ver 1

PHY1331
II MIDTERM TEST
October 3

1BB303

FIRST NAME: _____
LAST NAME: _____ STUDENT NUMBER:_____

Closed-book Test. Duration: 95 minutes

PART 1 MULTIPLE CHOICE QUESTIONS: 48% of your test grade
ANSWER THESE QUESTIONS USING SCANTRON SHEET
All questions are of the same point value. Attempt all questions. ***Best 6 count toward the grade***

1. A jogger runs west for 5.0 minutes at a speed of 6 m/s and continues for another 10 minutes at a speed of 4 m/s. What is his displacement in m west after 15 minutes?
a. 4200 b. 4000 c. 3800 d. 4600 e. 4400
ANS: a

2. Two cars (A and B) are moving in the same direction in parallel lanes. Car A's initial speed is 10 m/s. After 20 s, its speed is 30 m/s. Car B's initial speed is 5 m/s. After 20 s its speed is 25 m/s. Their accelerations are constant. Which of the following is true?
a. Car A has higher acceleration.
b. Car B has higher acceleration.
c. They both have the same acceleration.
d. Car B has greater acceleration during the first 5 seconds.
e. Car A has greater acceleration during the first 5 seconds.
ANS: c

3. A passenger in a balloon-supported gondola releases a small ball while the gondola is rising at a speed of 2.0 m/s relative to the ground. A person who measures the ball's velocity at the instant of release will find that the ball's velocity relative to the ground at that instant is
a. 0 m/s. b. 2.0 m/s, down. c. 2.0 m/s, up.
d. 7.8 m/s, down. e. 9.8 m/s, down.
ANS: c

4. A wheel of 0.50 m radius rotates at 15 rev/s. What is the acceleration at its outer rim in m/s^2?
a. 2.2×10^3 b. 3.3×10^2 c. 4.4×10^3 d. 5.5×10^2 e. 6.6×10^3
ANS: c

5. Jenna throws a ball with a speed of 12 m/s at an angle of 36.9° to the ground. At the instant the ball is thrown her dog, standing beside her, heads for the ball. Ignore air resistance and any difference in height between the initial position of the ball and the dog's mouth. For the dog to catch the ball as it reaches her, the dog must run at a constant speed of
a. 6.0 m/s. b. 9.60m/s. c. 12 m/s. d. 12.0m/s. e. 24.0m/s.
ANS: b

6. Two persons pull on the ends of a spring scale. They each exert 300 N of force. What does the scale read in N?
a. 200 b. 300 c. 400 d. 600 e. 800
ANS: b

7. A 32 kg mass is subjected to a constant acceleration for 0.80 s while its speed changes from 3.0 m/s to 9.0 m/s. What is the force on the mass in N?
a. 96 b. 120 c. 160 d. 190 e. 240
ANS: e

Ver 2

PHY1331
II MIDTERM TEST
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All questions are of the same point value. Attempt all questions. ***Best 6 count toward the grade***

1. A jogger runs west for 5.0 minutes at a speed of 6 m/s and continues for another 10 minutes at a speed of 4 m/s. What is his displacement in m west after 15 minutes?
a. 3800 b. 4000 c. 4200 d. 4400 e. 4600
ANS: c

2. Two cars (A and B) are moving in the same direction in parallel lanes. Car A's initial speed is 10m/s. After 20 s, its speed is 30m/s Car B's initial speed is 5m/s. After 10 s its speed is 25m/s. Their accelerations are constant. Which car, if either, has the greater acceleration?
a. Car A has higher acceleration.
b. Car B has higher acceleration.
c. They both have the same acceleration.
d. Car B has greater acceleration due to its lower initial speed.
e. Car A has greater acceleration due to its higher initial speed.
ANS: b

3. A passenger in a balloon-supported gondola releases a small ball while the gondola is rising at a speed of 5.0 m/s relative to the ground. A person who measures the ball's acceleration at the instant of release will find that the ball's acceleration relative to the ground at that instant is
a. 0 m/s^2. b. 2.0 m/s^2, down. c. 2.0 m/s^2, up.
d. 7.8 m/s^2, down. e. 9.8 m/s^2, down.
ANS: e

4. A wheel of 0.50 m radius rotates at 10 rev/s. What is the acceleration at its outer rim in m/s^2?
a. 2.0×10^3 b. 3.3×10^2 c. 4.4×10^3 d. 5.5×10^2 e. 6.6×10^3
ANS: a

5. Jenna throws a ball with a speed of 12 m/s at an angle of 60.0° to the ground. At the instant the ball is thrown her dog, standing beside her, heads for the ball. Ignore air resistance and any difference in height between the initial position of the ball and the dog's mouth. For the dog to catch the ball as it reaches her, the dog must run at a constant speed of
a. 6.00m/s. b. 9.60m/s. c. 11.5m/s, d. 12.0m/s. e. 24.0m/s.
ANS: a

6 Two persons pull on the ends of a spring scale. They each exert 200 N of force. What does the scale read in N?
a. 800 b. 600 c. 400 d. 300 e. 200
ANS: e

7. A 32 kg mass is subjected to a constant acceleration for 0.40 s while its speed changes from 1.0 m/s to 9.0 m/s. What is the force on the mass in N?
a. 960 b. 640 c. 480 d. 320 e. 240
ANS: b

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1. A jogger runs west for 5.0 minutes at a speed of 6 m/s and continues for another 10 minutes at a speed of 4 m/s. What is his displacement in m west after 15 minutes?
a. 4600 b. 4200 c. 4000 d. 3800 e. 3600
ANS: b

2. Two cars (A and B) are moving in the same direction in parallel lanes. Car A's initial speed is 10 m/s. After 10 s, its speed is 30 m/s. Car B's initial speed is 5 m/s. After 20 s its speed is 25 m/s. Their accelerations are constant. Which of the following is true?

a. Car A has higher acceleration.
b. Car B has higher acceleration.
c. They both have the same acceleration.
d. Car B has greater acceleration since it has lower initial speed .
e. Car A has greater acceleration since it has higher initial speed.
ANS: a

3. While the gondola is rising at a speed of 2.0 m/s, a passenger in a balloon-supported gondola throws a small ball down at a speed of 5.0 m/s relative to his body . A person who measures the ball's velocity at the instant of release will find that the ball's velocity relative to the ground at that instant is
a. 2.0 m/s, up. b. 3.0 m/s, down. c. 3.0 m/s, up.
d. 5.0 m/s, down. e. 12.8 m/s, down.
ANS: b

4. A wheel of 1.0 m radius rotates at 15 rev/s. What is the acceleration at its outer rim in m/s^2?
a. 2.2×10^3 b. 3.3×10^2 c. 4.4×10^3 d. 5.5×10^2 e. 8.9×10^3
ANS: e

5. Jenna throws a ball with a speed of 12 m/s at an angle of 16.6° to the ground. At the instant the ball is thrown her dog, standing beside her, heads for the ball. Ignore air resistance and any difference in height between the initial position of the ball and the dog's mouth. For the dog to catch the ball as it reaches her, the dog must run at a constant speed of
a. 6.00m/s b. 9.60m/s. c. 11.5m/s d.12.0m/s. e. 24.0m/s.
ANS: a

6. Two persons pull on the ends of a spring scale. They each exert 400 N of force. What does the scale read in N?
a. 200 b. 300 c. 400 d. 600 e. 800
ANS: c

7. A 32 kg mass is subjected to a constant acceleration for 0.60 s while its speed changes from 3.0 m/s to 9.0 m/s. What is the force on the mass in N?
a. 960 b. 640 c. 480 d. 320 e. 240
ANS: d

PART II /52% OF THE TEST GRADE /

IN YOUR EXAM BOOKLETS PROVIDE DETAILED SOLUTIONS TO 4 OUT OF FOLLOWING 5 QUESTIONS. FOR FULL MARKS NEAT LARGE NEAT AND CLEAR DIAGRAMS WHERE APPROPRIATE ARE NEEDED. EACH QUESTION IS WORTH 13 %

1 A ball is thrown directly downward, with an initial speed of 8.00 m/s, from a height of 30.0 m.

a) After what time interval does the ball strike the ground? (7p)
b) What will be the speed with which it will hit the ground? (6p)

2 A catapult launches a rocket at an angle of 53.0° above the horizontal with an initial speed of 100 m/s. The rocket engine immediately starts a burn, and for 3.00 s the rocket moves along its initial line of motion with an acceleration of 30.0 m/s². Then its engine fails

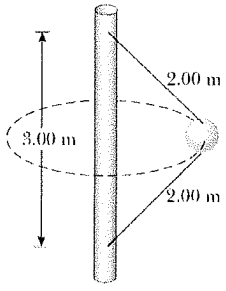
a) What is the acceleration experienced by the rocket after the failure of the engine ? (1p).
b) Draw a tentative diagram showing clearly the trajectory of the rocket. Do it as neatly as you can. Indicate changes of the type of motion that the rocket undergoes (if it does) as well the points at which it happens.(2p)
c) Find the maximum altitude reached by the rocket, (4p)
d) Find its total time of flight, and (3p)
e) Find the total horizontal distance traveled (3p)

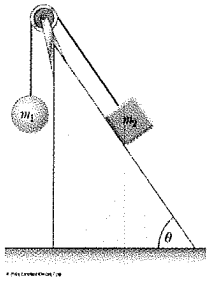
3. A ball swings in a vertical circle at the end of a rope 1.50 m long. When the ball is 36.9° past the lowest point on its way up, its total acceleration is $(-22.5\hat{\mathbf{i}} + 20.2\hat{\mathbf{j}})$ m/s². At that instant,

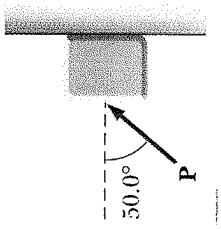
(a) sketch a vector diagram showing the components of its acceleration, (3p)
(b) determine the magnitude of its radial and tangential acceleration, (5p)
(c) determine the speed and the velocity of the ball. (3p and 2p)

4 The speed of a projectile when it reaches its maximum height is one half its speed when it is at half its maximum height. What is the initial projection angle of the projectile? (13p)

5 For each of the situation below draw free body diagrams and write down proper component equations for acting forces. Where appropriate assume friction exists (b and c are in equilibrium)
a) 3P b) 6P c) 4P







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1 A ball is thrown directly downward, with an initial speed of 9.00 m/s, from a height of 10.0 m.
a) After what time interval does the ball strike the ground? (7p)
b) What will be the speed with which it will hit the ground? (6p)

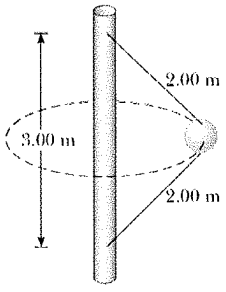
2 A catapult launches a rocket at an angle of 53.0° above the horizontal with an initial speed of 80 m/s. The rocket engine immediately starts a burn, and for 4.00 s the rocket moves along its initial line of motion with an acceleration of 20.0 m/s^2. Then its engine fails.

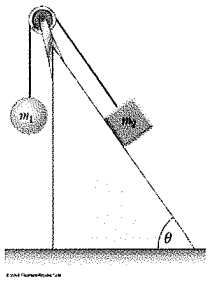
a) What is the acceleration experienced by the rocket after the failure of the engine ? (1p).
b) Draw a tentative diagram showing clearly the trajectory of the rocket. Do it as neatly as you can. Indicate changes of the type of motion that the rocket undergoes (if it does) as well the points at which it happens.(2p)
c) Find the maximum altitude reached by the rocket, (4p)
d) Find its total time of flight, and (3p)
e) Find the total horizontal distance traveled (3p)

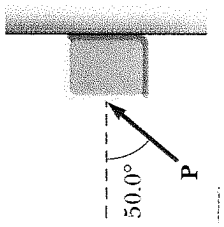
3. A ball swings in a vertical circle at the end of a rope 3.00 m long. When the ball is 16.6 ° past the lowest point on its way up, its total acceleration is $(-22.5\hat{\mathbf{i}} + 20.2\hat{\mathbf{j}})$ m/s^2. At that instant,
(a) sketch a vector diagram showing the components of its acceleration, (3p)
(b) determine the magnitude of its radial and tangential acceleration, (5p)
(c) determine the speed and the velocity of the ball. (3p and 2p)

4. The speed of a projectile when it reaches its maximum height is one half of its speed when it is at two thirds of its maximum height. What is the initial projection angle of the projectile? (13p)

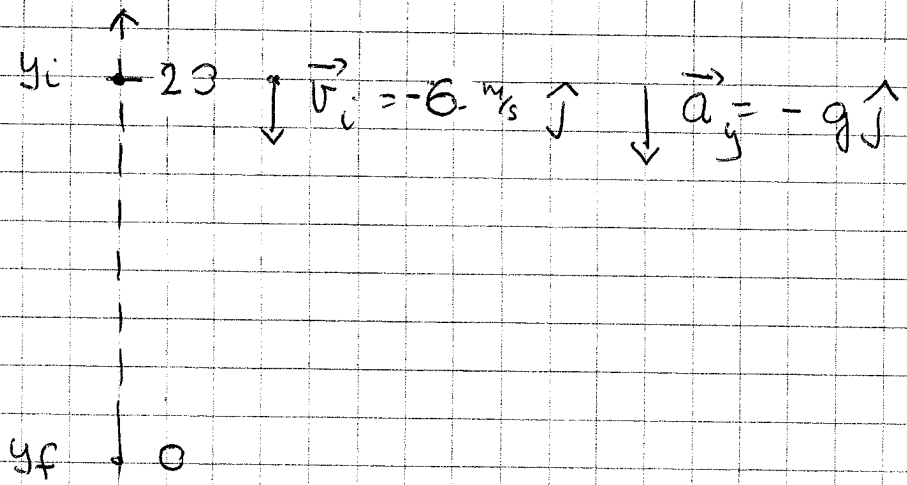
5. For each of the situation below draw free body diagrams and write down proper component equations for acting forces. Where appropriate assume friction exists (b and c are in equilibrium)
a) 3P b) 6P c) 4P







Problem #1



a) $y_f = y_i + v_i t + \frac{1}{2} a_y t^2$ ← It is free fall so the kinematic equations apply

$0 = 20 - 6t - 4.9t^2$

solving quadratic equation

$4.9t^2 + 6t - 20 = 0$

$b^2 - 4ac = 36 + 4 \cdot 4.9 \cdot 20 = 428$

$t_1 = \frac{-6 - \sqrt{356}}{9.8}$ $\quad t_2 = \frac{-6 + \sqrt{428}}{9.8}$

$t_1 < 0$ inadmissible

$t_2 = \frac{-6 + 20.68}{9.8} = 1.50\ s$

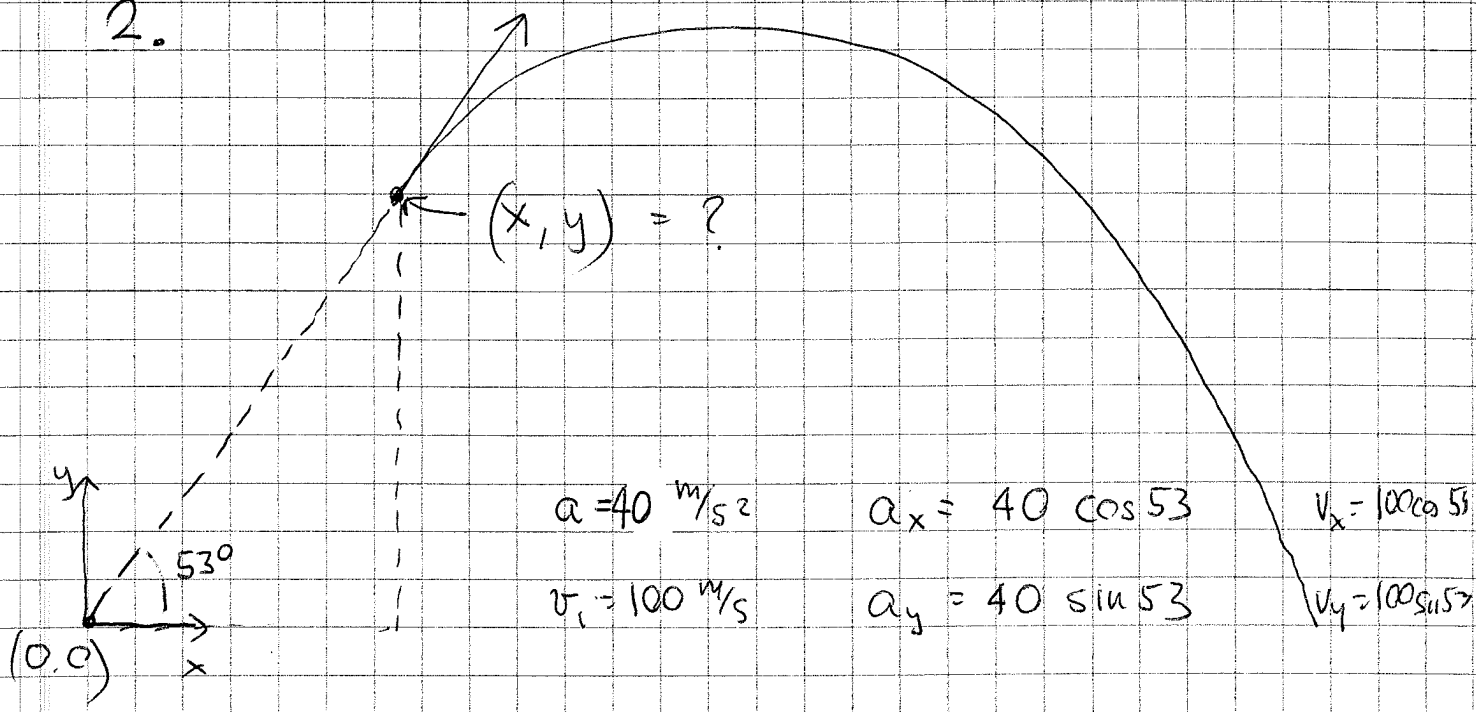
b) we may use $v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = 6^2 + 2(-9.8)(-20)$

$v_f^2 = 36 + 392 = 428$

$v_f = \sqrt{435.2} = 20.7\ m/s$

2.



There are two phases of this motion

I Phase : rocket moves along straight line in space with $a = 40\ m/s^2$ and $v_i = 100\ m/s$

II Phase : rocket moves as a projectile with previously acquired v

Phase I

$$x = 0 + v_x t + \frac{1}{2} a_x t^2 \qquad y = 0 + v_y t + \frac{1}{2} a_y t^2$$

$$x = (100 \cos 53)(2) + \frac{1}{2}(40 \cos 53)(2)^2 = 120 + 48 = 168\ m$$

$$y = (100 \sin 53)(2) + \frac{1}{2}(40 \sin 53)(2)^2 = 160 + 64 = 224\ m$$

$$v_x = v_{x_i} + a_x t = 100 \cos 53 + 40(\cos 53)(2) = 108$$

$$v_y = v_{y_i} + a_y t = 100 \sin 53 + 40(\sin 53)(2) = 144$$

Phase II

We use $x_i = 168\,m$ $y_i = 224\,m$ $v_{x_i} = 108$ $v_{y_i} = 144$ as our initial conditions for the projectile motion,

the maximum altitude is reached for $v_{y_f} = 0$

$$v_{y_f}^2 = v_{y_i}^2 - 2g(\Delta y)$$

$$0 = 144^2 - 19.6\,\Delta y$$

$$\underline{\Delta y = 1058}$$ Max altitude above the initial point

For the whole motion $H_{MAX} = y_i + \Delta y = 224 + 1058$

$$\underline{H_{MAX} = 1282\,m}$$

d) after initial 2 s the projectile travels for unknown time t

We can use the kinematic equation for y to find this time

$$y_f = y_i + v_{y_i} t + \tfrac{1}{2} a_y t^2$$

$$0 = 224 + 144t - 4.9t^2$$

$$b^2 - 4ac = 144^2 + (2)(4.9)224 = 27,931.2$$

$$\sqrt{b^2 - 4ac} = 151.4$$

$$t_1 = \frac{-144 - 151.4}{-9.8} = 30.15\,s$$

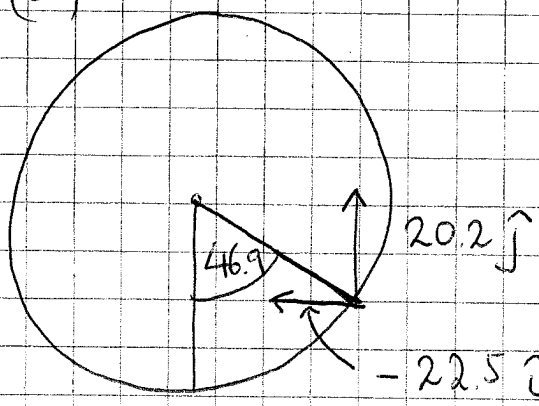
Ans d - total time : 32.15 s //

e) $x_f = x_i + v_{x_i} t$

$x_f = 168 + 108 \cdot 30.15s = 3,423.8 = 3424m$

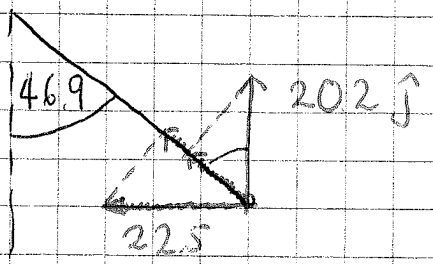
3(a)

$r = 3\ m$

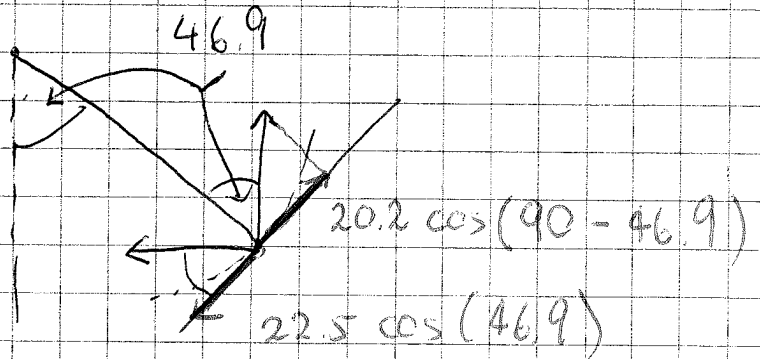


a) (3p)

b)



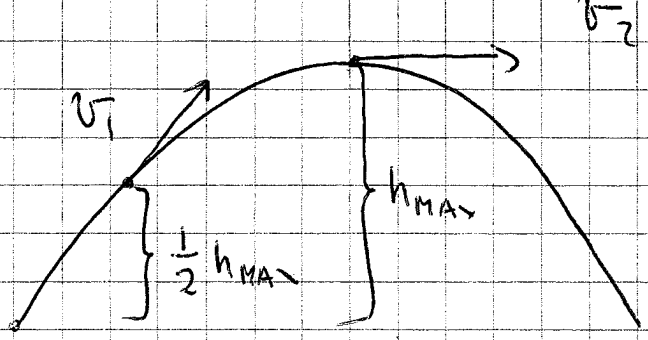
$$|a_r| = 20.2[\cos 46.9] + 22.5 \cos(90 - 46.9) = 30.23$$



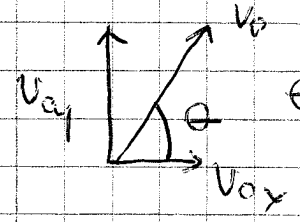
$$|a_t| = 20.2 \cos 43.1 - 22.5 \cos 46.9 = -0.62$$

$a_r = 30.23$ $\quad a_t = -0.62$

c) $\frac{v^2}{r} = a_r \Rightarrow v = \sqrt{a_r r} = 9.52$ tangent to the circle



$$\tan\theta = \frac{V_{oy}}{V_{ox}}$$



$\frac{1}{3}|\vec{v}_1| = |\vec{v}_2| = v_{ox}$ ← at the top $v_y = 0$

At the top

$$v_{2y}^2 = v_{oy}^2 - 2gh_{MAX}$$
$$0 = v_{oy}^2 - 2gh_{MAX}$$
$$v_{oy} = \sqrt{2gh_{MAX}}$$

At $\frac{1}{2} h_{MAX}$

$$v_{1y}^2 = v_{oy}^2 - 2g\left(\tfrac{1}{2} h_{MAX}\right)$$
$$v_{1y}^2 = 2gh_{MAX} - gh_{MAX} = gh_{MAX}$$

We are also told that $\frac{1}{3}\sqrt{v_{1x}^2 + v_{1y}^2} = v_{ox}$

$$\frac{1}{9}\left(v_{ox}^2 + v_{1y}^2\right) = v_{ox}^2$$
$$\frac{8}{9} v_{ox}^2 = v_{1y}^2$$
$$v_{ox}^2 = \tfrac{9}{8} v_{1y}^2 = \tfrac{9}{8} gh_{MAX}$$
$$v_{ox} = \sqrt{\tfrac{9}{8} h_{MAX} g}$$

to sum it up we have found that

$$v_{oy} = \sqrt{2gh_{MAX}}$$

$$v_{ox} = \sqrt{\frac{9}{8}gh_{MAX}}$$

$$\tan\theta = \frac{v_{oy}}{v_{ox}} = \frac{\sqrt{2}\sqrt{gh_{MAX}}}{\sqrt{\frac{9}{8}}\sqrt{gh_{MAX}}} = \sqrt{\frac{16}{9}} = \frac{4}{3}$$

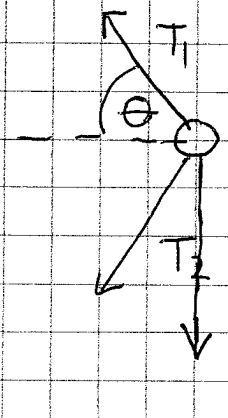
$$\tan\theta = \frac{4}{3}$$

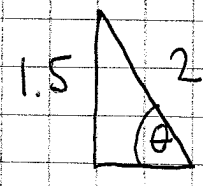
$$\theta = \tan^{-1}\frac{4}{3}$$

$$\underline{\theta = 53.13^\circ}$$

5

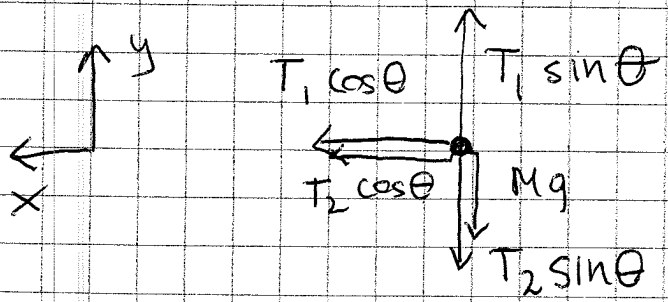
a)





$$\sin\theta = \frac{1.5}{2}$$

$$\theta = 48.6$$



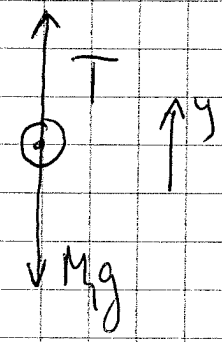
$$\sum F_y = 0$$

$$T_1\sin\theta - T_2\sin\theta - Mg = 0$$

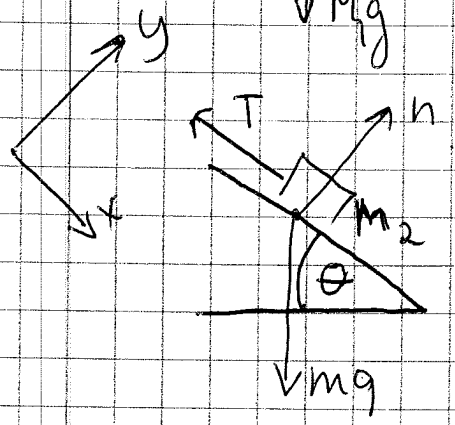
$$\sum F_x = M a_c = M\frac{v^2}{r}$$

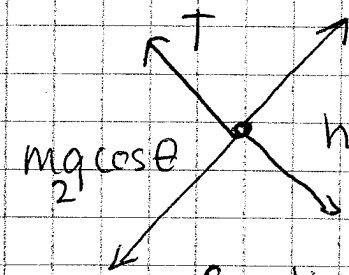
$$T_1\cos\theta + T_2\cos\theta = M\frac{v^2}{r}$$

b)



$$T - Mg = 0$$



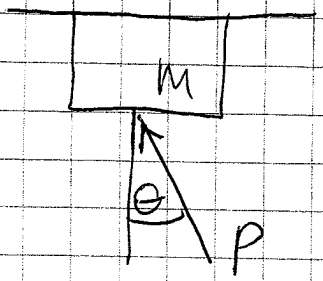


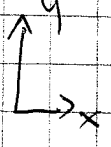
friction can be either way!

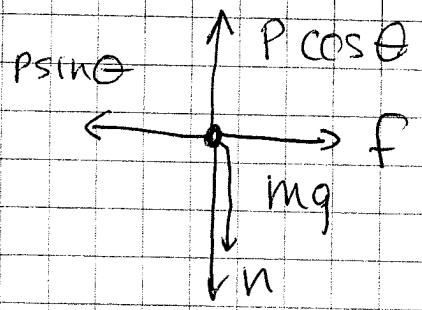
equilibrium

$$\begin{cases} \sum F_y = 0 \rightarrow n - m_2 g\cos\theta = 0 \\ \sum F_x = 0 \rightarrow m_2 g\sin\theta - T \pm f_{frict} = 0 \end{cases}$$

5c)







Equilibrium so

$\sum F_x = 0$ $\sum F_y = 0$

$f_{fnct} - P\sin\theta = 0$ $P\cos\theta - mg - n = 0$