M2 SUNE OI
1)

$$
\begin{aligned}
& r=\left(t^{2}+2 t\right) i+\left(t-2 t^{2}\right) j \\
& r=\frac{d r}{d t}=(2 t+2) i+(1-4 t) j \\
& a=\frac{d v}{d t}=2 i-4 j \Rightarrow|a|=\sqrt{2^{2}+4^{2}}=2 \sqrt{5} \mathrm{~ms}^{-2}
\end{aligned}
$$

2) 


$u=$ mass per unit $\mathrm{cm}^{2}$
(1) $M=100$ itu $g_{1}(0,10)$
(2) $M=400 \pi \mathrm{~K} \quad g_{2}(0,-20)$
(1) +2) $M=500 \pi h \quad G(0, \bar{y})$

$$
\begin{aligned}
\hat{T} \rightarrow \quad 100 \pi \operatorname{tag} x 10+400+\operatorname{lig} x-20 & =500+1 \text { lag } \bar{y} \\
\Rightarrow 1000-8000=500 \bar{y} & \Rightarrow \bar{y}=-14 \\
& \Rightarrow 6 \mathrm{~cm} \text { above B }
\end{aligned}
$$

b) $\int_{0}^{10} 10+14$

$$
\theta=t
$$

3) 


at greatest value of $u$, ladder will be in limiting equilibrium

$$
\Rightarrow \text { friction }=\text { fran }=\mu N R_{A}=\frac{1}{2} N / A
$$

$$
\begin{aligned}
& R+\uparrow=\downarrow \Rightarrow N R A=6 m g \Rightarrow f_{\text {max }}=3 m g . \\
& R \vec{F}=0 \Rightarrow N R B=f_{m a x}=3 m g .
\end{aligned}
$$

$$
\begin{array}{ll}
M=\frac{1}{2} & \text { Al mg } \times a \cos 60+5 m g \times 4 a \cos 60=3 i \operatorname{mg} \times 2 a \sin 60 \\
& \frac{1}{2} \alpha x+\frac{5}{2} u q x=3 \sqrt{3} x \quad u=\frac{3 \sqrt{3}-1}{s}=1.88(3 x)
\end{array}
$$

4) Mom before + Impulse = Mom after

$$
\begin{aligned}
& \Rightarrow 0 \cdot u+3 \cdot 5 i+3 j=0.1(10 i+25 j) \\
& \Rightarrow 0 \cdot 1 u=-2 \cdot 5 i-2.5 j \quad \Rightarrow u=-25 i+25 j m s^{\prime}
\end{aligned}
$$

b)

$$
\begin{array}{ll}
u \uparrow=2 s & v^{2}=u^{2}+2 a s \\
v \uparrow=0 & 0=2 s^{2}-19.6 s \\
a \uparrow=-9.8 & \Rightarrow 31.9 \mathrm{~m} \\
a 32.9 \mathrm{~m} \text { above }
\end{array}
$$

$\Rightarrow 32.9 \mathrm{~m}$ above ground.
c)

$$
\begin{aligned}
s \uparrow=0 \quad s=u t+\frac{1}{2} a t^{2} \Rightarrow & 0=2 s t-4 \cdot 9 t^{2} \\
0 & =t(25-4 \cdot 9 t) \\
& \Rightarrow t=5 \cdot 10 \ldots \\
\vec{H} \text { vel = } 10 \quad t=s \cdot 10 \ldots & x=10 \times 5 \cdot 10 \ldots \quad x=\sin (2 s t)
\end{aligned}
$$

5) 



$$
\begin{aligned}
& K E_{A}-\text { wd against } R=P E B \\
& \frac{1}{2}(0.5) s^{2}-R \times 2=0.5 g(2 \sin 20) \\
& \left.2 R=\frac{25}{4}-g \sin 20 \Rightarrow \frac{R=1.45 N}{(3 s \mathrm{~S}} \mathrm{L}\right)
\end{aligned}
$$

b)

$$
\begin{aligned}
& \frac{1}{2}(0.5) s^{2}-R \times s=0.5 g(s \sin 40) \\
& \frac{1}{2}(0.5) s^{2}=(0.5 g \sin 40+R) s \quad \Rightarrow s=1.36 m(3 s f)
\end{aligned}
$$

6) 

$$
\begin{aligned}
& A(2 m) \rightarrow 2 u \quad B \underset{\rightarrow V_{A}}{\rightarrow 4 m} \rightarrow u \quad e=\frac{1}{2}=\frac{V_{B}-V_{A}}{u} \Rightarrow u=2 V_{B}-2 V_{A} \\
& C L M B=u+2 V_{A} \\
& \Rightarrow 4 m u+4 m u=2 m V_{A}+4 m V_{B}
\end{aligned}
$$

$$
\begin{gathered}
\Rightarrow 8 m u=2 m V_{A}+2 m u+4 m V_{A} \Rightarrow 8 m u=6 m V_{A}+2 m u \\
\Rightarrow 6 u=6 V_{A} \Rightarrow V_{A}=u \\
\xrightarrow{u} \quad \stackrel{\frac{3}{2} u}{\rightarrow} \quad 0 \quad 2 V_{B}=3 u \Rightarrow V_{B}=\frac{3}{2} u
\end{gathered}
$$

$A \underset{\vec{u}}{2 m} B \underset{v_{B}}{\rightarrow \rightarrow v_{c}} C \underset{\rightarrow}{m}$

$$
\begin{aligned}
C M M \Rightarrow 6 m u & \Rightarrow 4 m V_{B}+m V_{C}
\end{aligned} \begin{aligned}
& \Rightarrow V_{C}=6 u-4 V_{B} \\
& \Rightarrow 10 V_{B}=12 u-3 e u \\
& \Rightarrow V_{B}=\frac{1}{10} u(12-3 e)
\end{aligned}
$$

If there ane no further collision $V_{B} \geqslant U$

$$
\begin{array}{cl}
\frac{1}{10} u(12-3 e) \geqslant u & \Rightarrow 12-3 e \geqslant 10
\end{array} \quad \Rightarrow 2 \geqslant 3 e
$$

7) $\tan \alpha=\frac{2}{3}$

$$
\frac{5}{3} 44 \begin{array}{ll}
\sin \alpha=\frac{4}{5} \\
\cos \alpha=\frac{3}{5}
\end{array}
$$

$V \uparrow$

$$
\begin{aligned}
& u \uparrow=23.75 \times \frac{4}{5} \\
& S \uparrow=-2.4 \\
& a \uparrow=-9.8
\end{aligned}
$$

$$
\begin{aligned}
& S=u t+\frac{1}{2} a t^{2} \Rightarrow-2.4=19 t-4.9 t^{2} \Rightarrow 4.9 t^{2}-19 t-2.4=0 \\
& t=\frac{19+\sqrt{19^{2}-4(4.9)(-2.4)}}{9.8} \rightarrow t=4 \mathrm{sec}
\end{aligned}
$$

b)

$$
\begin{aligned}
& V=\int a d t=-\frac{1}{12} t^{3}+c \quad V=18, t=0 \Rightarrow c=18 \\
& V=-\frac{1}{12} t^{3}+18
\end{aligned}
$$

when $t=T \quad V=0 \quad 0=-\frac{1}{12} T^{3}+18$

$$
\Rightarrow T^{3}=216 \Rightarrow T=6 \mathrm{sec}
$$

d)

$$
\begin{aligned}
& \vec{H} \quad \vec{u}=23.75 \times \frac{3}{s}=14.25 \\
& t=4 \\
& x=14.25 \times 4=57 \mathrm{~m} \quad A C=57 \mathrm{~m} . \\
& v=-\frac{1}{12} t^{3}+18 \quad S=\int v d t=-\frac{1}{48} t^{4}+18 t+C \\
& S=0, t=0 \Rightarrow C=0 \quad \Rightarrow S=-\frac{1}{48} t^{4}+18 t \\
& t=4 \quad S=66 \frac{2}{3} \mathrm{~m} .
\end{aligned}
$$

Lorry is $66 \frac{2}{3} \mathrm{~m}$ from $A$ wan $C$ hits the ground
$\therefore$ Lorry is $66 \frac{2}{3}-57=9 \frac{2}{3} \mathrm{~m}$ ahead of $C$

