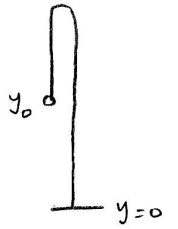
Exam 1 Solutions:

7.



$$y = y_0 + v_{y0}t + \tfrac{1}{2}a_y t^2$$

$$0 = y_0 + v_{y0}t - \tfrac{1}{2}gt^2$$

$$t = \frac{v_{y0} \pm \sqrt{v_{y0}^2 + 2gy_0}}{g} = \boxed{6.0\ s}$$

$v_{y0} = +19.6\ m/s$, $y_0 = 58.8\ m$, $a_y = -g$

8.

$v_{y0} = -19.6\ m/s$ compare #7 above

$t = \boxed{2.0\ s}$

9.

$v = v_0 - at = 0$ | $v^2 = v_0^2 - 2ad = 0$

$v_0 = at$ | $v_0^2 = 2ad$

$$a^2t^2 = 2ad \quad \Rightarrow \quad a = \frac{2d}{t^2} = \boxed{4\ m/s^2}$$

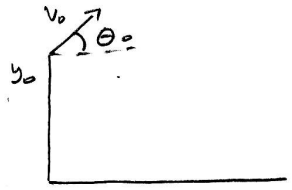
10. $\vec{F}_1 = 3\hat{i} + 2\hat{j}$ $\quad \vec{F}_2 = 2\hat{i} - 4\hat{j}$

$\vec{F} = \vec{F}_1 + \vec{F}_2 = 5\hat{i} - 2\hat{j} \equiv F_x\hat{i} + F_y\hat{j}$

$F = \sqrt{F_x^2 + F_y^2} = \boxed{5.4\ N}$

$\tan\theta = \frac{F_y}{F_x} = -\frac{2}{5} \Rightarrow \theta = \boxed{-22°}$

11.



$y - y_0 = v_{y0}t - \tfrac{1}{2}gt^2$

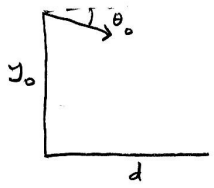
$d = v_{0x}t$

$$\therefore\ y - y_0 = v_{0y}\frac{d}{v_{0x}} - \frac{1}{2}g\left(\frac{d}{v_{0x}}\right)^2 = d\tan\theta_0 - \frac{gd^2}{2v_0^2\cos^2\theta_0}$$

$= -4.6\ m$

$\therefore\ y = y_0 - 4.6\ m = \boxed{6.4\ m}$

12.



$$v_y^2 = v_{y_0}^2 - 2g(y - y_0) = v_{y_0}^2 + 2g y_0$$

$$v_x = v_{x0}$$

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{v_0^2 + 2g y_0} = \boxed{138 \text{ m/s}}$$

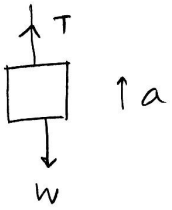
$$\tan\theta = \frac{v_y}{v_x} = \frac{\sqrt{v_0^2 \sin^2\theta_0 + 2gy}}{v_0 \cos\theta_0} \Rightarrow \boxed{\theta = -60^\circ}$$

13.

$$v_y = v_{y_0} - gt = 0 \qquad v_{y_0} = gt$$

$$y = v_{y_0} t - \frac{1}{2} g t^2 = + \frac{1}{2} g t^2 = \boxed{19.6 \text{ m}}$$

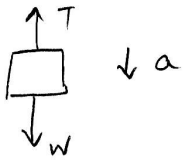
14.



$$T - w = ma$$

$$T = m(g + a) = \boxed{1.44 \times 10^4 \text{ N}}$$

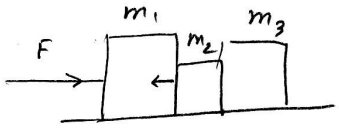
15.



$$w + T = ma$$

$$T = m(g - a) = \boxed{9.12 \times 10^3 \text{ N}}$$

16.



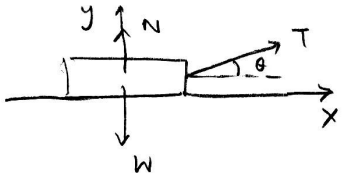
$$F - F_{2 \text{ on } 1} = m_1 a$$

$$F = (m_1 + m_2 + m_3)\, a$$

$$F_{2 \text{ on } 1} = F - m_1 a = (m_1 + m_2 + m_3)\, a - m_1 a$$

$$= \boxed{\frac{m_2 + m_3}{m_1 + m_2 + m_3} F}$$

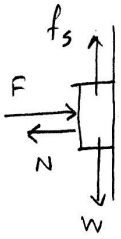
17.



$X: \quad N + T\sin\theta - mg = 0$

$N = \boxed{mg - T\sin\theta}$

18.

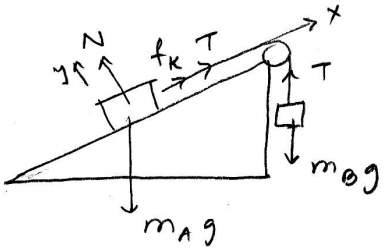


$X: \quad F = N$

$y: \quad f_s = W \qquad f_{s,max} = \mu_s N \geq W$

$F \geq \frac{W}{\mu_s} \qquad F_{min} = \frac{W}{\mu_s} = \boxed{12\ N}$

19.



$m_A \sin\theta > m_B$: A moves down

$y: \quad N - m_A g\cos\theta = 0$

$f_k = \mu_k N = \mu_k m_A g\cos\theta$

$= \boxed{17\ N}$

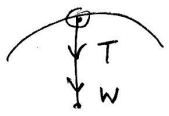
20. $X: \quad m_A g\sin\theta - T - f_k = m_A a$

$B: \quad T - m_B g = m_B a$

$\therefore \quad m_A g\sin\theta - m_B(g+a) - f_k = m_A a,$

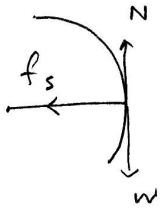
$a = \dfrac{m_A g\sin\theta - m_B g - f_k}{m_A + m_B} = \boxed{0.2\ m/s^2}$

21.



$T + mg = \frac{mv^2}{R}$

$T = 0: \quad v_{min} = \sqrt{gR} = \boxed{8\ ft/s}$

22. 

$f_{s,max} = \mu_s N \quad | \quad N = W = mg$

$= \mu_s mg$

$\mu_s mg = \frac{mv_1^2}{R_1}$

$\frac{v_1^2}{R_1} = \frac{(2v_1)^2}{R_2} \Rightarrow R_2 = \boxed{4R_1}$

23. As above : $\frac{v_1^2}{R_1} = \frac{(v_1/2)^2}{R_2} \Rightarrow R_2 = \boxed{R_1/4}$

24. 

$V = \frac{1}{2} \cdot \pi R^2 d = \boxed{1.9 \times 10^{22}\ cm^3}$