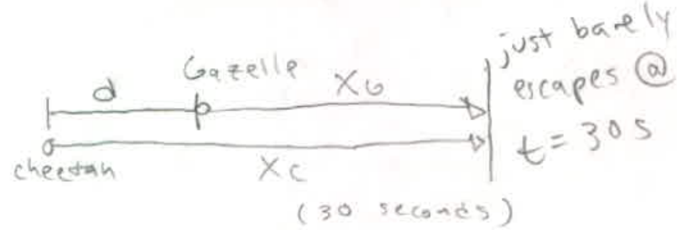
Final C
#s 1-3

1.

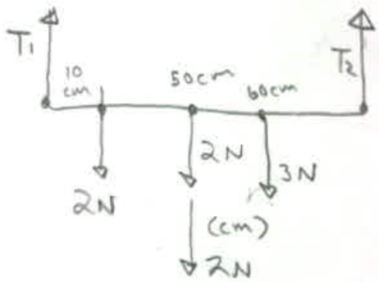


$X_C = d + X_G$

$100\,\frac{km}{hr} \cdot \frac{1\,hr}{3600\,s} \cdot 30s = d + \frac{80\,km}{hr} \cdot \frac{1\,hr}{3600\,s} \cdot 30s$

$d = \frac{1}{6}\ km = 167\ m$

2.



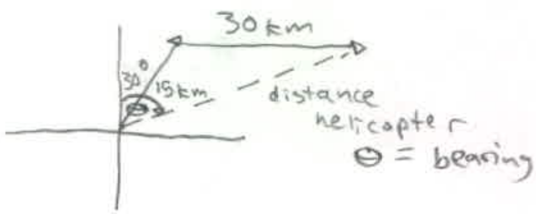
$\Sigma \tau = 0$

do w.r.t $x = 0\,cm$

$.1m(2N) + .5m(4N) + .6m(3N) - 1m\,T_2 = 0$

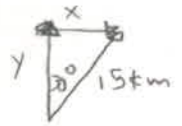
$T_2 = 4N$

3.



vector analysis

part 1



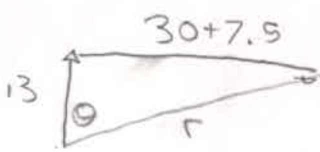
$\rightarrow y = \cos(30) \times 15 = 13.0$

$x = \sin(30) \times 15 = 7.5$

part 2

$y = 0$

$x = 30\,km$



r = distance travelled by helicopter @ bearing of θ

$r = \sqrt{13^2 + 37.5^2} = 39.7\,km$ @ $\Theta = \tan^{-1}\left(\frac{37.5}{13}\right) = 70.9^0$

Final C
#s 4 - 6

4.) $\Sigma F_y = \Sigma F_x = \Sigma F_{\substack{ramp \\ plane}} = 0$

$\Sigma F_y = T - 20N = 0$

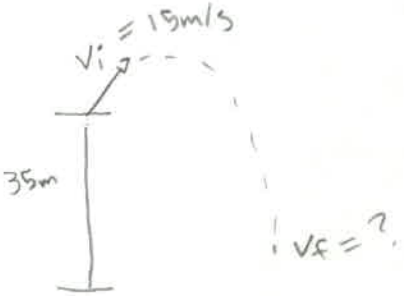
$T = 20N$

$\Sigma F_{ramp} = T - F_f = 0$

$F_f = T = 20N$

Friction balances out the weight of the other block

5.



can use kinematics, but energy is much easier!

$E_i = E_f$

$mgh_i + \frac{1}{2}mv_i^2 = mg\cancel{h_f}^{0} + \frac{1}{2}mv_f^2$

$gh + \frac{1}{2}v_i^2 = \frac{1}{2}v_f^2$

$\sqrt{2gh + v_i^2} = v_f \approx 30 m/s$

6.

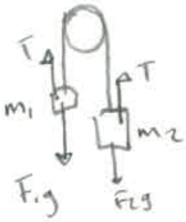
$v_f^2 = v_i^2 + 2ad \qquad v_i = 0$

$v_f^2/(2d) = a$, put your units in meters, seconds

$a = \left(\frac{120 km}{hr} \cdot \frac{1hr}{3600s} \cdot \frac{1000m}{1km}\right)^2 \div (480m)$

$a = 2.31 m/s$

7.



$T - m_1 g = m_1 a$
$T - m_2 g = -m_2 a$ } accelerating in different directions

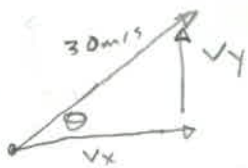
Final
#s 7, 8

$m_1 a + m_1 g = T$
$-m_2 a + m_2 g = T$

$m_1 a + m_1 g = -m_2 a + m_2 g$
$(m_1 + m_2) a = (m_2 - m_1) g$
$m_1 = 2\,kg, \quad m_2 = 6\,kg$
$8\,kg \cdot a = 4\,kg \cdot g$
$a = \frac{1}{2} g = 4.9\ m/s^2$

8.

$\theta = 35°$



$v_y = 30\ m/s \sin\theta = 17.2\ m/s$
$v_x = 30\ m/s \cos\theta = 24.6\ m/s$

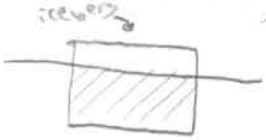
time to reach top of trajectory is given from eq
$v_{fy} = v_{iy} + a t$
$0 = 17.2\ m/s - (9.8\ m/s^2)\, t$
$t = 17.2/9.8\ s = 1.76$ seconds

Therefore it is in the air for $2t = 3.52\,s$
In this time it goes
$\Delta x = v_x \cdot \Delta t = 24.6\ \frac{m}{s} \times 3.52\,s = 86.6\ m$
(discrepancy with 86 as answer due to rounding.)

Final C
#s 9 - 12

9. 1 revolution passes through 2π radians
10 through 20π rad
so $\omega = \dfrac{20\pi \text{ rad}}{35 \text{ s}} = 1.8$ rad/s

10. A floating object displaces its own weight in fluid



weight of shaded volume, would, were it water, equal weight of entire iceberg.
$\omega = mg$ so factor out a g.

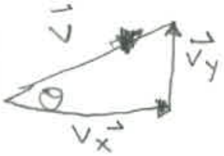
$M_{ice} = M_{I+} + M_{I-}$ (above and below the water line)
$V_{ice} = V_{I+} + V_{I-}$

Mass of volume below, filled w/water =
$V_{I-} \times \rho_w$ (ρ_w = density water) (ρ_I = density ice)
$V_{I-} \times \rho_w$ = Total mass of ice
$V_{I-} \times \rho_w = (V_{I-} + V_{I+})\rho_I$

Problem asks for $\dfrac{V_{I-}}{V_{I-}+V_{I+}} = \dfrac{\rho_I}{\rho_w} = \dfrac{920}{1030} = .893$ is submerged ("Eureka!")

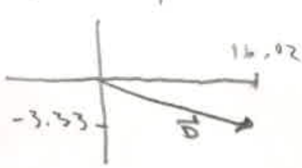
11. $y_f = y_i + v_0 t + \frac{1}{2}at^2$ $\downarrow v_i \downarrow g$
$\Delta y = (-1 \text{ m/s})(5 \text{ s}) + \frac{1}{2}(-9.8 \text{ m/s}^2)(5 \text{ s})^2$
$\Delta y = -128$ m, ie it travelled 128 m downwards

12. Divide vectors into components where, $\vec{Q}_x = Q\cos\theta\,\hat{x}$; $\vec{Q}_y = Q\sin\theta\,\hat{y}$
$\vec{Q} = (\vec{Q}_x, \vec{Q}_y)$



$\vec{A} = (8\cos 20°, 8\sin 20°) = (7.52, 2.74)$
$\vec{B} = (12\cos 300°, 12\sin 300°) = (6.00, -10.4)$
$\vec{C} = (5\cos 60°, 5\sin 60°) = (2.5, 4.33)$

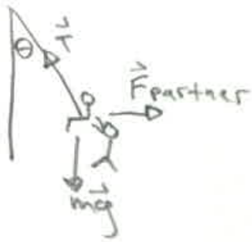
$\vec{D} = \vec{A} + \vec{B} + \vec{C} = (16.02, -3.33)$
add up components: D_x, D_y



from the pythagorean theorem, or a picture, magnitude of
$D = |D| = \sqrt{D_x^2 + D_y^2}$
$= \sqrt{(16.02)^2 + (-3.33)^2}$
$= 16.4$ units

13

Final C
#s 13-16



$\Sigma F_y = \Sigma F_x = 0$

y: $T_y - mg = 0$

$T\cos\theta = mg$

$T = \frac{mg}{\cos\theta}$

x: $T_x - F_{partner} = 0$

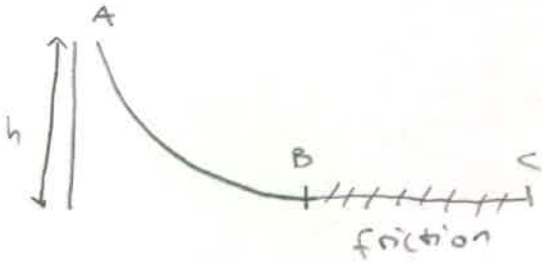
$F_p = T\sin\theta$

$F_p = mg\frac{\sin\theta}{\cos\theta} = mg\tan\theta$

$F_p = 800\text{ N}\tan(30°)$

$F_p = 462\text{ N}$

14, 15



14) up to point B, E is conserved

$E_A = E_B$

$\frac{1}{2}MV_1^2 + mgh = KE_B = (2\text{kg})(9.8\text{m/s}^2)(3\text{m}) + 2\text{J}$

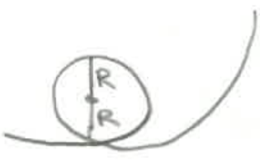
$KE_B = 60.8\text{ J}$

15) In the end, the box has no energy, since its @ ground level and not moving. This Energy went somewhere.

$E_B + W_F = 0$ ← final state

$W_F = -E_B = -60.8\text{ J}$

16



R = 2.6

$N + mg = \frac{mv^2}{r} = F_{centripital}$

minimum speed occurs when Normal force is zero (barely staying on circle)

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

$v = \sqrt{rg} = \sqrt{(2.6\text{ m})(9.8\text{ m/s}^2)}$

$= 5.0\text{ m/s}$

17.

Final C
#s 17-19

$\vec{V}$ is constant, so $\Sigma F = 0$

$F_{push} = -F_{friction}$

$\Delta X \cdot F_{push} = -\Delta X \cdot F_{friction}$

$W_{push} = \Delta x \cdot mg \cdot \mu_K$ (friction acts to the left, so two minus signs cancel.)

$W_{push} = (13\,m)(50\,kg)(9.8\,m/s^2)(.63)$

$W_{push} \approx 4000\,J$

18.

momentum conserved $\rightarrow m_A V_{1A} + m_B V_{2A} = m_A V_{2A} + m_B V_{2B}$

elastic so E conserved $\rightarrow \frac{1}{2} m_A V_{1A}^2 + \frac{1}{2} m_B V_{1B}^2 = \frac{1}{2} m_A V_{2A}^2 + \frac{1}{2} m_B V_{2B}^2$

$$V_{2A} = \frac{V_{1A}(m_A - m_B) + 2 m_B V_{1B}}{m_A + m_B}$$ (see book for derivation)

$V_{1B} = 0$, so

$$V_{2A} = V_{1A}\left(\frac{m_A - m_B}{m_A + m_B}\right)$$

$$\frac{KE_{2A}}{KE_I} = \frac{KE_{2A}}{KE_{1A}} = \frac{\frac{1}{2} m_A V_{2A}^2}{\frac{1}{2} m_A V_{1A}^2} = \left(\frac{m_A - m_B}{M_A + M_B}\right)^2 = \left(\frac{.10 - .15}{.10 + .15}\right)^2 = \left(\frac{-1}{5}\right)^2 = 4\%$$

19. $\Delta U(x) = -\int F \cdot dx$

$\Delta U(x) = -\int (\alpha - \beta x^3)\,dx$

$\Delta U(x) = -\alpha x + \frac{1}{4}\beta x^4 + C$

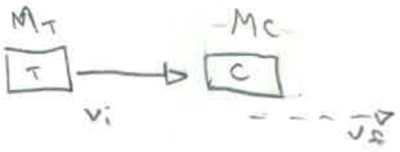
$C =$ constant

$\Delta U(0) = 0 \rightarrow C = 0$

$\Delta U(x) = -\alpha x + \frac{1}{4}\beta x^4$

Final C
#s 20-24
(there is no 24)

20)

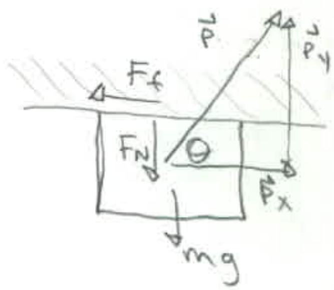


$$P_i = P_f$$
$$M_T V_i = (M_T + M_C) V_f$$
$$\frac{M_T V_i - M_T V_f}{V_f} = M_C$$
$$\frac{2500\,kg[(10\,m/s) - (7\,m/s)]}{7\,m/s} = 1070\,kg$$

21)

$$a_{ave} = \frac{\Delta v}{\Delta t} = \frac{(25\,m/s) - (-22\,m/s)}{3.5\,ms} \times \frac{1000\,ms}{1\,s}$$
(for ms, think mm, millimeter)
$$a_{ave} = 13{,}400\,m/s^2$$

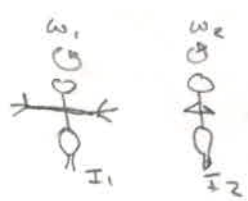
22)



The ball is not moving in the y-direction so $\Sigma F_y = 0$
$$F_N + mg = P_y$$
$$F_N = P_y - mg = P\sin\theta - mg$$
$$ma_x = \Sigma F_x \rightarrow a_x = \frac{\Sigma F_x}{m}$$
$$\Sigma F_x = P_x - F_f = P\cos\theta - F_f$$
$$\Sigma F_x = P\cos\theta - \mu F_N = P\cos\theta - \mu(P\sin\theta - mg)$$
$$\Sigma F_x = P_0(\cos\theta - \mu\sin\theta) + \mu mg$$
$$\Sigma F_x = 80(\cos 70 - .4\sin 70) + .4(5)(9.8) \quad N$$
$$\Sigma F_x = 16.89\,N$$
$$a = 16.89\,N / 5\,kg \approx 3.4\,m/s$$

23)

angular momentum is conserved



$$L_1 = L_2$$
$$I_1\omega_1 = I_2\omega_2$$
$$\omega_2 = \frac{I_1}{I_2}\omega_1 = \frac{(70\,kg\,m^2)}{(50\,kg\,m^2)} 4.1\,rad/s \rightarrow \omega_2 = 5.7\,\frac{rad}{s}$$

(note, dont say energy is conserved, we don't know that, also it takes work to bring in your arms and we get hot when we do exercise so...