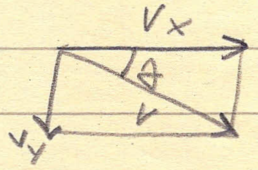
PHYSICS 6A FINAL
TR SECTION FORM A

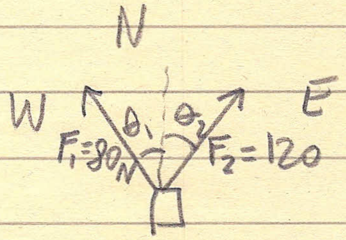
(1) $v_y = -\sqrt{2gh} = -\sqrt{2 \cdot 9.8 \cdot 2}\ m/s = -6.26\ m/s$

$\tan\theta = \frac{|v_y|}{v_x} = \frac{6.26}{28} \Rightarrow \underline{\theta = 12.6}$



D

(2)



$F_1 \sin\theta_1 = F_2 \sin\theta_2$

$\sin\theta_2 = \frac{F_1 \sin\theta_1}{F_2} = \frac{80 \sin 30}{120} = 0.333$

$\Rightarrow \theta_2 = 19.5°$ A

(3) Acceleration of system $a = \frac{F}{M_1 + M_2 + M_3} = \frac{50}{5+3+2}\ m/s^2 = 5\ m/s$

The contact force must impart the same a to the two boxes $F = (M_2 + M_3)a = (3+2)5\ N = 25\ N$ C

(4) $\omega^2 - \omega_0^2 = 2\alpha\Delta\theta$ $\alpha = \frac{-\omega_0^2}{2\Delta\theta} = -\frac{\left(30\frac{2\pi}{60}\right)^2}{2 \cdot 240 \cdot 2\pi}\ \frac{rad}{s^2} = -0.00327\ \frac{rad}{s^2}$

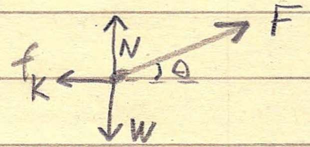
$\tau = I\alpha = 0.0850 \cdot 0.00327\ Nm = 0.000278\ Nm$ D

(5) $F = \frac{mv^2}{R} = \frac{2\ 25}{0.5}\ N = 100\ N$ E

(6) Net Force $= W_A - W_B = 1\,kg\ 9.8\,m/s^2 = 9.8\,N$

$$a = \frac{F}{m_A + m_B + m_C} = \frac{9.8}{10}\,m/s^2 = 0.98\,m/s^2 \quad \text{(A)}$$

(7)



Constant v means no acceleration

Vertical forces $N + F\sin\theta = W$

$\Rightarrow N = W - F\sin\theta$

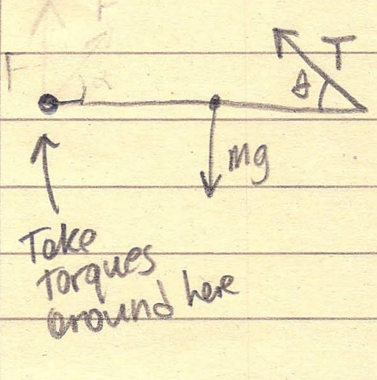
Horizontal forces $f_k = F\cos\theta$

$\mu_k N = F\cos\theta$ (A)

$$\mu_k = \frac{F\cos\theta}{N} = \frac{F\cos\theta}{W - F\sin\theta} = \frac{5\cos 30}{3 \cdot 9.8 - 5\sin 30} = 0.161$$

(8) $\omega = 210 \cdot \frac{2\pi}{60} \frac{rad}{s} = 22 \frac{rad}{sec}$ (B)

(9)



$$mg\frac{L}{2} = TL\sin\theta \quad \text{(B)}$$

$$T = \frac{1}{2}\frac{mg}{\sin\theta} = \frac{1}{2}\frac{20 \cdot 9.8}{\sin 25} N = 232\,N$$

(10) $K_T = \frac{1}{2}MV^2 \quad K_R = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{2}{5}MR^2\right)\frac{V^2}{R^2} = \frac{2}{5}K_T$

(A)

(11) Time taken to turn by 22° is $\Delta t = \frac{\Delta\theta}{\omega}$ ($\Delta\theta =$)

In that time the bullet travelled distance d

$$v = \frac{d}{\Delta t} = \frac{d\,\omega}{\Delta\theta}$$

$$V = 0.534 \cdot \frac{3000\left(\frac{2\pi}{60}\right)}{22\left(\frac{2\pi}{360}\right)}\ m/s = 0.534\ \frac{3000/60}{22/360}\ m/s$$

$$V = \frac{0.534 \cdot 3000 \cdot 6}{22}\ m/s = 437\ m/sec$$ [D]

(12) $V = at$ [A]

(13) $\tau = I\alpha \qquad \alpha = \frac{\tau}{I} = \frac{FR}{I}$

$$\omega^2 - \omega_0^2 = 2\alpha\Delta\theta$$

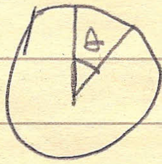
$\omega^2 = 2\alpha\Delta\theta$ Unwound by $L \Rightarrow \Delta\theta = 2\pi\frac{L}{R}$

$$\omega^2 = 2\alpha\, 2\pi\, L/R$$

$$\omega^2 = 2\,\frac{FR}{I}\,\frac{L}{R} = \frac{2FL}{I}$$ But $V = \omega R$

$$V^2 = \omega^2 R^2 = \frac{2FLR^2}{I} \qquad V = \sqrt{\frac{2FL}{I}}\,R = \sqrt{\frac{2 \cdot 5 \cdot 1.25}{0.0358}}\ 0.125\ m/sec$$

$V = 2.36\ m/sec$ (B)

(14)  $N = W\cos\theta$, $\cos\theta = \frac{1}{3}$, $\underline{\theta = 70.5°}$ (A)

(15) $X_{CM} = \frac{(6 \cdot 0 + 4 \cdot 3 + 2 \cdot 0)\,m}{6+4+2} = 1\,m$

$Y_{CM} = \frac{(6 \cdot 0 + 4 \cdot 0 + 2 \cdot 3)\,m}{6+4+2} = 0.5\,m$ [D]

(16) $a = \frac{\Delta V}{\Delta t} = \frac{19}{6}\,m/s^2 = 3.17\,m/s^2$ $W = 16{,}000N \Rightarrow m = 1600\,kg$ if $g = 10\,m/s^2$

$F = ma = 1600 \times 3.17\,N = 5072\,N$

$P = FV$ $V = at$, increases linearly, so $V_{AV} = \frac{19}{2}\,m/s = 9.5\,m/s$

$P = FV = 48.1\,kW$ [C]

(17) (E)

(18) ω is same _ $V = \omega r \Rightarrow V_A > V_B$ since $r_A > r_B$ (A)

(19) $F = \frac{\Delta p}{\Delta t} \Rightarrow$ [C]

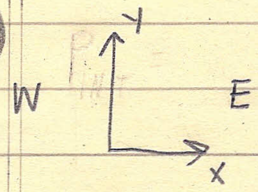
(20) [D]

(21) $F = m\omega^2 R = 10^{-3}\,kg \left(\frac{2\pi}{60}\right)^2 \frac{rad^2}{s^2}\, 0.1\, m = 1.10\, 10^{-6}\, N$ (A)

(22) $mgh = \frac{1}{2}mv^2 \quad v^2 = 2gh \quad v = \sqrt{2gh} = \sqrt{2 \cdot 10 \cdot 1}\ m/s$

$v = 4.5\, m/s$ (D)

(23)



$\vec{P}_{INIT} = m_1 v_1 \hat{x} + m_2 v_2 \hat{y}$

$|\vec{P}_{INIT}| = \sqrt{(m_1 v_1)^2 + (m_2 v_2)^2} = \sqrt{(900 \cdot 15)^2 + (750 \cdot 20)^2}\ kg\, m/sec$

$|\vec{P}_{INIT}| = \sqrt{182{,}250{,}000 + 225{,}000{,}000}\ kg\, m/sec = 20{,}180\ kg\, m/sec$

$P_{FIN} = (m_1 + m_2) V_F \quad V_F = \frac{P_{FIN}}{m_1 + m_2} = \frac{20{,}180}{1650}\ m/s = 12.2\, m/sec$ (B)

(24) [D] (Newton's 3rd Law)

(25)

initially: $U = mg\left(\frac{L}{2}\right)$, $K = 0$

finally: $K = \frac{1}{2} I \omega^2$ ← rotation about eraser, $U = 0$

$\Rightarrow mg\frac{L}{2} = \frac{1}{2}\left(\frac{1}{3}mL^2\right)\omega^2$

$gL = \frac{1}{3}L^2\omega^2 \quad \omega = \sqrt{\frac{3g}{L}} = \sqrt{\frac{3\ 9.8}{0.157}}\ \frac{rad}{s} = 13.7\ \frac{rad}{sec}$

(E)

(26)

$mg = K\Delta x \qquad \Delta x = \frac{mg}{K} = \frac{200}{2500}\ m = 8\ cm$ **C**

(27) $\Delta E = \frac{1}{2} m (v_2^2 - v_1^2) = \frac{1}{2} 1600 (40^2 - 15^2) J = 1.1\ 10^6 J$ **A**

(28) INITIALLY $U = M_1 g h \qquad K = 0$

FINALLY $U = 0 \qquad K = \frac{1}{2}(M_1 + M_2) v^2$

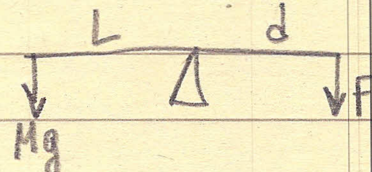
$\Rightarrow M_1 g h = \frac{1}{2}(M_1 + M_2) v^2 \Rightarrow v = \sqrt{\frac{2 M_1 g h}{M_1 + M_2}}$

$v = \sqrt{\frac{2 \cdot 2 \cdot 10 \cdot 0.8}{6}}\ m/s = 2.3\ m/sec$ **A**

(29) **D**

(30) **E**

(31)



$MgL = dF$

$d = \frac{MgL}{F} = \frac{15 \cdot 9.8 \cdot 1.5}{220}\ m$

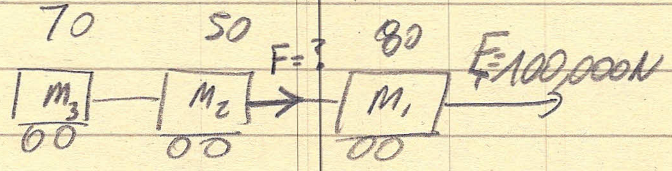
$d = 1.00\ m$

A

(32) **A**

(33) (B) Because $x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$

(34)



$F_T = (m_1+m_2+m_3)a \qquad F = (m_1+m_2)a$

$\Rightarrow F = \frac{m_1+m_2}{m_1+m_2+m_3} F_T = \frac{50+70}{50+70+80} 100{,}000N = 60{,}000N$ (D)