#29

Name: SOLUTION

Seat Assignment: _____

Specify your **EXAM ID** on the right. Use 000 if you do not know your exam ID.

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1 ○	1 ○	1 ○
2 ○	2 ○	2 ○
3 ○	3 ○	3 ○
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7 ○	7 ○	7 ○
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Circle your **LAB SECTION**

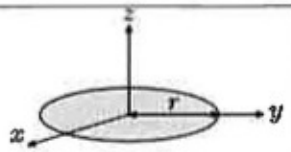
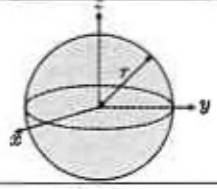
	102	212	216	217	218
8:10	A102 Jackson	A212 Adam	A216 Min	A217 Siavash	A218 Erik
9:40	B102 Jackson	B212 Dhruv	B216 Min	B217 Siavash	B218 Erik
11:10	C102 Savannah	C212 Adam	C216 Will	C217 Siavash	C218 Erik
12:40	D102 Savannah	D212 Min	D216 Will	D217 Teague	D218 Eric
2:10	E102 Savannah	E212 Adam	E216 Dhruv	E217 Teague	E218 Eric
3;40	F102 Jackson	F212 Will	F216 Dhruv	F217 Teague	F218 Eric

Instructions

- Sit in your assigned seat.
- Do not open the exam until instructed to do so.
- Completely color in the dot for your chosen answers on multiple choice.
- Do not leave if there is less than 5 minutes to go in the exam.
- When time is called, immediately stop writing, remain seated, and pass your exam to the center aisle.
- Working after time is called results in an automatic deduction.

Guidelines

- Assume 3 significant figures for all given numbers unless otherwise stated
- Show all of your work – no work, no credit
- Write your final answer in the box provided
- Include units for all answers and directions for all vectors

Thin rod	Solid disk	Solid sphere
		
$I_{center} = \frac{1}{12}mL^2$	$I_z = \frac{1}{2}mr^2$	$I = \frac{2}{5}mr^2$

1. (1 pt) The volume of a person is approximately:

#1 0.7/1 (70%)

1 m³	0.1 m³	0.01 m³	0.001 m³
○	●1	○	○

2. (1 pt) The angle of the vector $(12\hat{\imath} - 5.1\hat{\jmath})$ft counterclockwise from the x-axis is:

#2 0.9/1 (90%)

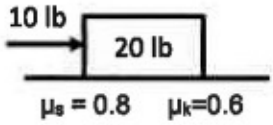
113°	157°	293°	337°
○	○	○	●1

3. (1 pt)) In a FBD of box sitting on a flat surface, are the weight and normal force 3rd law partners?

#3 0.5/1 (50%)

Yes	No
○	●1

4. (1 pt) The value of the friction force is:



#4 0.5/1 (50%)

10 lb	12 lb	16 lb
●1	○	○

5. (1 pt) A spring loaded gun shoots a ball with a speed of 1.0 m/s.
If the spring is compressed 3 times as far, the speed of the ball will be:

#5 0.5/1 (50%)

1.0 m/s	3.0 m/s	9.0 m/s
○	●1	○

6. (1 pt) The area under a force-time graph gives:

#6 0.8/1 (80%)

nge in velocity	change in kinetic energy	change in momentum
○	○	●1

7. (1 pt) A wheel is rotating in a clockwise direction with a constant angular velocity of 20 rev/sec.
What is true about the net torque acting on the wheel?

#7 0.6/1 (60%)

que is positive	Net torque is negative	Net torque is zero
○	○	●1

8. (1 pt) The direction of the torque vector is:

#8 0.8/1 (80%)

l to $\vec{F}$	parallel to $\vec{r}$	perpendicular to plane containing $\vec{r} \times \vec{F}$
○	○	●1

#3
2.6/3 (86.7%)

9. (3 pts) A cylindrical drinking glass has a diameter of 2.5 in and is 5.5 in tall. What is the volume of the drinking glass in cubic centimeters? (2.54 cm = 1.00 in)

442 cm^3

$\pi\left(\frac{2.5in}{2}\right)^2(5.5in) = 27.00\ in^3$

$27.00\ in^3\left(\frac{2.54cm}{in.}\right)^3 = 442.4cm^3$

-1 wrong volume formula
-1 used diameter (1770)
-1 math
-1 incorrect inch to cm conversion
-1 units don't match formula

#10
1.7/3 (56.7%)

10. (3 pts) A car makes a 100 km trip. It travels the first 50 km at an average speed of 70 km/hr. How fast must it travel the second 50 km so that its average speed is 90 km/hr?

126 $\frac{km}{hr}$

Avg speed = $\frac{\text{Total dist}}{\text{Total time}}$

$90\frac{km}{hr} = \frac{100\ km}{\frac{50km}{70\frac{km}{hr}} + \frac{50km}{V_2}}$

$V_2 = 126\frac{km}{hr}$

-2 110 km/hr
-1 units
-1 math error
-2 wrong eqn

#11
2.6/3 (86.7%)

11. (3 pts) Jeremy Pruitt climbs to the top of Neyland Stadium and drops a football over the side. It falls 80 m to the ground below. How long is the ball in the air before it hits the ground? (assume negligible air resistance)

4.04 sec

$S_1 = 80m$

$S_2 = S_1 + V_1 t + \frac{1}{2}at^2$

$0 = 80m + 0(t) + \frac{1}{2}\left(-9.81\frac{M}{s^2}\right)t^2$

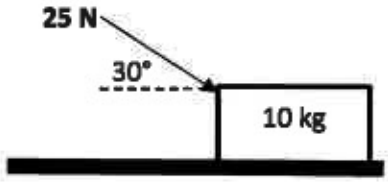
$t = 4.038s$

$S_2 = 0$ at

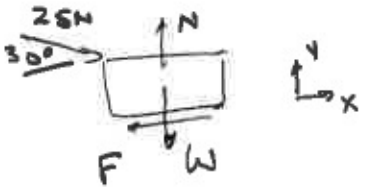
-1 math
-1 forgot 1/2 in equation
-1 used 32.2 for g (2.23)
-1 initial vel=0
-1 units
-1 initial height is 80m

#12
2.4/3 (80%)

12. (3 pts) Michael pushes a 10 kg box across a level floor at a constant speed. He pushes with a force of 25 N as shown. What is the coefficient of kinetic friction between the box and the floor?



0.196



$X: 25N\cos(30^\circ) - F = 0$

$F = 21.65N$

$Y: N - 10kg(9.81\frac{m}{s^2}) - 25N\sin 30^\circ$

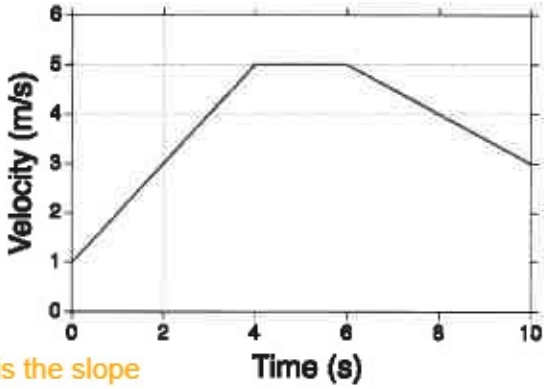
$N = 110.6N$

$\mu_k = \frac{F}{N} = \frac{21.65N}{110.6N} = 0.1958$

-1 used N as 98.1 (.221)
-1 wrong x equation
-1 math
-1 wrong y equation
-1 used W=10 (forgot g)
-1 didn't use a=0
-1 wrong trig
-1 no Mu equation

#13
2.1/3 (70%)

13. (3 pts) The graph below shows the velocity of a 5 kg object. What is the net force exerted on the object at t = 2 s?



5 N

$a = \frac{\Delta v}{\Delta t} = \frac{5m/s - 1m/s}{4s - 0s} = 1\,m/s^2$

$F_{net} = ma = 5kg(1\,m/s^2) = 5N$

-2 acceleration is the slope
-1 wrong slope
-1 multiply by mass
-3 acceleration is slope; multiply by mass
-1 units

#14
1.9/3 (63.3%)

14. (3 pts) A car travels around a flat horizontal curve with a radius of 200 ft. What is the maximum constant speed that the car can go around this curve without sliding ($\mu_k = 0.6$, $\mu_s = 0.8$)?

71.8 ft/s

$v = \sqrt{\mu_s g r}$

$= \sqrt{0.8(32.2\frac{ft}{s^2})(200ft)}$

$= 71.78\,ft/s$

-1 wrong coefficient of friction
-1 wrong value of g
-1 math error
-1 no units
-1 missing g
-2 did not include coefficient of friction
-1 not finished

#15
1.9/3 (63.3%)

15. (3 pts) A force of $(3\hat{\imath} + 5\hat{\jmath})$lb acts through a displacement of $(-6\hat{\imath} + 12\hat{\jmath})$ft. Determine the amount of work that was done.

42 ft·lb

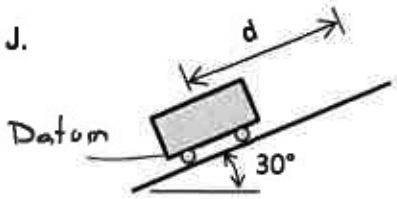
$(3\hat{i}+5\hat{j})\cdot(-6\hat{i}+12\hat{j})$

$= 3(-6) + 5(12) = 42$ ft·lb

-1 did sqrt(60^2+18^2) (62.6)
-2 cross product (66)
-2 did magnitude F*d (78.2)
-1 units
-1 math
-1 dot product is scalar

#16
2.3/3 (76.7%)

16. (3 pts) A 4 kg cart is traveling at 12 m/s. Determine the maximum distance d the cart can go up the incline if there is an energy loss of 50 J.



12.1 m

$\frac{1}{2}mv_1^2 = mgh_2 + E_{loss}$

$\frac{1}{2}(4kg)(12\frac{m}{s})^2 = 4kg(9.81\frac{m}{s^2})(h_2) + 50J$

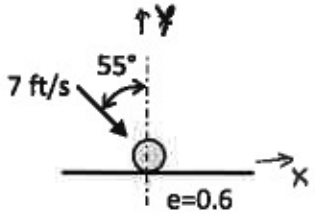
$h_2 = 6.065m$

$d = \frac{h_2}{\sin(30°)} = \frac{6.065m}{\sin(30°)} = 12.13m$

-1 found correct h (6.05) but not d
-1 math
-1 wrong sign for Eloss
-1 didn't include Eloss
-1 found h but not d
-1 found h but not d

#17
2.1/3 (70%)

17. (3 pts) Determine the magnitude of the velocity of the ball after it bounces off the floor.



6.22 ft/s

$v_x' = v_x = 7\frac{ft}{s}\sin(55°) = 5.734\frac{ft}{s}$

$v_y' = -ev_y = -0.6(-7\frac{ft}{s})\cos 55° = 2.409\frac{ft}{s}$

$v' = \sqrt{(v_x')^2 + (v_y')^2} = \sqrt{(5.734\frac{ft}{s})^2 + (2.409\frac{ft}{s})^2}$

$= 6.219$ ft/s

-1 units
-1 math
-1 didn't find x component
-1 didn't combine components
-1 applied COR to x direction
-1 switched sin and cos on components
-1 did not apply COR to the y direction
-2 didn't use components (4.2)

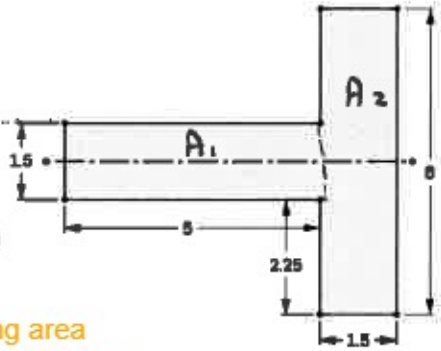
#18
2.4/3 (80%)

18. (3 pts) Your Rube Goldberg device has a Power T made out of a flat piece of wood with the dimensions shown. At what horizontal distance from the left edge should you place a hole on the dashed line so the T will be balanced when supported at the hole? (all dimensions are in inches)

4.27 inch

$A_1 = 5(1.5) = 7.5\,in^2$ $\quad \bar{x}_1 = 2.5\,in$

$A_2 = 6(1.5) = 9.0\,in^2$ $\quad \bar{x}_2 = 5 + \frac{1.5}{2} = 5.75\,in$



$$\bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2} = \frac{2.5in(7.5in^2) + 5.75in(9.0in^2)}{7.5in^2 + 9.0in^2}$$

$$= 4.273\,in.$$

-1 wrong area
-1 wrong distance
-1 incorrect COM formula
-1 math
-1 units

#19
1.8/3 (60%)

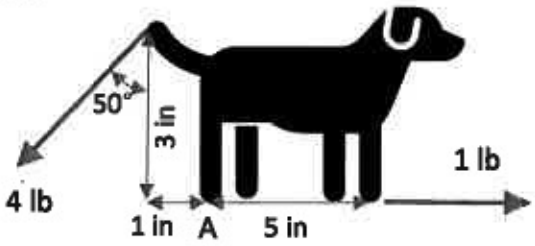
19. (3 pts) Your Rube Goldberg device has a dog-shaped trigger. What is the net torque about point A with the forces applied as shown? (counterclockwise positive)

+ 11.816 lb·in

$\tau = +4lb\sin(50°)(3in) + 4lb\cos 50°(1in) + 1lb(0)$

$= +9.192\,lb\cdot in + 2.571\,lb\cdot in$

$= +11.763\,lb\cdot in$



-1 wrong angle
-1 no torque from 1 lb force
-1 wrong sign
-1 trig function
-1 units

-1 add, not square root of sum of squares
-1 wrong distance
-1 missing a component from 4 lb force
-1 math error

#20
1.2/3 (40%)

20. (3 pts) Your Rube Goldberg device has a velcro covered blob (53g) being shot at a velcro covered rod (89g) hanging vertically and pivoting about its center as shown. What is the rotational speed of the rod/blob combination the instant after the blob hits the end of the rod and they stick together?

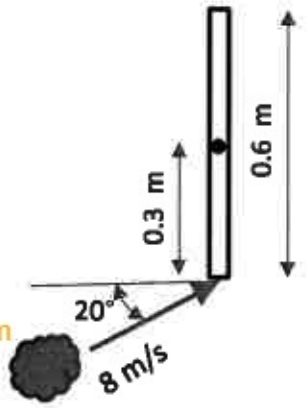
16.1 $\frac{rad}{s}$

$mv_1 r = I'\omega'$

$53g\left(8\frac{m}{s}\right)\cos 20°(0.3m) = \left(\frac{1}{12}89g(0.6m)^2 + 53g(0.3m)^2\right)\omega'$

$119.5 = (2.67 + 4.77)\omega'$

$\omega' = 16.06\,\frac{rad}{s}$

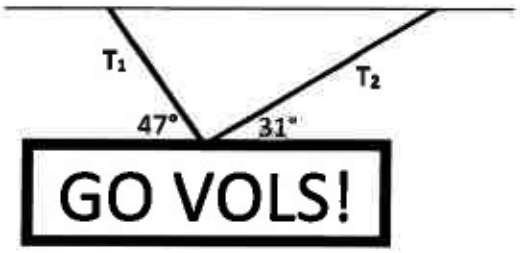


-1 incorrect angular momentum
-1 incorrect moment of inertia
-1 unit
-2 angular momentum is conserved
-1 math error
-2 Cant use COE

#21
5.2/7 (74.3%)

21. (7 pts) Two ropes support a 100 lb sign as shown. The system is in equilibrium. What is the magnitude of T_1?

87.6 lb



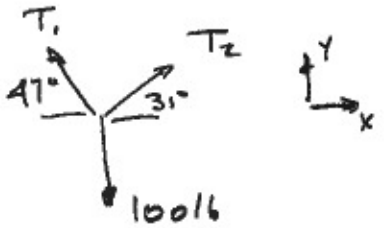
$X: -T_1 \cos 47^\circ + T_2 \cos 31^\circ = 0$

$Y: T_1 \sin 47^\circ + T_2 \sin 31^\circ - 100\,lb = 0$

Calculator

$T_1 = 87.63\,lb$

$T_2 = 69.72\,lb$

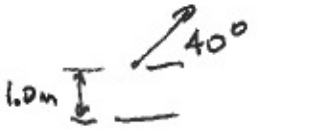


-2 solve equations
-2 did not include 100 lb force
-1 wrong solution to equations
-5 wrong equations
-1 wrong sign
-1 wrong unit
-4 need x component of Ts
-2 100lb only in y
-2 wrong trig
-4 need y component of Ts

#22
5.7/7 (81.4%)

22. (7 pts) A child throws a ball with an initial speed of 8.0 m/s at an angle of 40° above the horizontal. The ball leaves her hand 1.0 m above the ground. Ignoring any effects from air resistance, determine how long the ball is in flight before it hits the ground.

1.22 sec



$y: \quad y_1 = y_0 + v_{y_0} t + \frac{1}{2} a_y t^2$

$0\,m = 1.0\,m + 8.0\,\frac{m}{s} \sin(40^\circ)\, t + \frac{1}{2}\left(-9.81\,\frac{m}{s^2}\right) t^2$

$t = 1.216\,sec \quad or \quad -0.168\,sec$

-1 wrong sign
-2 use y component of v
-1 y=0, yo = 1
-1 wrong g
-1 math error
-3 wrong time (total motion is asked for)
-3 final velocity is not zero
-2 not constant velocity motion

#23
5.0/7 (71.4%)

23. (7 pts) A Ferris wheel with a radius of 14.0 m is turning about a horizontal axis through its center. The linear speed of a 60 kg passenger on the rim is constant and equal to 6.00 m/s. What is the magnitude of the force exerted by the seat on the passenger when she is at the lowest point on the Ferris wheel? **(FBD = KD Required)**

743 N

$N - W = ma_n$

$N - 60kg(9.81\frac{m}{s^2}) = 60kg\frac{(6.0\frac{m}{s})^2}{14.0\,m}$

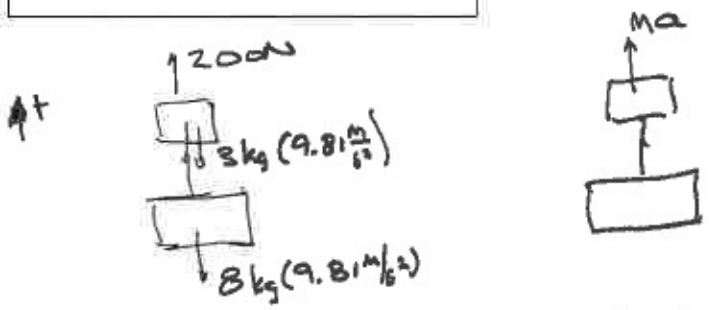
$N = 742.9\,N$

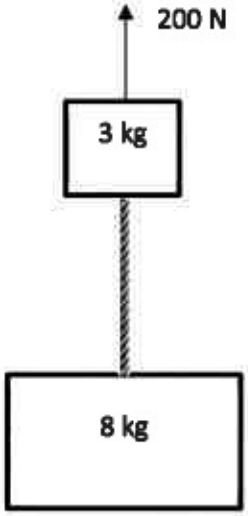
-3 an = (v^2)/r
-1 units
-1 math error
-2 Sum forces = N - W
-1 an goes to center of circle (+)
-2 atot = an
-3 [N-W = m(an)]
-1 W = mg
-3 No FBD = KD

#24
4.7/7 (67.1%)

24. (7 pts) The two blocks are connected by a light rope. An upward force of 200 N is applied as shown. What is the tension in the rope connecting the two blocks? **(Two FBD = KD Required)**

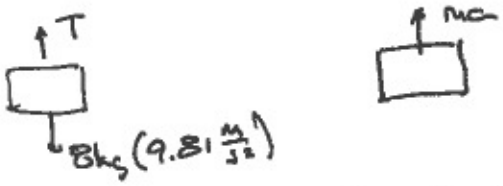
145 N





$200N - 3kg(9.81\frac{m}{s^2}) - 8kg(9.81\frac{m}{s^2}) = (3kg + 8kg)a$

$a = 8.372\,m/s^2$

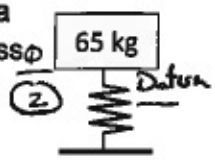


$T - 8kg(9.81\frac{m}{s^2}) = 8kg(8.372\frac{m}{s^2})$

$T = 145.4\,N$

#25
5.1/7 (72.9%)

25. (7 pts) A 65 kg mass is dropped and has a speed of 23 m/s when it hits a spring with a stiffness of 5000 N/m. Assuming that the spring is not compressed at all before the mass hits it, determine the maximum amount the spring compresses.



2.75m

$\frac{1}{2} m v_1^2 + mg x_1 = \frac{1}{2} k x_1^2$

$\frac{1}{2}(65\text{kg})(23\frac{m}{s})^2 + 65\text{kg}(9.81\frac{m}{s^2})x = \frac{1}{2}(5000\frac{N}{m})x^2$

$x = 2.753\text{m}$ or -2.498m

-2 missing initial KE
-2 missing initial mgh
-2 missing elastic potential energy
-1 units
-1 math error
-1 sign
-1 mgh wrong side

#26
6.0/7 (85.7%)

26. (7 pts) A 20 pound cart moving to the right at 6 ft/s collides with a 25 pound cart that is initially at rest. After the collision, the 20 pound cart is moving to the right at 2 ft/s. Determine the coefficient of restitution of the collision.

0.200

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$20\text{lb}(6\text{ft/s}) + 25\text{lb}(0) = 20\text{lb}(2\text{ft/s}) + 25\text{lb}(v_2')$

$v_2' = 3.2\text{ft/s}$

$e = -\frac{(v_2' - v_1')}{v_2 - v_1} = -\frac{(3.2\text{ft/s} - 2.0\text{ft/s})}{0 - 6.0\text{ft/s}}$

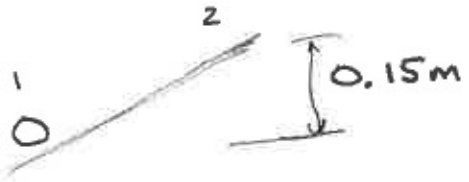
$e = 0.200$

-1 sign error
-1 math error
-2 wrong masses
-2 wrong velocities
-2 swapped masses
-3 incomplete
-3 wrong CoR equation
-3 wrong type of collision
-4 CoM, not CoE
-4 did not solve for final velocity
-4 incorrect velocity equation

#27
4.5/7 (64.3%)

27. (7 pts) A Rube Goldberg device has a marble (solid sphere) rolling up a ramp with an elevation change of 15 cm. What is the speed of the marble at the bottom in order for it to reach the top of the ramp with a speed of 0.8 m/s?

1.66 m/s



$$\frac{1}{2}mv_1^2+\frac{1}{2}I\omega_1^2=\frac{1}{2}mv_2^2+\frac{1}{2}I\omega_2^2+mgh$$

$$\frac{1}{2}mv_1^2+\frac{1}{2}\left(\frac{2}{5}mr^2\right)\left(\frac{v_1}{r}\right)^2=\frac{1}{2}mv_2^2+\frac{1}{2}\left(\frac{2}{5}mr^2\right)\left(\frac{v_2}{r}\right)^2+mgh$$

$$\frac{1}{2}v_1^2+\frac{1}{2}\left(\frac{2}{5}\right)v_1^2=\frac{1}{2}v_2^2+\frac{1}{2}\left(\frac{2}{5}\right)v_2^2+gh$$

$$0.7v_1^2=0.7v_2^2+gh$$

$$0.7v_1^2=0.7\left(0.8\tfrac{m}{s}\right)^2+9.81\tfrac{m}{s^2}(0.15m)$$

$$v_1=1.656\ m/s$$

-1 units
-1 math error
-1 did not finish
-2 Did not include both rot eng calc
-2 Incorrect COE eqn
-3 No rotational calc.

#28
3.6/7 (51.4%)

28. (7 pts) A Rube Goldberg device consists of an electric motor that will rotate a 0.1 m radius solid disk with a mass of 420g. The motor is 85% efficient. What is the angular acceleration when disk is spinning at 1900 rpm and the power input to the motor is 3.0 watts?

6.10 rad/s²

$$I=\frac{1}{2}mr^2=\frac{1}{2}(0.1m)^2(0.420kg)=0.0021\ kg\cdot m^2$$

$$P_{useful}=\eta P_{in}=0.85\left(3.0\tfrac{J}{s}\right)=2.55\tfrac{J}{s}$$

$$\omega=1900\tfrac{rev}{min}\cdot\tfrac{2\pi rad}{rev}\cdot\tfrac{1min}{60sec}=199.0\tfrac{rad}{s}$$

$$P=\tau\omega$$

$$2.55\tfrac{J}{s}=\tau\left(199.0\tfrac{rad}{s}\right)$$

$$\tau=0.01281\ N\cdot m$$

$$\alpha=\frac{\tau}{I}=\frac{0.01281\ N\cdot m}{0.0021\ kg\cdot m^2}=6.102\ rad/s^2$$

+1 correct moment of Inertia equation
+1 correct angular velocity conversion
+1 correct Power
+1 torque=I*a equation
+2 correct P=Torque x w equation
+1 correct answer
-1 wrong/missing units
-1 math error
-1 incorrect Power
-1 incorrect moment of Inertia
-1 incorrect angular velocity conversion