Name_____

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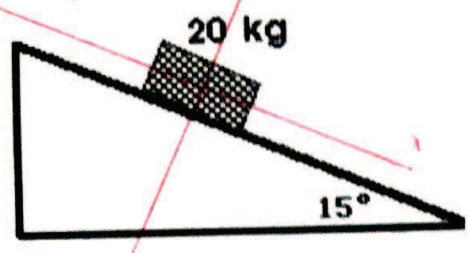
Worksheet 6

1. A 20 kg mass is allowed to accelerate down a *frictionless* 15° ramp.



$\Sigma F_x = ma$

$mg \sin\theta = ma$

a. Draw a force diagram for the block.

b. Determine the value of the x-component of the force of gravity.

$mg \sin\theta = (20\text{kg})(10\text{m/s}^2)(\sin 15) = \boxed{51.8\text{ N}}$

c. What is the acceleration of the block down the ramp?

$mg \sin\theta = ma$

$a = g \sin\theta = (10\text{m/s}^2)(\sin 15) = \boxed{2.6\text{m/s}^2}$

d. How long will it take for the block to slide 30.0m?

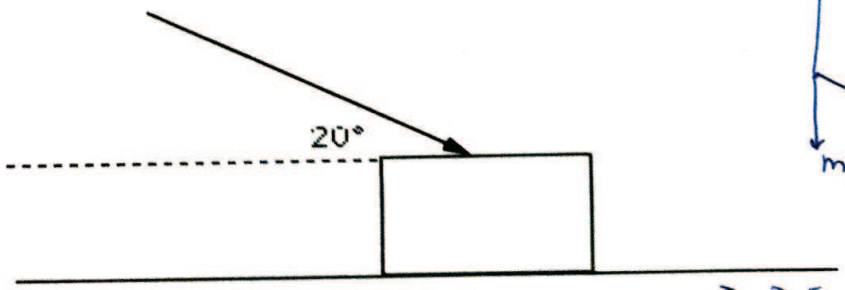
Assume block starts from rest

$\Delta x = v_i t + \frac{1}{2}at^2$

$\Delta x = \frac{1}{2}at^2$

$t = \sqrt{\frac{2\Delta x}{a}} = \sqrt{\frac{2(30\text{m})}{2.6\text{m/s}^2}} = \boxed{4.8\text{s}}$

2. An applied 25 N force pushes on a 5.0 kg block resting on a *frictionless* horizontal surface. The force is directed downwards at an angle of 20°.



a. Draw a force diagram for the block.

b. Determine the x-component of the applied force.

$F_x = F_{Push}(\cos\theta)$

$= 25\text{N}(\cos 20°) = \boxed{23.5\text{N}}$

c. What is the acceleration of the block?

$\Sigma F_x = ma$

$F_{x\,Push} = ma$

$a = \frac{F_{x\,Push}}{m} = \frac{23.5\text{N}}{5\text{kg}} = \boxed{4.7\text{m/s}^2}$

d. What is the normal force on the block?

$\Sigma F_y = 0$

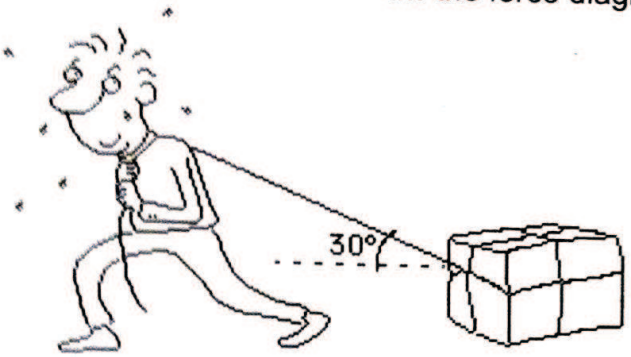
$N - F_{y\,Push} - mg = 0$

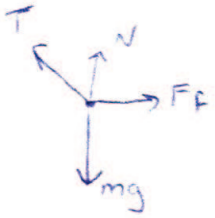
$N = F_{y\,Push} + mg$

$N = 8.55\text{N} + (5\text{kg})(10\text{m/s}^2)$

$= \boxed{58.55\text{ N}}$

3. A 70.0 kg box is pulled by a 400. N force at an angle of 30.° to the horizontal. The force of kinetic friction is 75.0 N. Draw the force diagram for the box.





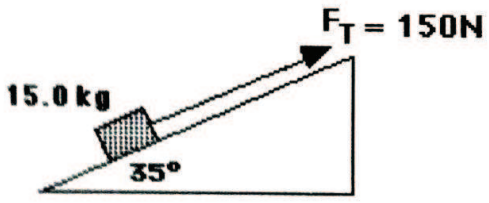
$\Sigma F_x = ma$

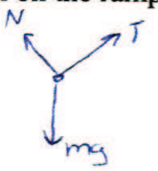
What is the acceleration of the box? $T\cos\theta - F_f = ma$

$a = \dfrac{T\cos\theta - F_f}{m} = \dfrac{400\,N(\cos 30) - 75\,N}{70\,kg}$

$= \boxed{3.9\ m/s^2}$

4. A block is being pulled up a ramp as shown in the diagram below. Assume that the ramp is *frictionless*. Draw the force diagram for the block on the ramp.





What is the x-component of the force of gravity acting on the block on the ramp?

$mg\sin\theta$

$= (15\,kg)(10\,m/s^2)\sin 35° = \boxed{86\ N}$

What is the acceleration of the block?

$\Sigma F_x = ma$

$T - F_{g(x)} = ma$

$a = \dfrac{T - F_{gx}}{m} = \dfrac{150N - 86N}{15\,kg} = \boxed{4.3\ m/s^2}$

5. Repeat problem 4, except now, assume that the frictional force acting on the block on the ramp is 25.0 N.

FBD

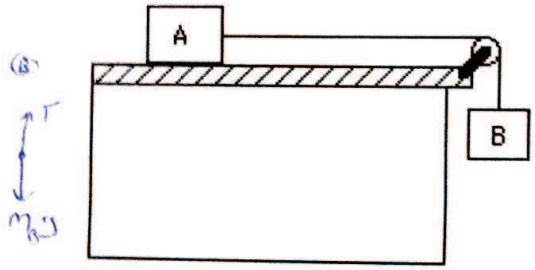
$\Sigma F_x = ma$

$T - F_f - F_{g(x)} = ma$

$a = \dfrac{T - F_f - F_{g(x)}}{m} = \dfrac{150N - 86N - 25N}{15\,kg} = \boxed{2.6\ m/s^2}$

2-body problems

6. 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.
   a) Clearly draw and label the force vectors acting on each object.
   b) Calculate the acceleration of the block and mass.
   c) Calculate the tension in the cord.



Equation for Block B

A (x-direction)

$\Sigma F = (m_A)a$

$T = m_A a$ — substitute

$\Sigma F_y = m_B a$

$m_B g - T = m_B a$

$m_B g - m_A a = m_B a$

$m_B g = m_A a + m_B a$

$a = \frac{m_B g}{m_A + m_B}$

$= \frac{100\,N}{30\,kg}$

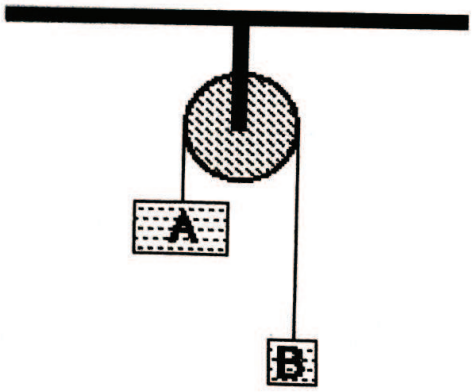
$= 3.3\,m/s^2$

7. Two lovers are parked 10.0 m from the edge of a cliff in a car whose mass, including that of the occupants is 1000. kg. A jealous suitor ties a rope to the car's bumper and a 50. kg rock to the other end of the rope. He then lowers the rock over the edge of the cliff, and the car, which is in neutral, accelerates toward the edge.

   a) Draw a force diagram; label the forces acting on the rock and car.
   b) What is the acceleration of the car towards the edge?
   c) How long do the lovers have to apply the brakes before they go over the edge?

8. Below is a picture of an Atwood's Machine: two masses attached to a frictionless, massless pulley (pretty neat how physicists dream up equipment like this, huh?).
   The mass of block A is 5.0 kg, and the mass of B is 2.0 kg.

   a) What is the acceleration of the system when the blocks are released?
   b) How long will it take for block A to fall 2.0 m?



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Course Title: **Period:**

Teacher Name: **Form #:**

Written Response to Exam Item #:

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6) c to find the tension, substitute the acceleration back into either equation

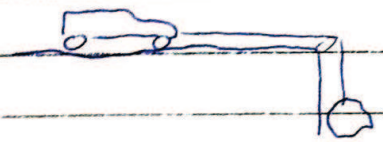
$\Sigma F_x = m_A a$

$T = m_A a$

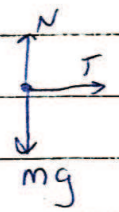
$= (20\text{kg})(3.3\text{m/s}^2)$

$= \boxed{66.7\text{ N}}$

(7)



for car



for rock

(a) $\Sigma F_x = m_{car} a$ $\quad$ $\Sigma F_y = m_{rock} a$

$T = m_{car} a$ $\xrightarrow{\text{substitute}}$ $m_{rock} g - T = m_{rock} a$

(b) $V_i = 0\text{m/s}^{\rightarrow}$

$a = .48\text{m/s}^{2\rightarrow}$

$\Delta x = 10\text{m}$

$t = ?$

$\Delta x = v_i t + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2\Delta x}{a}} = \sqrt{\frac{2(10\text{m})}{.48\text{m/s}^2}}$

$= \boxed{6.5\text{s}}$ => Plenty of time to apply brakes so noone gets hurt !!

$m_{rock} g - m_{car} a = m_{rock} a$

$m_{rock} g = (m_{car} + m_{rock}) a$

$a = \frac{m_{rock} g}{(m_{car} + m_{rock})} = \frac{(50\text{kg})(10\text{m/s}^2)}{(1000\text{kg} + 50\text{kg})}$

$= \boxed{.48\text{m/s}^{2\rightarrow}}$

MCPS Countywide Final Examination
Constructed Response Answer Sheet

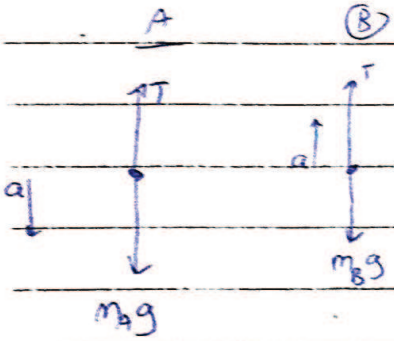
Student Name: **Date:**

Course Title: **Period:**

Teacher Name: **Form #:**

Written Response to Exam Item #: 8

(8) FBD



$\Sigma F_y = m_A a$

$m_A g - T = m_A a$

$\Sigma F_y = m_B a$

$T - m_B g = m_B a$

solve for T

$T = m_A g - m_A a$

Then sub into

$m_A g - m_A a - m_B g = m_B a$

solve for a

$m_A g - m_B g = m_A a + m_B a$

$g(m_A - m_B) = a(m_A + m_B)$

$a = \frac{g(m_A - m_B)}{(m_A + m_B)} = \frac{10\ m/s^2 (3\ kg)}{(7\ kg)} = 4.3\ m/s^2$

(b) $\Delta y = -2m$

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

$t = ?$

$V_i = 0\ m/s$

$\Delta y = v_i t + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2\Delta y}{a}} = \sqrt{\frac{2(-2m)}{-4.3\ m/s^2}} = .96s$