Calc based Physics: Midterm 2
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Answers:

Unit 4:

1a. $F(x) = \frac{d}{dx}[F(x^4 - x^2)] = -K(4x^3 - 2x)$
$0 = x(4x^2 - 2)$
$x = 0$ or $x = \pm\sqrt{\frac{2}{2}}$

1b. $U(0) = K(0^4 - 0^2) = 0$
$K(x^4 - x^2) = 0 \rightarrow x^2(x^2 - 1) = 0$
$x = 0$ or $x = \pm 1$
largest: $x = 1$

2a. $W = F\Delta x$ $W = (5)(1)$ $W = 5J$

2b. $\Delta x = \hat{T} + \hat{J} = \hat{T} + 2\hat{J}$
$\Delta x = 5 \rightarrow$ along $\hat{J}$
$W = (5)(1)$ $W = 5J$

2c. $\Delta x = 1\hat{J} + \hat{J} = 0\hat{T} + \hat{J}$
$\Delta x = -\hat{T}$
$W = (-5)(-1)$ $W = 5J$

2d. $\Delta x = 0\hat{T} + \hat{J} = 0\hat{T} + 0\hat{J}$
$\Delta = -\hat{J}$
$W = (-5)(-1)$ $W = 5J$

2e. $5 + 5 + 5 + 5 = 20J$ $W_{total} = 20J$

2f. Conservative would mean a loop so no energy would dissapate. $W_{total\ (conservative)} = 0J$

Unit 5:

1. $mv_1 + mv_2 = (2m)_{final}$
$m(350) + m(-350) = 2m_{final}$
$0 = 2mv_{final}$
$C: 0 m/s$

2. $P_1 = P_2 = mv = (20 \times 10^{-25})(350)$
$\sqrt{P_1^2 + P_2^2 + 2P_1P_2\cos(45°)} = P_1\sqrt{2+\sqrt{2}}$
$v_{final} = \frac{P_1\sqrt{2+\sqrt{2}}}{2m}$

3a. $J = F\Delta t$
$J = 4000N \cdot 0.200s = 800Ns$
$800Ns$

3b. $J = \Delta P$
$800 = 200(v_{final} - 2.80)$
$v_{final} = \frac{800}{200} + 2.80$
$4.80 m/s$

4. Kinetic energy & momentum are Conserved — C: Elastic

5a. $m_1v_1 + m_2v_2 = (m_1 + m_2)v_{(final)}$ — 0.182 m/s

$(30,000)(6.850) + (110.000)(0) = (30,000 + 110,000)_{final}$

$v_{final} = \frac{25,500}{140,000}$

5b. initial: $\frac{1}{2}m_1v_1^2 = \frac{1}{2}(30000)(6.85^2)$

$KE_{initial} = 10,837.5\,J$

Final: $\frac{1}{2}(m_1 + m_2)v^2_{final} = \frac{1}{2}(140,000)(0.182^2)$ — lost: 8,518.7J

$KE_{final} = 2,318.8\,J$

$10,837.5 - 2,318.8 = 8,518.7\,J$

6 b4: $\frac{m(v) + 2m(-v)}{m + 2m} = -\frac{v}{3}$ — moves at the same velocity before & after.

After: $m(v) + 2m(-v) = -mv$

$v_{CM} = \frac{-mv}{3m} = -\frac{v}{3}$

Unit 6:

1. $rpm = \frac{60s/min}{1.33s/rev} \approx 45rpm$ — B: 45rpm, 4.7 rad/sec

$\omega = \frac{2\pi\,rad/rev}{1.33s/rev} \approx 4.7\,rad/sec$

2. $a_c = \omega^2 r$ — B: $1.1\,m/s^2$

not A or C

3. $a_c \propto \omega^2$ — D: $\omega \to 10\omega$

$\omega^2_{new} = 100\omega^2 \to \omega_{new} = 10\omega$

4. $\omega = 200rpm = \frac{200 \times 2\pi}{60}\,rad/s \approx 20.94\,rad/s$ — B: 0.53N

$F_c = m\omega^2 r = (0.01)(20.94^2)(0.12) \approx 0.53N$

5a. $KE_{trans} = \frac{1}{2}Mv^2 = \frac{1}{2}(1)(8) = 32J$ — $KE = \frac{1}{2}I\omega^2$

$KE_{rot} = \frac{1}{2}I\omega^2 \to I = 2mr^2$

what is radius ???

5b. $L = I\omega$ Cant do without radius ??

$I = 2mr^2$

$\omega = 4 \times 2\pi = 8\pi$

5c. $KE_{trans} = \frac{1}{2}Mv^2$

$= \frac{1}{2}(1)(8^2) = 32J$ 3.27m

$PE_{max} = Mgh_{max}$

$32 = (1)(9.8)h_{max}$

$h_{max} = \frac{32}{9.8} \approx 3.27$

6a. $T = r_x F_y - r_y F_x$ 100Ncm

$T = (5)(10) - (5)(-10)$

$T = 100$

6b. $\vec{F} = 2(5\hat{i} + 5\hat{j}) = 10\hat{i} + 10\hat{j}$ cm 200Ncm

$T = r_x F_y - r_y F_x = (10)(10) - (10)(-10)$

$T = 200$

6c. $30 = 5F_y - 5F_x$ $F_x = 2$ $\vec{F} = 2\hat{i} + 8\hat{j}$N

$6 = F_y - F_x$ $F_y = 6 + 2 = 8$

7. $\omega(t) = (10t + 60) \cdot \frac{2\pi}{60} = \frac{\pi}{3}t + 2\pi$ rad/s

$\alpha = \frac{\pi}{3}$ rad/s

$T = I\alpha$ $T \approx 0.00524$Nm

$T = \frac{1}{2}MR^2 \cdot \alpha$

$= 0.00167\pi$Nm

8a. $\omega = 30 \cdot \frac{2\pi}{60} = \pi$ rad/s 353.43kgm²/s

$I = \frac{1}{2}(100)(1.5)^2 = 112.5$kgm²

$L \approx 353.43$kgm²/s

8b. $I_{initial} \cdot \omega_{initial} = I_{total}\,\omega_{final}$ 16.67 rpm

$\omega_{final} = \frac{112.5 \cdot \pi}{202.5} \approx 1.744$ rad/s

$1.744 \cdot \frac{60}{2\pi} \approx 16.67$

Unit 7:

1. $T_{bricks} = r_{bricks}(m_{bricks} \cdot g)$
$= 3(40 \cdot 9.8)$
$= 1176N$

$T_{concrete} = r_{concrete}(m_{concrete} \cdot g)$
$= 2(60 \cdot 9.8)$
$= 1176N$

A: Remain Motionless

2. $T_1 = F_1(2.00 - 1.00) = F_1 \cdot 1.00$
$T_2 = F_2(1.00 - 0.50) = F_2 \cdot 0.50$

$F_1 \cdot 1.00 = F_2 \cdot 0.50$
$F_1 = 0.5F_2$

$0.5F_2 + F_2 = 196$
$1.5F_2 = 196$
$F_2 = \frac{196}{1.5} \approx 130.67N$

$F_1 = 0.5 \cdot 130.67 \approx 65.33N$

$F_1 = 65.33N$
$F_2 = 130.67N$