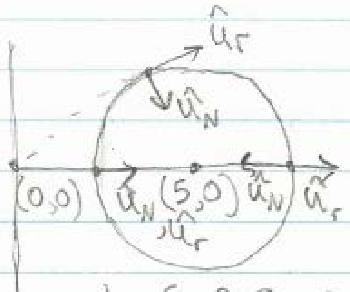
Question 1

a)



$\hat{u}_r$ will always point to the right

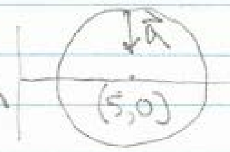
$\hat{u}_N$ will always point towards (5,0)

$\therefore$ $5-2.8=2.2$, or $(2.2, 0)$ is the only point $\hat{u}_r = \hat{u}_N$. At $(7.8, 0)$, $|\hat{u}_r| = |\hat{u}_N|$, but direction is different

b) V = constant $\therefore$ $a_t = 0$

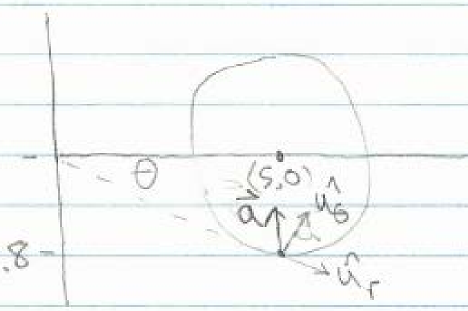
$$a_N = \frac{V^2}{r} = \frac{9^2}{2.8} = 28.93 \text{ m/s}^2$$

At the top, $\hat{u}_N$ will point down



$\therefore$ $a_N = -28.93\,j$ m/s^2

c) At the bottom, we know $|a_N|$ is still 28.93 m/s^2



$\tan\theta = \frac{2.8}{5}$ $\therefore$ $\theta = 29.25°$

$a_\theta = \vec{a}\cos 29.25$
$= 25.24$

$a_r = \vec{a}\sin 29.25$
$= 14.13$

From diagram, a_r is negative

$\therefore$ $\vec{a} = 25.24\,\hat{u}_\theta - 14.13\,\hat{u}_r$

d) Slowing down means $\frac{dV}{dt}$, or $\hat{a}_t$

$\therefore a_t = 1.3 \, m/s^2$

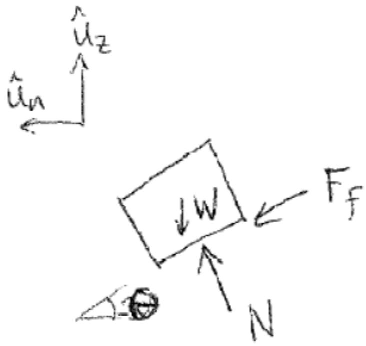
$\therefore a_n = \frac{v^2}{r} = a_t = 1.3$

$V = V_0 + at = 9 - 1.3t$

$\therefore 1.3 = \frac{(9 - 1.3t)^2}{2.8}$

$\therefore t = 5.46$ sec

Question 2



$$\Sigma F_z = m a_z$$

$$N\cos\theta - W - F_f \sin\theta = 0$$

$$F_f = |F_s|_{max} = \mu_s N$$

$$\therefore\ N(\cos\theta - \mu_s \sin\theta) = W$$

$$N = \frac{W}{\cos\theta - \mu_s \sin\theta} \cancel{= \frac{(5)(9.81)}{\cos 30 - 0.28\sin 30}}$$

$$= \frac{(5)(9.81)}{\cos 30° - 0.28 \sin 30} = 67.6\ N$$

$$\Sigma F_n = m a_n$$

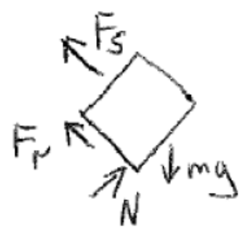
$$N\sin\theta + F_f \cos\theta = m\frac{v^2}{\rho}$$

$$N(\sin\theta + \mu_s \cos\theta) = m\frac{r^{\cancel{2}}\dot{\theta}^2}{\cancel{r}}$$

$$r = \frac{N}{m\dot{\theta}^2}(\sin\theta + \mu_s \cos\theta) = \frac{67.6}{(5)(10)^2}(\sin 30 + 0.28\cos 30)$$

$$= 0.1\ m$$

Question 3



(a) $\Sigma F_y = 0 = N - mg\cos 50$

$N = (25)(9.81)(0.643) = 157.6$ Newtons

At critical point, $\Sigma F_x = 0 = -\mu_s N - F_s + mg\sin 50$

$0 = -157.6\mu_s - (20)(4) + (25)(9.81)(0.766) \Rightarrow \mu_s = 0.68$

Block does not slide for $\mu_s > 0.68$

(b) $a_x = \Sigma F_x/m = -\mu_k N - F_s + mg\sin 50$

$= [(-0.15)(157.6) - (20)(4) + (25)(9.81)(0.766)]/25$

$a_x = 3.37$ m/s^2

(c) $\frac{1}{2} m v_2^2 = \frac{1}{2} m v_1^2 - mg\Delta h - F_f \Delta s - \frac{1}{2}k(x_2^2 - x_1^2)$

$(\frac{1}{2})(25)(v_2^2) = (\frac{1}{2})(25)(3^2) - (25)(9.81)(-1.5\sin 50) - (.15)(158)(1.5)$

$- (\frac{1}{2})(20)(5.5^2 - 4^2)$

$\Rightarrow v_2 = 4.16$ m/s