*PHY1321*
*I MIDTERM TEST*
October 4

1BB303

ver C

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

Closed-book Test. Duration: 90 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 person walks north for 20 minutes at a speed of 1.2 m/s. She then has lunch, while resting for 10 minutes. She continues to walk north for another 30 minutes at 1.2 m/s. What is her average speed in m/s during this hour?
a. 1.4 b. 1.0 c. 0.5 d. 0.7 e. 1.5
ANS: b

2. Two balls are thrown from a height of 10 m. Ball one is thrown upward with a speed of 1m/s. Ball two is thrown downward with a speed of 1m/s. What is the ratio of the speed of ball one with the speed of ball two when each hits the ground?
a. 1:20 b. 20:1 c. 2:1 d. 1:1 e. 1:4
ANS: d

3. A race car moving with a constant speed of 40 m/s completes one lap around a circular track in 50 s.

What is the magnitude of the acceleration of the race car?

a. 8.8 $m/s^2$ b. 7.5 $m/s^2$ c. 9.4 $m/s^2$ d. 6.3 $m/s^2$ e. 5.0 $m/s^2$
ANS: e)

4. A particle moving in a circle is subjected to a total acceleration that has a magnitude of 9.1$m/s^2$. If its radial acceleration has a magnitude of 3.3 $m/s^2$, what is the magnitude of its tangential acceleration in $m/s^2$?
a. 8.8 b. 8.5 c. 7.7 d. 7.5 e. 7.3
ANS: b

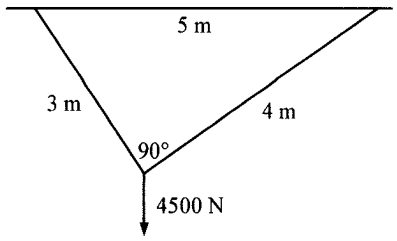
5 Pitching machines throw three balls into the air from ground level at the same time. Ball A is thrown at a speed of 50 m/s at an angle of 45.0° to the ground. Ball B is thrown at a speed of 60m/s at an angle of 60° to the ground. Ball C is thrown at a speed of 40m/s at an angle of 90° to the ground. In what order do the balls return to the ground?
a. A, B, C b. C, B, A c. C, A, B d. A, C, B e. They all return to the ground at the same time.

6. Two forces, $F_1$ and $F_2$ act in opposite directions on a 10 kg mass. If $F_1 = 20$ N and $F_2 = 40$ N, what is the acceleration of the mass in $m/s^2$?
a. 1 b. 2 c. 3 d. 4 e. 5
ANS: b

7 . A cable system hanging from a beam is configured as shown in the diagram below. A 4500 N weight hangs from the cables. What is the tension in the 3 m cable in N?

a. 2100
b. 2500
c. 2700
d. 3600
e. 4200

ANS: d



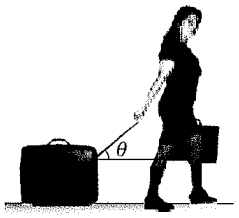
**PART 2** **52%** of your test grade
ANSWER FOUR OUT OF THE FOLLOWING FIVE QUESTIONS
PRESENT YOUR FULL SOLUTIONS IN THE EXAM INATION BOOKLETS
INDICSATE CLEARLY WHICH QUESTIONS SHOULD BE MARKED
*All questions are of the same point value.*

1. A steel ball of mass m=1kg is thrown vertically up from point(0m,0m) with the initial speed of 6m/s. At the same moment the vase of mass 3kg fells off the window that is at point (0m,20m).
Draw a diagram of this situation
A) Find the time at which these two object collide (7p)
B) Find the exact position of the collision. (6p)

2. A projectile is launched from a origin (0cm, 0cm) on the tilted plane (as in the class demonstration). The plane makes 30 degrees with horizontal. The launcher sends the ball with a speed of 20cm/s.
a) At what angle should the projectile be launched to hit target at (70cm, 60cm) location? (8p)
b) How long will it take for the projectile to reach the target. (7p)
(Assume that there are no resistive forces to the projectile motion in this plane)

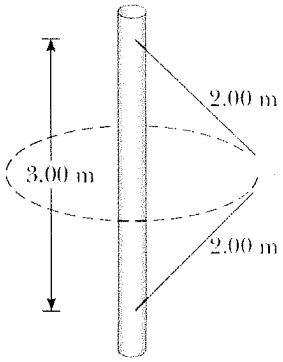
3. A train slows down as it rounds a sharp horizontal turn, slowing from 40.0 m/s to 20.0 m/s in the 20.0 s that it takes to round the bend. The radius of the curve is 200 m. Compute the magnitude of the total acceleration and its orientation with respect to the radius, at the moment the train speed reaches 30.0 m/s Assume that it slows down at constant rate.

4. A woman at an airport is towing her 20.0-kg suitcase at constant speed by pulling on a strap at an angle $\theta$ above the horizontal (Fig. P5.8). She pulls on the strap with a 35.0-N force, and the friction force on the suitcase is 20.0 N.




a) Draw a free-body diagram of the suitcase. (3p)
b) Write the proper Newton's Laws describing this situation(4p)
c) What angle does the strap make with the horizontal? (2p)
d) What normal force does the ground exert on the suitcase?(2P)
e) What is the kinetic friction coefficient(2p)

5. A 4.00-kg object is attached to a vertical rod by two strings as shown. The object rotates in a horizontal circle at constant speed 6.00 m/s.




a) Find the tension in the upper string(4p)
b) The lower string. (3p)

The system is then rotated by 90 deg so that the rod is horizontal and the object makes a vertical circle
c) Find the tension in each of the strings when the object is in the top position.(3p)
d) Find the tension in the strings when the object is in the bottom position. (3p)

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ver b

Closed-book Test. Duration: 90
**PART 1** MULTIPLE CHOICE QUESTIONS: 48% of your test grade
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1. A person walks north for 20 minutes at a speed of 1.2 m/s. She then has lunch, while resting for 10 minutes. She walks south for another 30 minutes at 1.2 m/s. What is her average speed in m/s during this hour?
a. 1.5 b. 1.4 c. 1.0 d. 0.7 e. 0.5
ANS: c)

2. Two balls are thrown from a height of 10 m. Ball one is thrown upward with a speed of 1m/s. Ball two is thrown downward with a speed of 1m/s. What is the ratio of the speed of ball one with the speed of ball two when each hits the ground?
a. 1:20 b. 1:2 c. 1:1 d. 2:1 e. 4:1
ANS: c)

3. A race car moving with a constant speed of 40 m/s completes one lap around a circular track in 50 s.

What is the magnitude of the acceleration of the race car?

a. . 5.0 $m/s^2$ b. 6.3 $m/s^2$ c. 7.5 $m/s^2$ d. 8.8 $m/s^2$ e. 9.4 $m/s^2$
ANS: a)

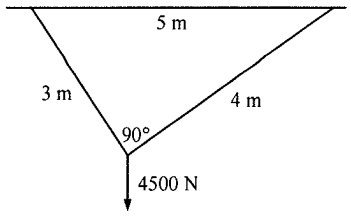
4. A particle moving in a circle is subjected to a total acceleration that has a magnitude of 8.2 $m/s^2$. If its radial acceleration has a magnitude of 3.3 $m/s^2$, what is the magnitude of its tangential acceleration in $m/s^2$?
a. 8.8 b. 8.5 c. 7.7 d. 7.6 e. 7.5
ANS: e

5. Pitching machines throw three balls into the air from ground level at the same time. Ball A is thrown at a speed of 50 m/s at an angle of 36.9° to the ground. Ball B is thrown at a speed of 37.5 m/s at an angle of 53.1° to the ground. Ball C is thrown at a speed of 30 m/s at an angle of 90° to the ground. In what order do the balls return to the ground?
a. They all return to the ground at the same time
b. A, B, C c. C, B, A d. C, A, B e. A, C, B
ANS:a

6 Two forces, $F_1$ and $F_2$ act on a 20 kg mass. If $F_1 = 20$ N and $F_2 = 40$ N and they act in the same direction, what is the acceleration of the mass in $m/s^2$?
a. 3 b. 4 c. 5 d. 6 e. 7
ANS: a

7. A cable system hanging from a beam is configured as shown in the diagram below. A 4500 N weight hangs from the cables. What is the tension in the 4 m cable in N?

a. 2100
b. 2500
c. 2700
d. 3600
e. 4200
ANS c



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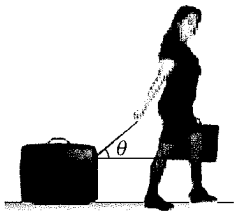
1. A steel ball of mass m =1kg is thrown vertically up from point(0m,0m) with the initial speed of 5m/s. At the same moment the vase of mass 3kg fells off the window that is at point (0m,20m).
Draw a diagram of this situation
A) Find the time at which these two object collide (7p)
B) Find the exact position of the collision. (6p)

2. A projectile is launched from a origin (0cm,0cm) on the tilted plane ( as in the class demonstration). The plane makes 30 degrees with horizontal. The launcher sends the ball with a speed of 20cm/s.
a) At what angle should the projectile be launched to hit target at (70cm, 60cm) location? (8p)
b) How long will it take for the projectile to reach the target. (7p)
(Assume that there are no resistive forces to the projectile motion in this plane)

3. A train slows down as it rounds a sharp horizontal turn, slowing from 40.0 m/s to 20.0 m/s in the 15.0 s that it takes to round the bend. The radius of the curve is 150 m. Compute the magnitude of the total acceleration and its orientation with respect to the radius, at the moment the train speed reaches 30.0 m/s Assume that it slows down at constant rate.

4. A woman at an airport is towing her 20.0-kg suitcase at constant speed by pulling on a strap at an angle $\theta$ above the horizontal (Fig. P5.8). She pulls on the strap with a 35.0-N force, and the friction force on the suitcase is 10.0 N.




a) Draw a free-body diagram of the suitcase. (3p)
b) Write the proper Newton's Laws describing this situation(4p)
c) What angle does the strap make with the horizontal? (2p)
d) What normal force does the ground exert on the suitcase?(2P)
e) What is the kinetic friction coefficient(2p)

5. A 4.00-kg object is attached to a vertical rod by two strings as shown. The object rotates in a horizontal circle at constant speed 4.00 m/s.
a) Find the tension in the upper string(4p)
b) The lower string. (3p)

The system is then rotated by 90 deg so that the rod is horizontal and the object makes a vertical circle
c) Find the tension in each of the strings when the object is in the top position.(3p)
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a. 1.5 b. 1.4 c. 1.0 d. 0.7 e. 0.5
ANS: c

2. Two balls are thrown from a height of 20 m. Ball one is thrown upward with a speed of 2 m/s. Ball two is thrown downward with a speed of 2 m/s. What is the ratio of the speed of ball one with the speed of ball two when each hits the ground?
a. 1:2 b. 1:1 c. 2:1 d. 20:1 e. 1:20
ANS: b

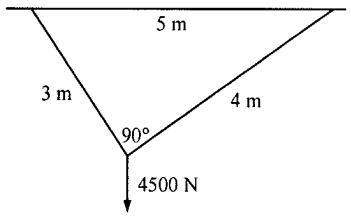
3. A race car moving with a constant speed of 60 m/s completes one lap around a circular track in 50 s.
What is the magnitude of the acceleration of the race car?
a. 8.8 $m/s^2$ b. 7.5 $m/s^2$ c. 9.4 $m/s^2$ d. 6.3 $m/s^2$ e. 5.0 $m/s^2$
ANS: b)

4. A particle moving in a circle is subjected to a total acceleration that has a magnitude of 8.2 $m/s^2$. If its radial acceleration has a magnitude of 3.3 $m/s^2$, what is the magnitude of its tangential acceleration in $m/s^2$?
a. 8.8 b. 8.5 c. 7.7 d. 7.5 e. 7.3
ANS: d

5. Pitching machines throw three balls into the air from ground level at the same time. Ball A is thrown at a speed of 50 m/s at an angle of 36.9° to the ground. Ball B is thrown at a speed of 37.5 m/s at an angle of 53.1° to the ground. Ball C is thrown at a speed of 30 m/s at an angle of 90° to the ground. In what order do the balls return to the ground?
a. A, B, C b. C, B, A c. C, A, B d. A, C, B
e. They all return to the ground at the same time.
ANS:e

6. Two forces, $F_1$ and $F_2$ act on a 10 kg mass. If $F_1 = 20$ N and $F_2 = 40$ N and they act in the same direction, what is the acceleration of the mass in $m/s^2$?
a. 3 b. 4 c. 5 d. 6 e. 7
ANS: d

7. A cable system hanging from a beam is configured as shown in the diagram below. A 4500 N weight hangs from the cables. What is the tension in the 4 m cable in N?
a. 2500
b. 2700
c. 3600
d. 3800
e. 4200
ANS: b



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1. A steel ball of mass m =3kg is thrown vertically up from point(0m,0m) with the initial speed of 4m/s. At the same moment the vase of mass 1kg fells off the window that is at point (0m,20m).
Draw a diagram of this situation
A) Find the time at which these two object collide (7p)
B) Find the exact position of the collision. (6p)

2. A projectile is launched from a origin (0cm,0cm) on the tilted plane ( as in the class demonstration). The plane makes 40 degrees with horizontal. The launcher sends the ball with a speed of 20cm/s.
a) At what angle should the projectile be launched to hit target at (60cm, 50cm) location? (8p)
b) How long will it take for the projectile to reach the target. (7p)
(Assume that there are no resistive forces to the projectile motion in this plane)

3. A train slows down as it rounds a sharp horizontal turn, slowing from 50.0 m/s to 25.0 m/s in the 20.0 s that it takes to round the bend. The radius of the curve is 250 m. Compute the magnitude of the total acceleration and its orientation with respect to the radius, at the moment the train speed reaches o30.0 m/s Assume that it slows down at constant rate.

4. A woman at an airport is towing her 30.0-kg suitcase at constant speed by pulling on a strap at an angle $\theta$ above the horizontal (Fig. P5.8). She pulls on the strap with a 35.0-N force, and the friction force on the suitcase is 10.0 N.


a) Draw a free-body diagram of the suitcase. (3p)
b) Write the proper Newton's Laws describing this situation(4p)
c) What angle does the strap make with the horizontal? (2p)
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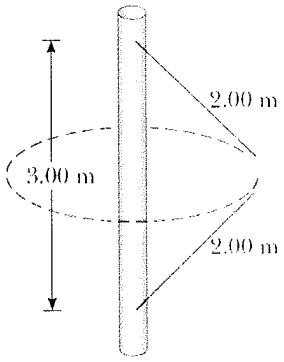
e) What is the kinetic friction coefficient(2p)

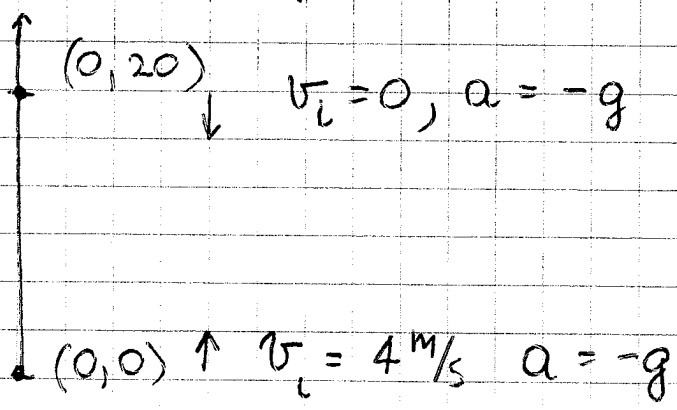
5. A 3.00-kg object is attached to a vertical rod by two strings as shown. The object rotates in a horizontal circle at constant speed 5.00 m/s.




a) Find the tension in the upper string(4p)
b) The lower string. (3p)
The system is then rotated by 90 deg so that the rod is horizontal and the object makes a vertical circle

c) Find the tension in each of the strings when the object is in the top position.(3p)
d) Find the tension in the strings when the object is in the bottom position. (3p)

Answer to problem #1




masses are irrelevant in this problem.

Position of the vase is given by

$$y_1 = y_i + v_i t - \frac{1}{2} g t^2$$

$$\underline{y_1 = 20 - \frac{1}{2} g t^2}$$

Position of the ball is given by

$$y_2 = y_i + v_i t - \frac{1}{2} g t^2$$

$$y_2 = 4t - \frac{1}{2} g t^2$$

During the collision $y_1 = y_2$

$$20 - \frac{1}{2} g t^2 = 4t - \frac{1}{2} g t^2$$

$$20 = 4t$$

$$\underline{t = 5\ s} \quad \rightarrow y = -102.5\ m$$

However... (If we presume that the (0,0) is on the ground) the free falling vase will be in the air only for

$$0 = 20 - \frac{1}{2} g t_v^2 \quad \rightarrow \quad t_v = \sqrt{\frac{40}{9.8}} = 2.02\ s$$

while the ball maximum height will be $h_{MAX} = 0.84\ m$

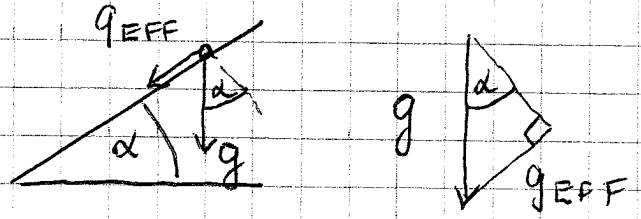
$$t_b = 0.888 \approx 0.889\ s$$

this leads to the following conclussion objects collide on the ground (0,0) after 2.02s)

Note: ball moves up and down and is back at (0,0) after 0.889s while the vase is still moving down.
After 2.02s vase hits the ground thus colliding with the ball.

Problem #2

Tilted plane results in having effective $g_{EFF}$ acting on the projectile:




$$\boxed{g_{EFF} = (\sin\alpha)\, g}$$

$\alpha = 40^\circ \rightarrow g_{EFF} = \sin 40\, g = 6.3\ m/s^2 = 630\ cm/s^2$

to make solution applicable to all three versions

I'll keep $g_{EFF} = g\sin\alpha$

$$\left.\begin{aligned} x &= x_i + v_{0x}\, t \\ y &= y_i + v_{0y}\, t - \tfrac{1}{2} g_{EFF}\, t^2 \end{aligned}\right\} \text{ projectile motion equations}$$

In our case $x_i = 0$; $y_i = 0$ $\quad v_{0x} = v_0 \cos\theta$

$v_0 = 20$ $\quad v_{0y} = v_0 \sin\theta$

Projectile hits the point $(x, y) \equiv (60, 50)$

$$60 = 0 + v_{0x} t = (v_0 \cos\theta)\, t$$

$$50 = 0 + v_{0y} t - \tfrac{1}{2} g_{EFF}\, t = (v_0 \sin\theta)\, t - \tfrac{1}{2} g \sin\alpha\, t^2$$

$$t = \frac{60}{v_0 \cos\theta} = \frac{60}{20\cos\theta}$$

$$50 = 20\sin\theta \frac{60}{20\cos\theta} - \tfrac{1}{2}(630)\left(\frac{60}{20\cos\theta}\right)^2$$

$$50 = 60\tan\theta - 2835\frac{1}{\cos^2\theta} = 60\tan\theta - 2835(\tan^2\theta + 1)$$

$$2835 \tan^2\theta - 60 \tan\theta + 2885$$

$$b^2 - 4ac < 0$$

no solutions

ANSW. There is no angle $\theta$ for which this target may be reached.

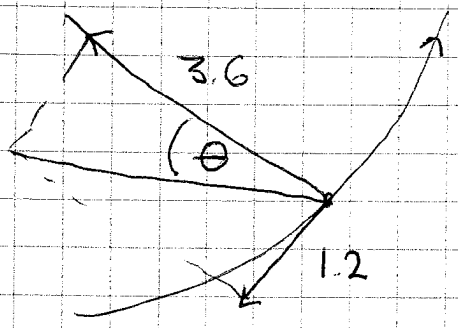
Problem # 3

A train slows down at constant rate $a_t = \text{const}$

$$a_t = \frac{v_f - v_i}{\Delta t} = \frac{25\ m/s - 50\ m/s}{20 s} = -\frac{25}{20}\ m/s^2$$

$$a_t = -1.2\ m/s^2$$

When $v = 30\ m/s$ $\quad a_r = \frac{v^2}{r} = \frac{900}{250} = 3.6\ m/s^2$



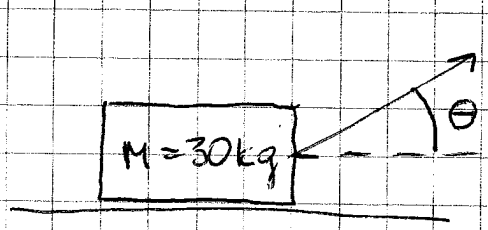

$$\tan\theta = \frac{1.2}{3.6} = \frac{1}{3}$$

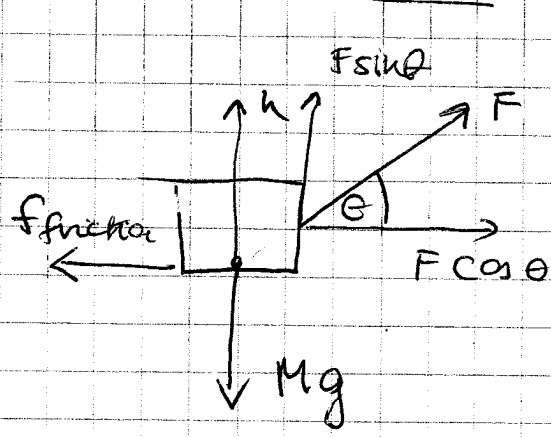
$$\theta = 18.43°$$

$$a = \sqrt{a_r^2 + a_t^2} = \sqrt{1.2^2 + 3.6^2} = 3.8\ m/s^2$$

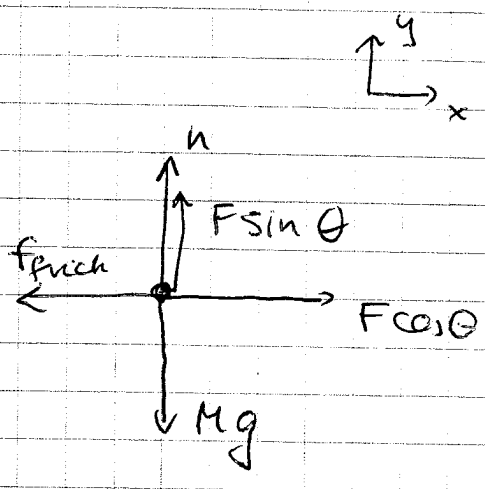
ANS Magnitude of acceleration is $3.8\ m/s^2$ at $18.43°$ w. respect to radius.

4




or




constant speed → $a = 0$ → equilibrium

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

b) $F\cos\theta - f_{friction} = 0 \qquad n + F\sin\theta - Mg = 0$

c) $F\cos\theta = f_{friction}$

$35\cos\theta = 10$

$\cos\theta = \frac{2}{7}$

$\theta = 73.4^\circ$

d) $n = Mg - F\sin\theta$

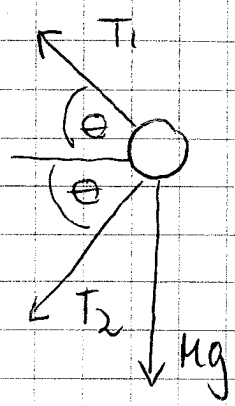
$n = 30 \cdot 9.8 - 35\sin 73.4 = 260.5 = 261\,N$

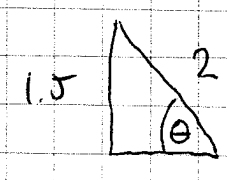
e) $f_{friction} = \mu n$

$10\,N = \mu\, 261 \rightarrow \mu = \frac{10}{261} = 0.038$

# Problem #5

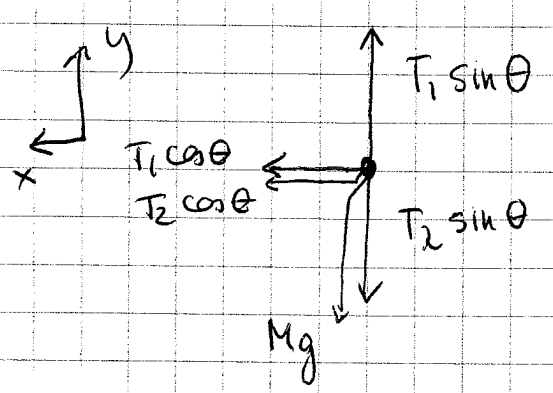
FBD




$\sin\theta = \frac{1.5}{2} = \frac{3}{4}$

$\cos\theta = 0.66 \approx \frac{2}{3}$




$$\sum F_x = ma_c = m\frac{v^2}{r}$$

$$\sum F_y = 0$$

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

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

$r = \sqrt{2^2 - 1.5^2} = 1.32$

$r = 1.32$

$$(T_1 + T_2)\cos\theta = 3 \cdot \frac{25}{1.32} = 56.8$$

$$T_1 + T_2 = 86\ N$$

$$T_2 = 86 - T_1$$

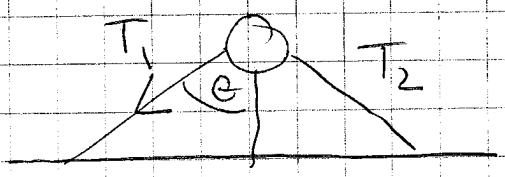
$$0.75T_1 - 0.66(86 - T_1) - 29.4 = 0$$

$$0.75T_1 + 0.66T_1 = 29.4 + 0.66 \cdot 86$$

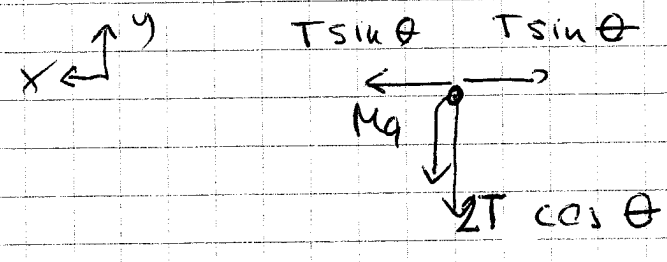
$$1.41T_1 = 86.16$$

$$T_1 = 61.1 \qquad T_2 = 24.9$$

c




$T_1 = T_2 = T$




$T\sin\theta - T\sin\theta = 0$

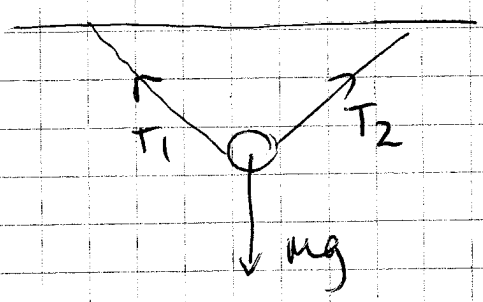
$Mg + 2T\cos\theta = M\frac{v^2}{r}$

$29.4 + 2T \times 0.66 = 56.8$

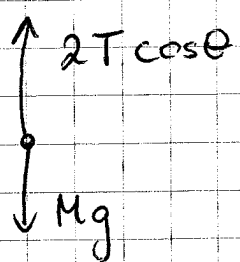
$1.32\ T = 27.4$

$T = 20.8$

d)




$T_1 = T_2 = T$




$2T\cos\theta - Mg = M\frac{v^2}{r}$

$2T \cdot 0.66 - 29.4 = 56.8$

$1.32\ T = 86.2$

$T = 65.3$