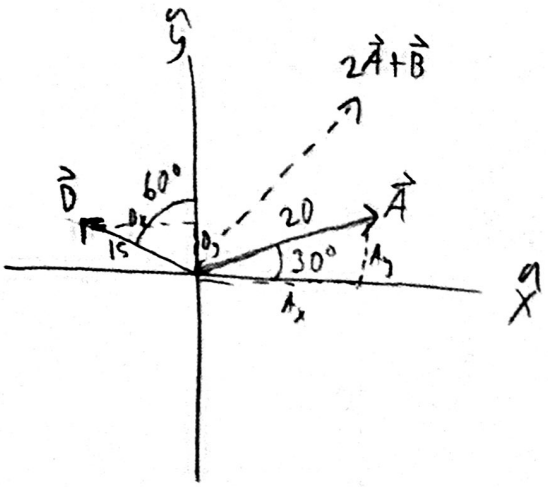
1)



$$\vec{A} = 20\cos(30)\hat{x} + 20\sin(30)\hat{y}$$
$$= 17.3\,\hat{x} + 10\,\hat{y}$$

$$\vec{B} = -15\sin(60)\hat{x} + 15\cos(60)\hat{y}$$
$$= -12.99\,\hat{x} + 7.5\,\hat{y}$$

$$2\vec{A}+\vec{B} = (2\cdot 17.3 - 12.99)\hat{x} + (2(10)+7.5)\hat{y}$$
$$= 21.65\,\hat{x} + 27.5\,\hat{y}$$

$$\sqrt{2\vec{A}+\vec{B}} = \sqrt{21.65^2 + 27.5^2} = \boxed{35\text{ m}}$$

$$\sin^{-1}\left(\frac{O}{H}\right) = \theta$$
$$\sin^{-1}\left(\frac{27.5}{35}\right) = \boxed{51.8^\circ}$$

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2) $t = 0.25\text{ s}$, $s = 0.8\text{ m/s}$

$$a = \frac{s}{t} = \frac{0.8\text{ m/s}}{0.25\text{ m/s}} = \boxed{3.2\text{ m/s}^2}$$

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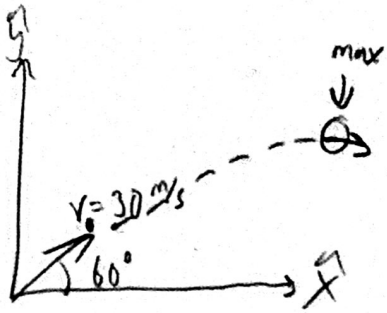
3)



max → Horizontal → $\theta_m = 0^\circ$

$V_y = 0$

$V_x = ?$ ← unchanged

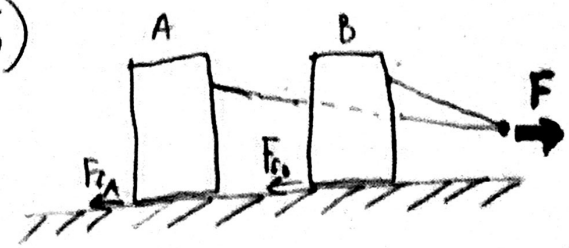
$$\vec{V}_0 = 30\cos(60)\hat{x} + 30\sin(60)\hat{y}$$
$$= 15\,\hat{x} + 25.98\,\hat{y}$$

$$\Rightarrow V_m = V_x + \cancel{V_y}^{\,0} = \boxed{15\text{ m/s}}$$

4) $F = ma$ → $\frac{F}{a} = m$

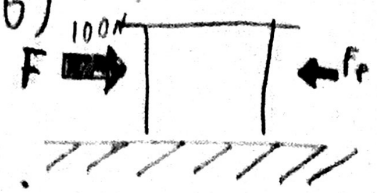
$F = 48\,N$, $a = 3\,m/s^2$ → $\frac{48\,N}{3\,m/s^2} = \boxed{16\,kg} = m$

5)



Friction force points opposite direction of motion <u>always</u>.

6)



If $F_{total} = F - F_f$ & $|F| = |F_f|$

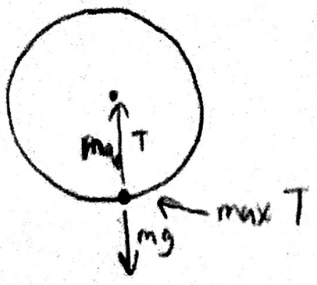
then $a = 0$ → <u>V = constant.</u> Thus, $\boxed{|F| = |F_f| = 100\,N}$

7) $F = kx$ => $k = \frac{F}{x}$

$x = 0.0375\,m$, $F = 1.5\,N$

$k = \frac{1.5\,N}{0.0375\,m} = \boxed{40\,N/m}$

8)



$T_{max} = ma_r + mg$, $a_r = \frac{v^2}{r}$

$m = 0.2\,kg$

$r = 0.5\,m$

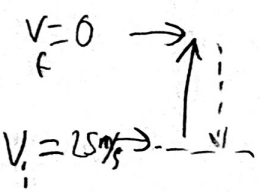
$T_{max} = 100\,N$

$\frac{T_{max} - mg}{m} = a_r = \frac{v_{max}^2}{r}$ => $v_{max} = \sqrt{r \cdot \left(\frac{T_{max} - mg}{m}\right)}$

$\boxed{v_{max} = 16\,m/s}$

9)

$$h = \frac{v_i^2 - v_f^2}{2g} = \frac{(25\ m/s)^2 - (0)^2}{2(9.8\ m/s^2)} = 46.8\ m$$



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10)

$E = K + U$

$U_f = U_i$

$K_i = \frac{1}{2} m v_i^2$

$K_f = 0$

$K_f - K_i = -\frac{1}{2}(1.5\ kg)(13\ m/s)^2$

$= \boxed{127\ J}$

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11) $P = F \cdot v$

$P_{walk} = 300\ W$

$P_{climb} = 0.05(mg)v$

$= (0.05)(70)(9.8)(1.388)$

$= 47.6388\ W$

$m = 70\ kg$

$v = 5\ km/h = 1.388$

$P_{total} = P_{walk} + P_{climb} = \boxed{347.6388}$

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12) $m_A = \frac{(625\ N)}{(9.8\ m/s^2)} = 63.8\ kg$, $m_B = \frac{(725\ N)}{(9.8\ m/s^2)} = 74\ kg$, $V_{Bf} = 1.5\ m/s$

$P_i = P_f$

$P_i = 0 \rightarrow P = 0 = m_A V_{Af} + m_B V_{Bf} \Rightarrow V_{Af} = -\frac{m_B}{m_A} V_{Bf} = \boxed{-1.74\ m/s}$

13) $m_1 = 0.4\,kg$ $v_{1i} = 2\,m/s$

$m_2 = 0.5\,kg$ $v_{2i} = -3\,m/s$

Relative v: (elastic collisions only) $v_{Bf} - v_{Af} = -(v_{Bi} - v_{Ai})$

Cons. of P: (elastic collision only) $P_i = P_f$

$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

divide by m_2 (or m)

$-1.7\,(m/s) = 0.8 v_{1f} + v_{2f}$

$\Delta v = -(-3 - 2) = +5\,m/s$

$= v_{2i} - v_{1i}$

$v_{1f} = v_{2f} - \Delta v$

$-1.7 = 0.8(v_{2f} - 5) + v_{2f}$

$v_{2f} = 1.44\,(m/s)$

$v_{1f} = 1.44 - 5 = -3.55\,(m/s)$

14)

	m	x	y
m_a	0.3	0.2	0.3
m_b	0.4	0.1	-0.4
m_c	0.2	-0.3	0.6

$$x_{cm} = \frac{(0.3)(0.2) + (0.4)(0.1) + (0.2)(-0.3)}{0.3 + 0.4 + 0.2}$$

$= 0.0444\,m$

$$y_{cm} = \frac{(0.3)(0.3) + (0.4)(-0.4) + (0.2)(0.6)}{0.3 + 0.4 + 0.2}$$

$= 0.0556$

15) $T = 1 \text{ revolution} = \boxed{2.25 \text{ s}}$ $\quad \omega = \frac{2\pi}{T} = \boxed{2.79 \frac{\text{rad}}{\text{s}}}$

16) $V = r\omega$ $\quad r = \frac{d}{2} = 30.5\text{cm} = 0.305\text{m}$

$\omega = 50 \text{ rad/s}$

$\Rightarrow r = (0.305)(50) = \boxed{15.3 \text{ m/s}}$

17) $\tau = F \cdot \ell$

$\tau_{Big} = 5\,\tau_{small}$

$(10N)\,\ell_{big} = 5\,(4N)(0.2m)$

$\ell_{big} = \frac{20}{10}(0.2m) = \boxed{0.4\,m}$

18) $L_f = L_i \rightarrow L_i = \frac{m_b v_b R}{2}$ $\quad L_f = I\omega = \left(\frac{m_b R^2}{4} + \frac{M R^2}{2}\right)\omega$

$m_b = 0.01 \text{ kg}$

$v_b = 500 \text{ m/s}$

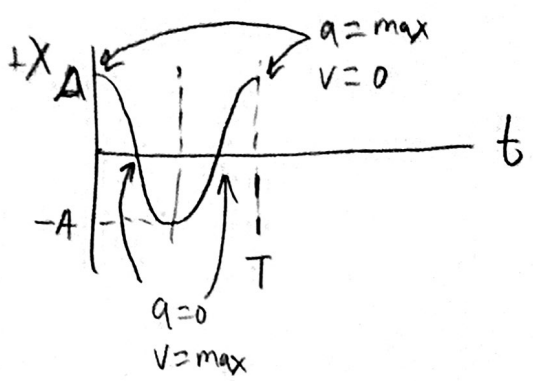
$M = 2 \text{ kg}$

$\frac{m_b v_b R}{2} = I\omega \Rightarrow \omega = \frac{m_b v_b R}{2} \cdot \frac{1}{I}$

$= \frac{(0.01)(500)(0.4)}{2} \cdot \left(\frac{1}{\frac{(0.01)(0.4)^2}{4} + \frac{2(0.4)^2}{2}}\right)$

$\omega = \boxed{6.2\left(\frac{\text{rad}}{\text{s}}\right)}$

19)



20) $\omega = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$

$\frac{\omega}{2} = \frac{1}{2\pi}\sqrt{\frac{g_p}{L}} \Rightarrow \frac{1}{4\pi}\sqrt{\frac{g}{L}} = \frac{1}{2\pi}\sqrt{\frac{g_p}{L}}$

$\frac{g}{4} = g_p$

21) $V = \lambda f = \text{const.} \rightarrow V$ does not change

$\lambda \propto \frac{1}{f} \rightarrow$ If λ doubles then f halves

22) $50\ dB - 30\ dB = 20\ dB \Rightarrow$ 100 x increase in intensity = 10 x decrease in distance

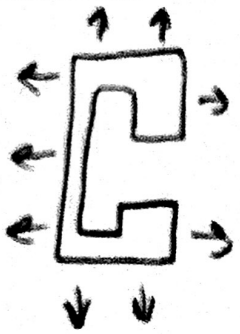
$50/10 = 5\ m$

23) $f' = f\frac{(V + V_L)}{(V + V_S)} = (600\ Hz)\frac{(344 + 16)}{(344 - 24)}$

$f' = 675\ Hz$

24) $V = \sqrt{2gh}$

$$h = \frac{V^2}{2g} = \frac{(10)^2}{2(9.8)} = \boxed{5.1\ m}$$

25) 

Gaps in objects expand when the object expands, to contact when the object contracts.

26) $H = k \cdot A \cdot \frac{T_H - T_c}{L} \Rightarrow k = \frac{H}{A} \cdot \frac{L}{T_H - T_c}$

$T_H =$

$T_c =$

$$= \frac{(75\ W)(0.00075\ m)}{(2\ m^2)(310\ K - 303\ K)} = \boxed{4E\text{-}3\ \frac{W}{m \cdot K}}$$

27) $N = n \cdot N_A$ $\qquad N_A = 6.022E+23$, $n = 3.2$

$$N = (3.2)(6.022E+23) = \boxed{1.927E+24}$$

28) $pV = nRT$ STP → 273 K, 1.013E+5 Pa $R = 8.31 \frac{J}{mol \cdot K}$

$m = 5g$

$mw = 0.125 \frac{g}{cm^3}$ or $4 \frac{g}{mol}$ ↑ periodic table

$n = \frac{5g}{4 \frac{g}{mol}} = 1.2 mol$

$V = \frac{nRT}{p}$

$= \frac{(1.2)(8.31)(273)}{(1.013E+5)}$

$= 0.0288 m^3$

$V = L^3 \Rightarrow L = V^{1/3}$

$\Rightarrow L = (0.0288 m^3)^{1/3} = \boxed{0.3 m}$

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29) $T = 273 K$ $Q = mL_f = (1 kg)(3.34E+3 \frac{J}{kg}) = 3.34E3 J$

$\Delta S = \frac{Q}{T} = \frac{3.34E3 J}{273 K} = \boxed{1220 \frac{J}{K}}$

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30) $e = \frac{W}{Q_H}$, $W = 2.5E4 J$, $e = 0.59$

$Q_H = \frac{W}{e} = \frac{2.5E4 J}{0.59} = 4.24E4 J$

$\approx \boxed{42 kJ}$