21W-PHYSICS5A-1 Huang-Phys5A-W21-Final-Exam

CHRISTINA KILKEARY

TOTAL POINTS

94 / 100

QUESTION 1

1 Problem 1 **10 / 10**

✓ **+ 10 pts All correct**

- **+ 5 pts** A) Correct
- **+ 3 pts** A) $$m_2$$ FBD Correct
- **+ 2 pts** A) m2 FBD missing force or extra force
- **+ 1 pts** A) FBD 2, 2 incorrect or missing forces
- **+ 2 pts** A) m1 FBD Correct
- **+ 1 pts** A) m1 FBD 1 extra or missing force
- **+ 5 pts** B) Correct
- **+ 1 pts** B) F = ma
- **+ 1 pts** B) M1 Newton Equation correct
- **+ 1 pts** B) M2 Newton Equation correct
- **+ 1 pts** B) Friction Equation correct with correct normal force
- **+ 1 pts** B) Final Answer Correct
- **+ 4 pts** B) Correct but m1 and m2 flipped

QUESTION 2

2 Problem 2 **10 / 10**

✓ **+ 10 pts Correct**

- **+ 1 pts** Free-body (A)
- **+ 1 pts** Free-body (B)
- **+ 1 pts** Free-body (C)
- **+ 1 pts** $$a_A = -9.8m/s^2$$
- **+ 3 pts** $$a_B = \pm12.9m/s^2$$
- **+ 3 pts** $$a_C = \pm6.68m/s^2$$
- **+ 0 pts** Incorrect

QUESTION 3

3 Problem 3 **10 / 10**

✓ **+ 10 pts All Correct**

- **+ 2 pts** A) Correct 37.7 = $$12 \pi$$
- **+ 2 pts** B) Correct -12.6 = $$ 4 \pi$$
- **+ 3 pts** C) All Correct 1.58
- **+ 1 pts** C) $$ \tau = I \alpha$$
- **+ 1 pts** C) $$\tau = rF$$
- **+ 3 pts** D) All Correct 22.2
- **+ 1 pts** D) $$W = E_i - E_f$$
- **+ 1 pts** D) $$E_i = 1/2 (1/2 m R^2) \omega^2$$
- **+ 1 pts** D) $$E_f=0$$
- **+ 1 pts** D) $$W = Fd cos(\theta)$$
- **+ 1 pts** D) $$\theta = 1/2 \alpha t^2 + \omega_0 t = 56.4 = (\omega^2 - \omega_0^2)/(2 \alpha)$$
- **+ 1 pts** D) $$ s = r \theta$$
- **+ 0 pts** Incorrect or empty

QUESTION 4

4 Problem 4 **9 / 10**

- **+ 10 pts** All Correct
- **+ 4 pts** A) Correct

✓ **+ 3 pts A) One incorrect or extra force**

- **+ 2 pts** A) Two incorrect or extra forces
- **+ 1 pts** A) Three incorrect or extra forces

✓ **+ 4 pts B) Correct 10584**

- **+ 1 pts** B) $$ \tau = rF Sin(\theta)$$
- **+ 2 pts** B) One incorrect or extra torque
- **+ 1 pts** B) Two incorrect or extra torque

✓ **+ 1 pts C) $$F_x = 9166$$**

✓ **+ 1 pts C) $$F_y = 5096$$**

- **+ 0 pts** Incorrect or Blank

math mistake but correct work

QUESTION 5

5 Problem 5 **14 / 15**

- **+ 15 pts** All Correct: 4.43, 1.1, 4.9

✓ **+ 5 pts A) Correct 4.43**

- **+ 1 pts** A) $$E_i = E_f$$
- **+ 1 pts** A) $$E_i = m_1 g h$$
- **+ 1 pts** A) $$E_f = 1/2 m_1 v^2 + 1/2 I \omega^2$$

+ **1 pts** A) Correctly substitute $$I$$ and $$\omega$$

+ **3 pts** A) $$v_f^2 = v_0^2 + 2a(s-s_0)$$

✓ + **5 pts** **B) Correct 1.1**

+ **2 pts** B) $$ L = I \omega$$

+ **2 pts** B) $$L = 1/2 m_2 R^2 (v/R)$$

+ **1 pts** B) $$\omega = \alpha t$$

+ **1 pts** B) Final answer correct in terms of answer from A 1.1

+ **5 pts** C) Correct 4.9

+ **2 pts** C) $$v^2 - v_0^2 = 2 a (s - s_0)$$

+ **1 pts** C) Correctly plug in $$v^2 = gh$$

+ **1 pts** C) Correctly plug in $$\Delta s = h$$

+ **1 pts** C) Final answer correct in terms of velocity, 4.9

✓ + **1 pts** **C) $$F = ma$$**

✓ + **1 pts** **C) $$\tau = I \alpha$$**

✓ + **1 pts** **C) Correctly plug in both torque and force equations**

✓ + **1 pts** **C) Correctly convert a to $$\alpha$$ or $$\alpha$$ to a**

+ **0 pts** Incorrect or Empty

QUESTION 6

6 Problem 6 15 / 15

✓ + **15 pts** **All Correct: 1.73, 289.5, 249.9**

+ **5 pts** A) Correct 1.73

+ **2 pts** A) $$E_i = E_f$$

+ **1 pts** A) $$E_i = 1/2 (m_1 + m_2) v^2$$

+ **1 pts** A) $$E_f = 1/2 k \Delta x^2$$

+ **5 pts** B) Correct 289.5

+ **2 pts** B) $$P_i = P_f$$

+ **1 pts** B) $$P_i = m_1 v_0$$

+ **1 pts** B) $$P_f = (m_1 + m_2) v$$

+ **5 pts** C) Correct 249.9

+ **2 pts** C) $$E_i + W = E_f$$

+ **1 pts** C) $$E_i = 1/2 m_1 v_0^2$$

+ **1 pts** C) $$E_f = 1/2(m_1 + m_2) v^2$$ or $$1/2 k \Delta x^2$$

+ **0 pts** Incorrect or Empty

QUESTION 7

7 Problem 7 11 / 15

+ **15 pts** Correct

✓ + **3 pts** **(A) Free-body diagram (1pt per force)**

✓ + **4 pts** **(B) $$E_i = mgH$$ and $$E_f = {1\over 2}mv^2 +{1\over 2}I\omega^2 $$ $$\to v=\sqrt{gH}$$**

+ **4 pts** (C) $$v^2 = 2a\Delta L\to a = {g\over 4}$$

✓ + **4 pts** **(D) Only torque due to friction $$\tau = fR =I\alpha = mR^2({a\over R}) \to f = ma = {1\over 4}mg$$**

+ **0 pts** Incorrect

correct formulas but sin30 = 1/2 not 1/3

QUESTION 8

8 Problem 8 15 / 15

✓ + **15 pts** **Correct**

+ **5 pts** (1) $$E_i = {1\over 2}k\Delta x^2 + mgh$$ and $$E_f = {1\over 2}mv^2 + mgh \to v = 7.07 m/s$$

+ **5 pts** (2) $$E_i = {1\over 2}k\Delta x^2 +mgh $$ and $$E_f = {1\over 2}mv^2 \to v = 15.68 m/s$$

+ **5 pts** (3) $$\Delta E = W_{friction} = -\mu mg\cos\theta\Delta L \to \Delta L = 18.6m$$

+ **0 pts** Incorrect

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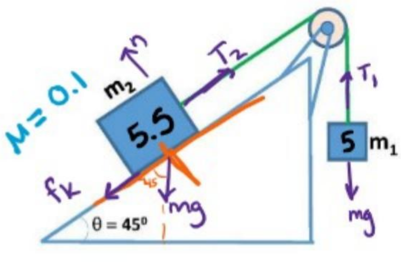
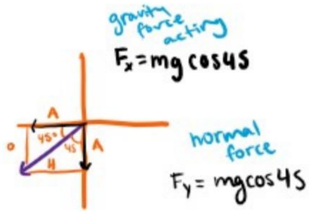
Problem 1 (10 points)

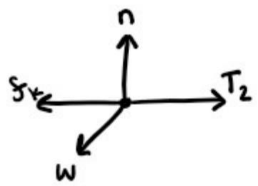
Two blocks of m_1 = 5 kg and m_2 = 5.5 kg are connected by a light string through a massless pulley as shown in the Figure. There is no friction between the string and the pulley. The kinetic friction coefficient between the block m_2 and the inclined plane is 0.10. Draw the force diagram for these blocks (5 points). What is the acceleration of these blocks (5 points)?





a) force diagram

m_2 block:



m_1 block:

b) $\Sigma F = \Sigma m \cdot a$

friction

$-\mu n - m_2 g\cos 45 + m_1 g = (m_1 + m_2)a$

$-(0.1)(5.5\cdot 9.8\cdot \cos 45) - (5.5)(9.8)\cos 45 + 5(9.8) = (5.5+5)a$

$-3.811 - 38.11 + 49 = (10.5)a$

$a = 0.6741$

$a = 0.674\ m/s^2$

toward m_1

1 Problem 1 10 / 10

✓ + **10 pts** **All correct**

+ **5 pts** A) Correct
+ **3 pts** A) $$m_2$$ FBD Correct
+ **2 pts** A) m2 FBD missing force or extra force
+ **1 pts** A) FBD 2, 2 incorrect or missing forces
+ **2 pts** A) m1 FBD Correct
+ **1 pts** A) m1 FBD 1 extra or missing force
+ **5 pts** B) Correct
+ **1 pts** B) F = ma
+ **1 pts** B) M1 Newton Equation correct
+ **1 pts** B) M2 Newton Equation correct
+ **1 pts** B) Friction Equation correct with correct normal force
+ **1 pts** B) Final Answer Correct
+ **4 pts** B) Correct but m1 and m2 flipped

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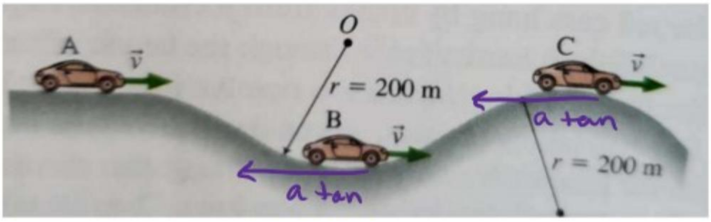
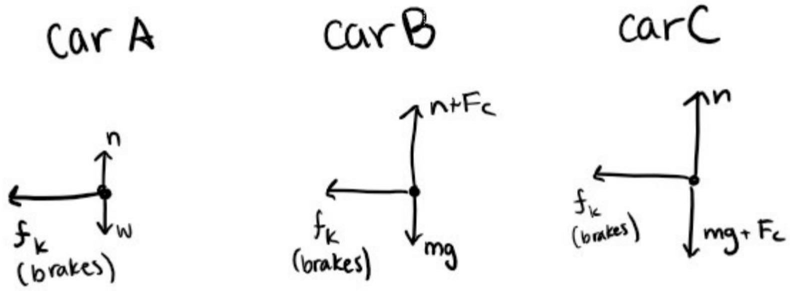
Problem 2 (10 points)

Three cars are driving at 25 m/s along the road shown in the Figure. Car A is at a flat section, Car B is at the bottom of the hill and car C is at the top. The hill approximately follows the arc of a circle with radius r = 200 m as shown. Suppose each car suddenly brakes hard and starts to skid. Draw the force diagram for each car when the car brakes (3 points). What is the tangential acceleration (i.e., the acceleration parallel to the road) for each car (A-1 points, B-3 points, C-3 points)? Assume μ_k=1.0.





$F_c = \frac{mv^2}{r}$

$n - mg = \frac{mv^2}{r}$

$n = mg + \frac{mv^2}{r}$

$f_k = \mu_k n$

$f_k = \mu_k \left(mg + \frac{mv^2}{r}\right)$

$F = ma$

$\mu_k m \left(g + \frac{v^2}{r}\right) = ma$

$\mu_k \left(g + \frac{v^2}{r}\right) = a$

$a = 1\left(9.8 + \frac{25^2}{200}\right)$

$a_B = -12.925 \ m/s^2$

$a_A = -\mu_k g$

$a_A = -9.8 \ m/s^2$

$a_c = -\mu_k \left(g - \frac{v^2}{r}\right)$

$= -1\left(9.8 - \frac{25^2}{200}\right)$

$a_c = -6.675 \ m/s^2$

2 Problem 2 **10 / 10**

✓ **+ 10 pts** **Correct**

- **+ 1 pts** Free-body (A)
- **+ 1 pts** Free-body (B)
- **+ 1 pts** Free-body (C)
- **+ 1 pts** $a_A = -9.8m/s^2$
- **+ 3 pts** $a_B = \pm12.9m/s^2$
- **+ 3 pts** $a_C = \pm6.68m/s^2$
- **+ 0 pts** Incorrect

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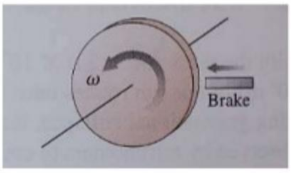
Problem 3 (10 points)

A uniform m = 1.0 kg, R = 0.25 m radius disk in the Figure is spinning at 360 rpm (revolution per minute). What is the angular velocity of the disk (2 points)? A friction is applied to the rim by a brake to bring the disk to a halt in 3.0 second. What is the angular acceleration of the disk during the 3 second (2 points)? How much friction force must the brake apply (3 points)? How much work was done by the friction force (3 points)? The rotational inertia of a uniform disk about the center axis is $\frac{1}{2}mR^2$.



$f = \frac{360 \text{ rev}}{1 \text{ min}}$

$\frac{360 \text{ rev}}{1 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = 6 \text{ rev/s} = f$

$\omega = 2\pi f$

a) $\omega = 37.7 \text{ rad/s}$

$\omega_f = \omega_i + \alpha \Delta t$

$0 = 37.7 + \alpha(3)$

b) $\alpha = -12.567 \text{ rad/s}^2$

$\tau = I\alpha$

$\tau = \frac{1}{2}mr^2\alpha$

$= \frac{1}{2}(1)(0.25)^2(12.567)$

$\tau = 0.393$

$F = \tau / r$

$F = 0.393 / 0.25$

c) $F_f = 1.572 \text{ N}$

d) $W = F\Delta X$

$v = \omega r = (37.7)(0.25) = 9.425$

$a = \alpha r = -12.567(0.25) = -3.14175$

$v_f^2 = v_i^2 + 2a\Delta x$

$0 = (9.425)^2 - 2(-3.14)\Delta X$

$\Delta x = 14.145 \text{ m}$

$W = 1.572(14.145)$

d) $W = 22.236 \text{ J}$

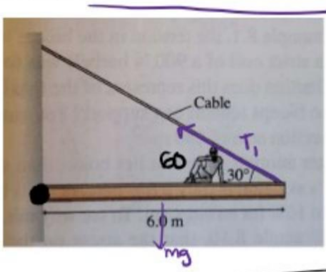
3 Problem 3 **10 / 10**

✓ **+ 10 pts All Correct**

- **+ 2 pts** A) Correct 37.7 = $$12 \pi$$
- **+ 2 pts** B) Correct -12.6 = $$ 4 \pi$$
- **+ 3 pts** C) All Correct 1.58
- **+ 1 pts** C) $$ \tau = I \alpha$$
- **+ 1 pts** C) $$\tau = rF$$
- **+ 3 pts** D) All Correct 22.2
- **+ 1 pts** D) $$W = E_i - E_f$$
- **+ 1 pts** D) $$E_i = 1/2 (1/2 m R^2) \omega^2$$
- **+ 1 pts** D) $$E_f=0$$
- **+ 1 pts** D) $$W = Fd cos(\theta)$$
- **+ 1 pts** D) $$\theta = 1/2 \alpha t^2 + \omega_0 t = 56.4 = (\omega^2 - \omega_0^2)/(2 \alpha)$$
- **+ 1 pts** D) $$ s = r \theta$$
- **+ 0 pts** Incorrect or empty

Problem 4 (10 points)

A 60.0 kg construction worker sits down 2.0 m from the end of a 1000.0 kg steel beam to eat his lunch as shown in the Figure. The steel beam is attached to the wall with a hinge. Draw the force diagram for the steel beam (4 points). What is the tension in the cable (4 points)? What are the horizonal and vertical forces on the steel beam from the hinge (2 points)?



$T_y = T\sin 30$

$T_x = T\cos 30$

$\Sigma \tau = 0$

$T_y r - m_{beam} g r - m_{man} g r = 0$

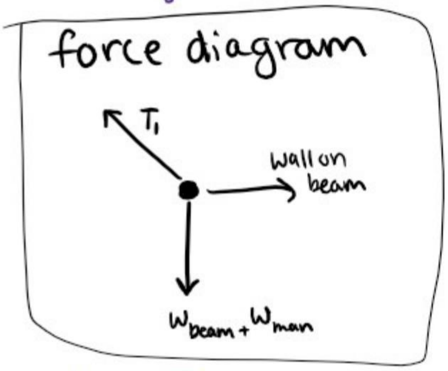
$T_y = \dfrac{1000(9.8)(3) + 60(9.8)(4)}{6}$

$T_y = 5292$ N

$T_y = T\sin 30$

$5292\text{N} = T\sin 30$

$T = 101{,}115.95$ N



$H_x = T\cos 30$

$= 87569$ N

$H_y = T\sin 30 - m_{beam} g - m_{man\ beam}$

$= 40170$ N

4 Problem 4 **9 / 10**

- \+ **10 pts** All Correct
- \+ **4 pts** A) Correct
- ✓ + **3 pts** **A) One incorrect or extra force**
- \+ **2 pts** A) Two incorrect or extra forces
- \+ **1 pts** A) Three incorrect or extra forces
- ✓ + **4 pts** **B) Correct 10584**
- \+ **1 pts** B) $$ \tau = rF Sin(\theta)$$
- \+ **2 pts** B) One incorrect or extra torque
- \+ **1 pts** B) Two incorrect or extra torque
- ✓ + **1 pts** **C) $$F_x = 9166$$**
- ✓ + **1 pts** **C) $$F_y = 5096$$**
- \+ **0 pts** Incorrect or Blank

math mistake but correct work

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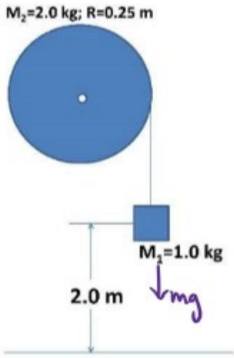
Problem 5 (15 points)

One uniform metal disk of radius R = 0.25 m and mass M_2 = 2.0 kg is mounted on a frictionless axis through the center of the disk. A light string is wrapped around the edge of the disk, and a M_1=1.0 kg block is suspended from the free end of the string. If the block is released from rest at a distance 2.0 m above the ground, what is the speed of the block just before the block strikes the ground (5 points)? What is the angular momentum of the disk before the block strikes the ground (5 points)? What is the acceleration of the block before it hits the ground (5 points)? The rotational Inertia of a uniform disk of mass M and radius R is $\frac{1}{2}MR^2$.



$\Sigma\tau = I\alpha$

$Tr = I\frac{a}{r}$

$Tr = \frac{1}{2}mr^2\frac{a}{r}$

$= \frac{1}{2}mra$

$F = ma$

$mg - T_1 = ma$

$mg - \frac{1}{2}mra = ma$

$(1)9.8 - \frac{1}{2}2(0.25)a = 1a$

$9.8 = 1.25a$

$a = 7.84\ m/s^2$

$v_f^2 = v_i^2 + 2a\Delta y$

$= 2(7.84)(2)$

$v_f = \sqrt{31.36}$

$v_f = 5.6\ m/s$

angular momentum:

$L = I\omega$

$L = \frac{1}{2}mr^2\left(\frac{v}{r}\right)$

$L = \frac{1}{2}mrv$

$= \frac{1}{2}(2)(0.25)(5.6)$

$L = 1.4\ kgm^2/s$

5 Problem 5 **14 / 15**

- \+ **15 pts** All Correct: 4.43, 1.1, 4.9
- ✓ + **5 pts** **A) Correct 4.43**
- \+ **1 pts** A) $$E_i = E_f$$
- \+ **1 pts** A) $$E_i = m_1 g h$$
- \+ **1 pts** A) $$E_f = 1/2 m_1 v^2 + 1/2 I \omega^2$$
- \+ **1 pts** A) Correctly substitute $$I$$ and $$\omega$$
- \+ **3 pts** A) $$v_f^2 = v_0^2 + 2a(s-s_0)$$
- ✓ + **5 pts** **B) Correct 1.1**
- \+ **2 pts** B) $$ L = I \omega$$
- \+ **2 pts** B) $$L = 1/2 m_2 R^2 (v/R)$$
- \+ **1 pts** B) $$\omega = \alpha t$$
- \+ **1 pts** B) Final answer correct in terms of answer from A 1.1
- \+ **5 pts** C) Correct 4.9
- \+ **2 pts** C) $$v^2 - v_0^2 = 2 a (s - s_0)$$
- \+ **1 pts** C) Correctly plug in $$v^2 = gh$$
- \+ **1 pts** C) Correctly plug in $$\Delta s = h$$
- \+ **1 pts** C) Final answer correct in terms of velocity, 4.9
- ✓ + **1 pts** **C) $$F = ma$$**
- ✓ + **1 pts** **C) $$\tau = I \alpha$$**
- ✓ + **1 pts** **C) Correctly plug in both torque and force equations**
- ✓ + **1 pts** **C) Correctly convert a to $$\alpha$$ or $$\alpha$$ to a**
- \+ **0 pts** Incorrect or Empty

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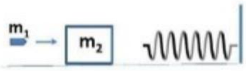
Problem 6 (15 points)

A rifle bullet with mass m_1=6.00 g strikes and embeds itself in a block of mass m_2 = 1.00 kg that rests on a frictionless horizontal surface. The block after the collision encounters a spring and compresses the spring 0.10 m. The spring has a force constant of 300 N/m. a) Find the speed of the block just after the bullet strikes the block (5 points); b) Calculate the initial speed of the bullet when it was fired from the rifle (5 points); c) Find the amount of heat generated when the bullet was stopped by the block (5 points).



momentum conserved hitting block

$\Sigma m_i v_i = \Sigma m_f v_f$

$m_1 v_{1i} = (m_1 + m_2) v_f$

$(0.006)(v_{1i}) = (1.006)(1.729)$

b) $v_{1i} = 290$ m/s

$K_E \rightarrow U_{spring}$

$\frac{1}{2} m v_f^2 \rightarrow \frac{1}{2} k \Delta x^2$

$\frac{1}{2}(1.006) v_f^2 = \frac{1}{2}(300)(0.1)^2$

$v_f^2 = 2.982$

a) $v_f = 1.729$ m/s

$K_E - E_{th} \rightarrow U_{spring}$

$\frac{1}{2} m v_i^2 - E_{th} \rightarrow \frac{1}{2} k \Delta x^2$

$\frac{1}{2}(0.006)(290)^2 - E_{th} = \frac{1}{2}(300)(0.1)^2$

c) $E_{th} = 250.8$ J

6 Problem 6 **15 / 15**

- ✓ **+ 15 pts All Correct: 1.73, 289.5, 249.9**
- **+ 5 pts** A) Correct 1.73
- **+ 2 pts** A) $$E_i = E_f$$
- **+ 1 pts** A) $$E_i = 1/2 (m_1 + m_2) v^2$$
- **+ 1 pts** A) $$E_f = 1/2 k \Delta x^2$$
- **+ 5 pts** B) Correct 289.5
- **+ 2 pts** B) $$P_i = P_f$$
- **+ 1 pts** B) $$P_i = m_1 v_0$$
- **+ 1 pts** B) $$P_f = (m_1 + m_2) v$$
- **+ 5 pts** C) Correct 249.9
- **+ 2 pts** C) $$E_i + W = E_f$$
- **+ 1 pts** C) $$E_i = 1/2 m_1 v_0^2$$
- **+ 1 pts** C) $$E_f = 1/2(m_1 + m_2) v^2$$ or $$1/2 k \Delta x^2$$
- **+ 0 pts** Incorrect or Empty

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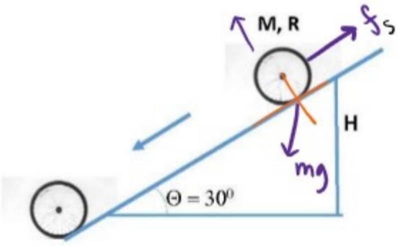
Problem 7 (15 points)

A wheel of mass M, radius R starts from at rest and rolls down an incline without slipping as shown in the Figure. a) Draw the force diagram for the wheel (3 points); b) Calculate the speed of the center of the wheel after the wheel rolls down by a height H (4 points); c) Find the acceleration of the center of the wheel (4 points); d) Determine the magnitude of the friction force on the wheel (4 points). The rotational Inertia of a wheel is $I = MR^2$. Express your results in terms of M, R, H and gravitational acceleration g.

$\sin 30° = 0.5$; $\cos 30° = 0.866$.



$U_{gravity} \rightarrow K_T + K_R$

$mgh = \frac{1}{2}mv_f^2 + \frac{1}{2}I\omega^2$

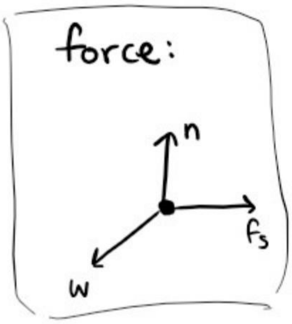
$\omega = v/r$

$mgh = \frac{1}{2}mv_f^2 + \frac{1}{2}I\frac{v_f^2}{r^2}$

$mgh = \frac{1}{2}(m + \frac{I}{r^2})v_f^2$

$v_f = \sqrt{2mgh/(m + I/r^2)}$ $I = mr^2$

$v_f = \sqrt{\frac{2mgh}{(m+m)}}$



acting gravity: $mg\sin 30$

$F = ma$

$mg\sin\theta - f_s = ma$

$\tau = I\alpha$

$r \cdot f_s = I\alpha$

$f_s r = I\alpha$

$\alpha = a/r$

$a = \frac{f_s r^2}{I}$

$f = \frac{mg\sin\theta}{1 + \frac{mr^2}{I}}$

plugin: $I = mr^2$ $\theta = 30$

$f = mg/6$

7 Problem 7 **11 / 15**

+ **15 pts** Correct

✓ + **3 pts** (A) Free-body diagram (1pt per force)

✓ + **4 pts** (B) $$E_i = mgH$$ and $$E_f = {1\over 2}mv^2 +{1\over 2}I\omega^2 $$ $$\to v=\sqrt{gH}$$

+ **4 pts** (C) $$v^2 = 2a\Delta L\to a = {g\over 4}$$

✓ + **4 pts** (D) Only torque due to friction $$\tau = fR =I\alpha = mR^2({a\over R}) \to f = ma = {1\over 4}mg$$

+ **0 pts** Incorrect

correct formulas but sin30 = 1/2 not 1/3

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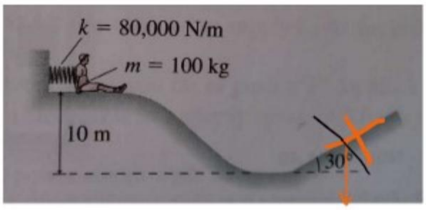
Problem 8 (15 points)

The spring shown in the Figure has a force constant of 80000.0 N/m. The spring is compressed 0.25 m to launch a 100 kg student. The track is frictionless until it starts up the incline. The student's coefficient of kinetic friction on the 30^0 incline is 0.20. 1) What is the student's speed just after losing contact with the spring while on the horizontal section of the track at the top (5 points)? 2) What is the student's speed at the bottom of the track before going up the incline (5 points)? 3) How far up the incline does the student go (5 points)?

$\sin 30° = 0.5$; $\cos 30° = 0.866$.



$U_{spring} \rightarrow K_E$

$\frac{1}{2}k\Delta x^2 = \frac{1}{2}mv_f^2$

$\frac{1}{2}(80000)(0.25)^2 = \frac{1}{2}(100)v_f^2$

$v_f^2 = 50$

a) $v_f = 7.07$ m/s

F = mgcos30

$U_{spring} + U_{gravity} \rightarrow K_E$

$\frac{1}{2}k\Delta x^2 + mgh = \frac{1}{2}mv_f^2$

$\frac{1}{2}(80000)(0.25)^2 + 100(9.8)(10) = \frac{1}{2}(100)v_f^2$

$v_f^2 = 246$

b) $v_f = 15.68$ m/s

$K_E = W_f + U_{gravity}$

$\frac{1}{2}mv^2 = \mu_k \cdot mg\cos 30 + mgh$

$\frac{1}{2}(100)\,15.68^2 = 0.2(100)(9.8)\cos 30 \cdot d + (100)(9.8)(\sin 30)d$

$12293.12 = 659.741\, d$

c) $d = 18.6$ m

8 Problem 8 **15 / 15**

✓ **+ 15 pts** Correct

- **+ 5 pts** (1) $$E_i = {1\over 2}k\Delta x^2 + mgh$$ and $$E_f = {1\over 2}mv^2 + mgh \to v = 7.07 m/s$$
- **+ 5 pts** (2) $$E_i = {1\over 2}k\Delta x^2 +mgh $$ and $$E_f = {1\over 2}mv^2 \to v = 15.68 m/s$$
- **+ 5 pts** (3) $$\Delta E = W_{friction} = -\mu mg\cos\theta\Delta L \to \Delta L = 18.6m$$
- **+ 0 pts** Incorrect

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