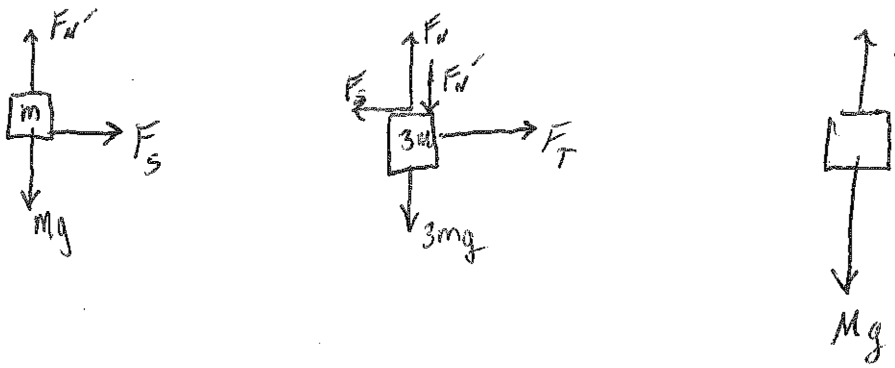
APC Version 1 Dynamics Test

4pts.

1. (a)




$\frac{1}{4}$ for correct scales everywhere ie $Mg > F_T$

$\frac{1}{4}$ for each diagram correct

2pts. (b) $F_s = ma$

$\mu_s mg = m a_{max}$

$\boxed{a_{max} = \mu_s g}$

3pts (c.) system

$\Sigma F = \Sigma m \cdot a$ — From part (b.)

$Mg = (M + 4m)\mu_s g$

$Mg = \mu_s Mg + 4m\mu_s g$

$Mg - \mu_s Mg = 4m\mu_s g$

$M(g - \mu_s g) = 4m\mu_s g$

$M(1 - \mu_s) = 4m\mu_s$

$\boxed{M = \dfrac{4m\mu_s}{1 - \mu_s}}$

2 pts

(d.) using $v^2 = v_0^2 + 2a\Delta x$

$\boxed{v = \sqrt{2\mu_s g d}}$

2pts

(e) vertical:

$h = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{2h/g}$

horizontal

$L = v_x t$

$L = \sqrt{2\mu_s g d} \cdot \sqrt{\frac{2h}{g}}$

$\boxed{L = \sqrt{4\mu_s d h} \text{ or } 2\sqrt{\mu_s d h}}$

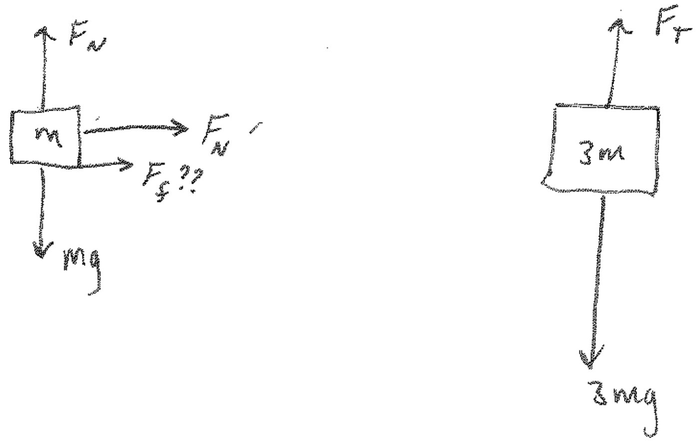
2pts. (f.) Decreased. If m even makes it to edge w/out falling off, it will have lower v since $\mu_k < \mu_s$ & accel. would have been lower on table. $\frac{1}{2}$ point for answer

$\frac{1}{2}$ for explaining

Version 2. Dynamics

1.)

+3 (a.) ✓




+3 (b) system

$$3mg - F_f = \Sigma m \cdot a$$

$$3mg - \mu_K(3mg) = 6ma$$

$$\boxed{a = \frac{g - \mu_K g}{2}}$$

+3 (c.) $v^2 = v_0^2 + 2ad$

$$\boxed{v = \sqrt{(g - \mu_K g)d}}$$

+3 (d.) ~~the~~ using $h = \frac{1}{2}gt^2$

$$t = \sqrt{\frac{2h}{g}}$$

$$L = v_0 \cdot t$$

$$l = \sqrt{(g - \mu_K g)d} \cdot \sqrt{\frac{2h}{g}}$$

$$L = \sqrt{g(1-\mu_K)d \cdot \frac{2h}{g}}$$

$$\boxed{L = \sqrt{(1-\mu_K)d \cdot 2h}}$$

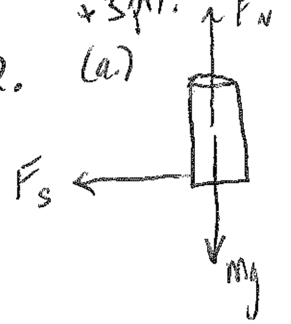
+3 (e.)

(i) with $F_g$ down incline a might be lower than before. Thus v is less at "launch".

(ii) 1.) Higher launch angle $\theta > 0$ might mean more range.

2.) Reduction in friction on ~~the~~ incline might mean a is higher, thus v is higher.

2. +3pts. (a)




3pts.
(b) $\Sigma F = ma$

$F_s = m\omega^2 r$

$\mu_s \cancel{m} g = \cancel{m}\omega^2 r$

$$\boxed{\omega_{max} = \sqrt{\mu_s g / r}}$$

3pts.
(c) Turntable has no real mass.

system mass $= m$

$\Sigma F_{ext} = ma$ ← this is tangential accel.

$$\boxed{-bv^3 = m\frac{dv}{dt}}$$

2pts.
(d.) $$\int_0^t -\frac{b}{m}\,dt = \int_{v_0}^{v} \frac{dv}{v^3}$$

$$-\frac{b}{m}t = \frac{v^{-2}}{-2}\Big|_{v_0}^{v}$$

$$+\frac{2b}{m}t = \frac{1}{v^2} - \frac{1}{v_0^2}$$

$$\frac{1}{v^2} = \frac{2b}{m}t + \frac{1}{v_0^2}$$

$$v = \sqrt{\frac{1}{\frac{2b}{m}t + \frac{1}{v_0^2}}}$$

note: when $t = 0$, $v = v_0$

also as $t \to \infty$ $v \to \frac{1}{\infty} = 0$

(e) centripetal component

2pts. $F_s = \frac{mv^2}{r} = \frac{1}{\left(\frac{2bt}{m} + \frac{1}{v_0^2}\right)r}$

Since turntable has no real mass we cant calculate an internal system force tangent to circle on the mass $m$.

2pts.
(f.) when $F_A = bv^3$ we have $V_{terminal}$

$$\boxed{V_T = V_{max} = \left(\frac{F_A}{b}\right)^{1/3}}$$