD for each mass and write your Fnet equations.





Calculate the force of tension and the acceleration of the system if $\mu = 0.40$

m_1

$F_{NET_y} = 0$

$F_N - F_g = 0$

$F_N = F_g = 225N$

$F_F = \mu F_N = 0.4(225)$

$F_F = 90N$

$F_{NET_x} = m_1 a$

$F_t - F_F = m_1 a$

$F_t - 90 = 23a$

$F_t = 23a + 90$

m_2

$F_{NET_y} = m_2 a$

$F_t - F_g = m_2 a$

$F_t - 176 = -18a$

$F_t = 176 - 18a$

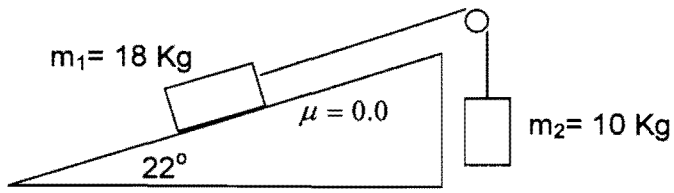
$23a + 90 = 176 - 18a$

$41a = 86 \Rightarrow a = \frac{86}{41} = 2.10 m/s^2$

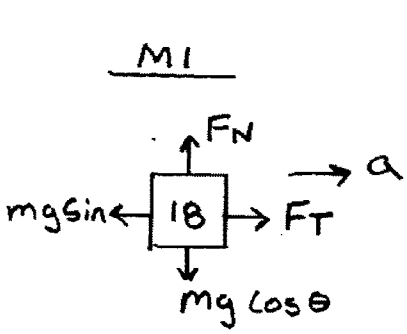
$F_t = 23a + 90 = \underline{138 N}$

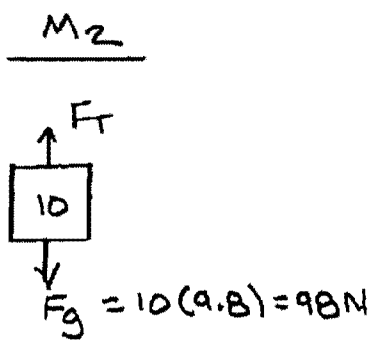
Two Body Problems - Box on Incline Plane with Hanging Mass

1. Two masses are connected as shown below.



Calculate the acceleration and force of tension of the system.





// $F_{NET} = m_1 a$

$F_T - mg\sin\theta = m_1 a$

$F_T - 18(9.8)\sin(22) = 18a$

$F_t = 18a + 66.1$ ⟸ SET THESE = ⟹ $F_T = 98 - 10a$

$18a + 66.1 = 98 - 10a$

$28a = 98 - 66.1 = 31.9$

$a = \frac{31.9}{28} = \boxed{1.14\ m/s^2}$

$F_{yNET} = m_2 a$

$F_T - F_g = m_2 a$

$F_T - 98 = -10a$

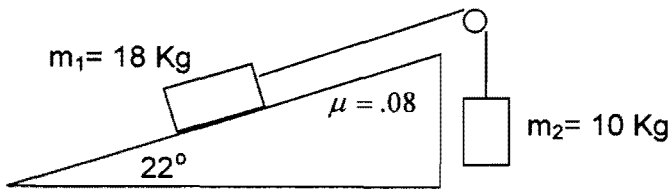
USE a to find F_t

$F_t = 98 - 10a$

$98 - 10(1.14)$

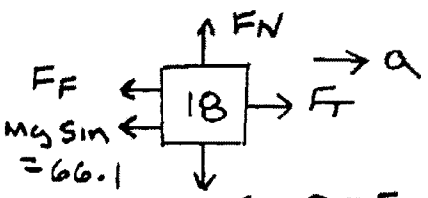
$F_t = \boxed{86.6\ N}$

2. Two masses are connected as shown below.



Calculate the acceleration and force of tension of the system.

m_1



$F_{g\perp} = 18(9.8)\cos 22$

$= 164\ N$

$\perp\ F_{NET} = 0$

$F_N - F_{g\perp} = 0$

$F_N = F_{g\perp} = 164\ N$

$F_F = \mu F_N$

$F_F = 0.08(164) = 13\ N$

m_2

SAME AS ABOVE

$F_T = 98 - 10a$

$\parallel\ F_{NET} = m_1 a$

$F_T - F_{g\parallel} - F_F = m_1 a$

$F_T - 66.1 - 13 = 18a$

$F_T = 79.1 + 18a$

SOLVE FOR a

$79.1 + 18a = 98 - 10a$

$28a = 98 - 79.1$

$a = \frac{18.9}{28} = \boxed{0.66\ m/s^2}$

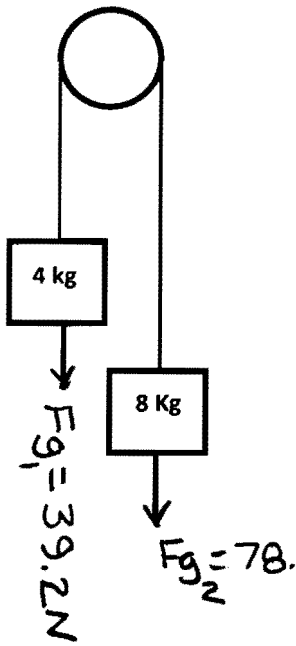
$F_T = 98 - 10a$

$F_T = 98 - 10(0.66)$

$F_T = 91.4\ N$

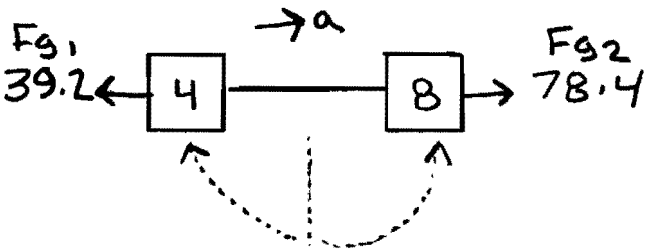
Alternate Method for solving Two Body Problems

In this method we will consider the system as a single body, and then apply Newton's Second Law to the overall system rather than breaking up the system into multiple free body diagrams and solving a system of equations.



Consider the Atwood problem that we did earlier with a 4 Kg mass on the left and an 8 kg mass on the right. First draw all the forces acting on the system as shown to the right.

Secondly, redraw the diagram with the masses rotated so that the string between the masses is completely horizontal. Make sure that all forces are rotated along with the masses. (see below)



Solve for the acceleration using Newton's Second Law. Consider the whole system as a single mass.

$F_{NET} = ma$

$F_{g_2} - F_{g_1} = (m_1 + m_2)a$

$78.4 - 39.2 = (4+8)a$

$39.2 = 12a$

$a = \frac{39.2}{12} = \underline{3.27 m/s^2}$

To find F_t, use 1 mass & acceleration

$a = 3.27$

$F_{NET} = m(+a)$

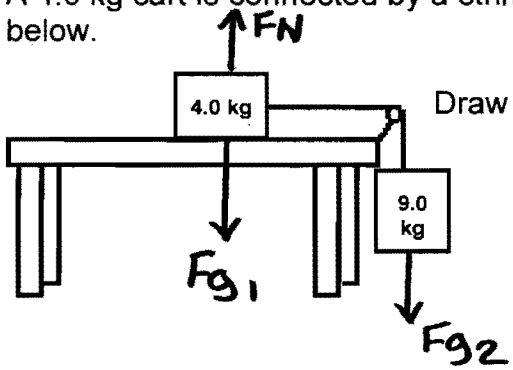
$F_t - 39.2 = 4(3.27)$

$\underline{F_t = 52.3 N}$

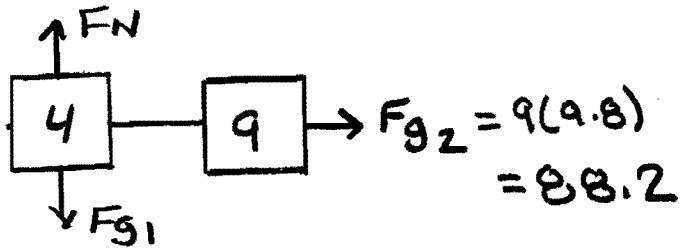
* This Worksheet uses the Alternate Method

Two Body Problems - Box on Flat Surface with Hanging Mass

1. A 4.0 kg cart is connected by a string to a 9.0 kg mass hanging over the desk as shown below.



Draw your FBD for each mass and write your F_{net} equations.



Calculate the force of tension and the acceleration of the system if $\mu = 0.0$

$F_{net} = ma$

$88.2 = (9+4)a$

$a = \frac{88.2}{13} = 6.78\ m/s^2$

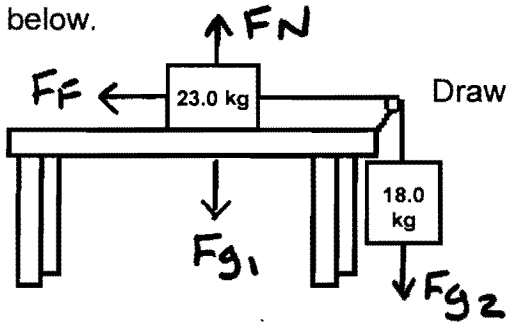
4 → Ft

$F_t = 4a$

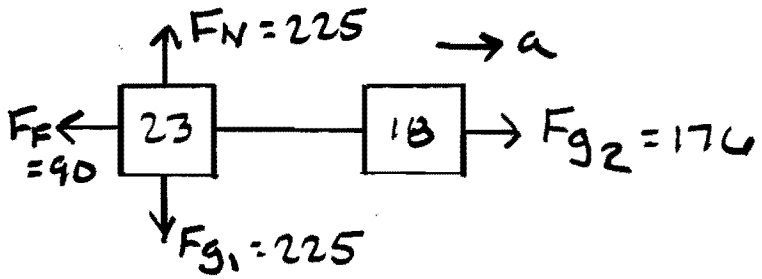
$F_t = 4(6.78)$

$F_t = 27.1\ N$

2. A 23.0 kg cart is connected by a string to an 18.0 kg mass hanging over the desk as shown below.



Draw your FBD for each mass and write your F_{net} equations.



Calculate the force of tension and the acceleration of the system if $\mu = 0.40$

$F_{NET} = ma$

$F_{g2} - F_F = (m_1 + m_2)a$

$176 - 90 = (23+18)a$

$86 = 41a$

$a = \frac{86}{41} = 2.10\ m/s^2$

FT ← □ → Fg2

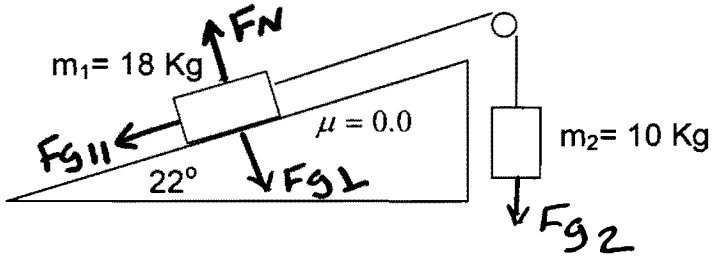
$-F_T + F_{g2} = ma$

$F_t + 176 = -18(2.1)$

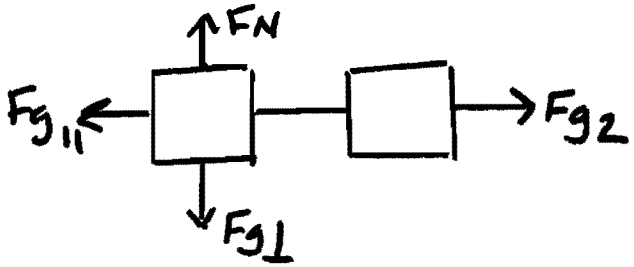
$F_t = 138\ N$

Two Body Problems - Box on Incline Plane with Hanging Mass

1. Two masses are connected as shown below.



Calculate the acceleration and force of tension of the system.



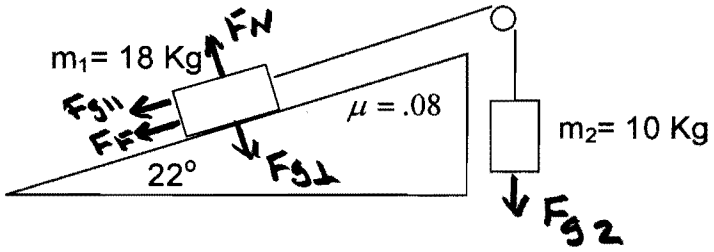
$F_{NET} = ma$

$F_{g2} - F_{g11} = (m_1 + m_2)a$

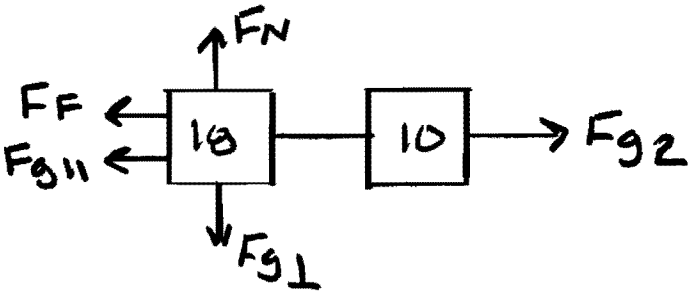
$98 - 66.1 = (18+10)a$

$a = \frac{31.9}{28} = \underline{1.14\ m/s^2}$

2. Two masses are connected as shown below.



Calculate the acceleration and force of tension of the system.



$F_{NET} = ma$

$F_{g2} - F_F - F_{g11} = (m_1 + m_2)a$

$98 - 13 - 66.1 = (18+10)a$

$a = \frac{18.9}{28} = \underline{0.66\ m/s^2}$