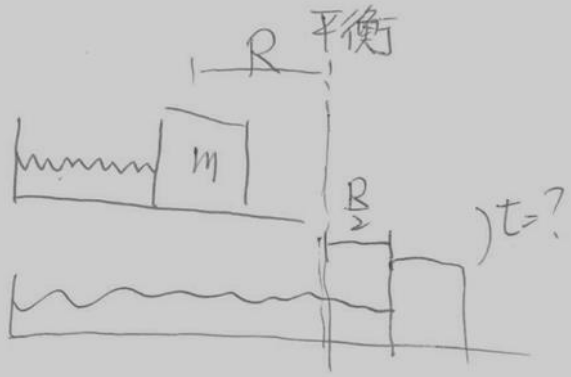
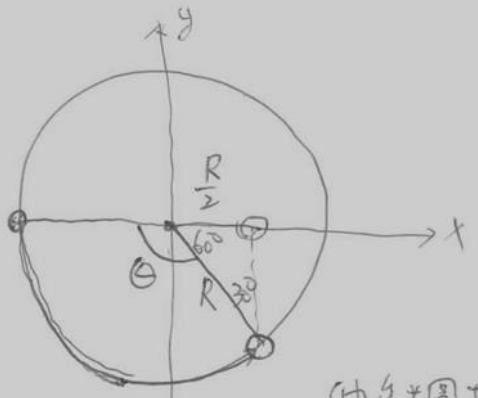
單1.





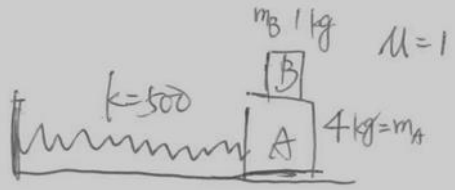
(由參考圓找時間)

$$t = T \cdot \frac{\theta}{360}$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$\therefore t = 2\pi\sqrt{\frac{m}{k}} \cdot \frac{120}{360} = \frac{2\pi}{3}\sqrt{\frac{m}{k}}$$

單2.



for B 簡諧運動由 靜摩擦 提供外力來作簡諧 $\because f_s \le f_{smax}$ 且 $F_{合力} = ma$

知 $m_B a_B \le f_{smax} = N \cdot \mu_s$ $(N = m_B g$

for (A+B) 簡諧運動由彈力提供

$$F = -kx = (m_A + m_B) a_{(A+B)} \quad \because A、B \text{ 無分開}$$

$$\therefore a_A = a_B = a_{(A+B)}$$

$$\therefore kx = (m_A + m_B) \cdot a_B \le \frac{m_B g}{m_B} \mu_s \cdot (m_A + m_B)$$

$$x \le \frac{10 \cdot 1 \cdot (4+1)}{500} = 10cm$$

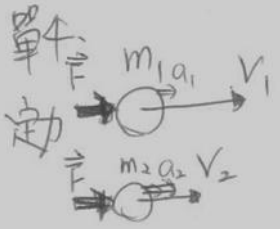
單3.

$\because$ 當物體置在木塊上時水平方向所受外力一樣是 $F = -kx$(彈力)，平衡點一樣是原長，而當所受合力 $= F = -kx$ 時週期即為 $T = 2\pi\sqrt{\frac{m}{k}}$ → 振動物質量 → 比例常數

$$\therefore T_1 = T_2 = \sqrt{20} = \sqrt{25} = 2\pi = 5$$

$T_2 = 5$ [illegible]

單4、



動

$\vec{P}_{末} = \vec{P}_{原} + \vec{F}_{合} t$ ∴只有$\Delta\vec{P}$同

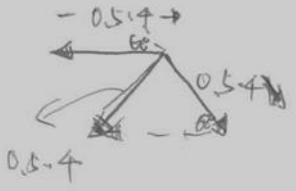
$\Delta\vec{P} = \vec{F} \cdot \Delta t$ 其它不一定

$\vec{V}_{末} = \frac{\vec{P}_{末}}{m}$ (E)有可能$a_1 < a_2$但t很小

單5、

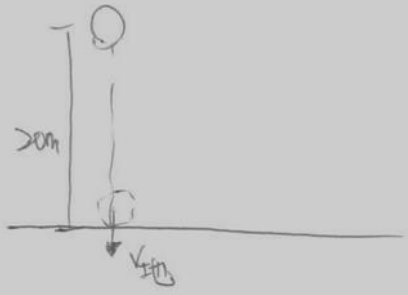
$F_{av\,壁} = -F_{av\,水} = -\frac{\Delta P_{水}}{\Delta t}$ = (1秒內動量變化量)

$= -\frac{0.5 \cdot 4 \rightarrow - 0.5 \cdot 4 \rightarrow}{1}$



$= 0.5 \cdot 4 \nearrow = 2N \nearrow$

單6、



物體從運動→靜止是"合力"造成運動改變

$\therefore F_{合} = F_{av} = \frac{\Delta P}{\Delta t}$

$F_{合力} = N - mg$

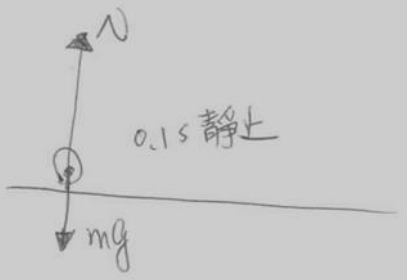
而ΔP為落地在接觸地面時(0.1s內)的動量變化

$P_{原} = mV_{地}$ $P_{末} = 0$

$V_{地}^2 = 0^2 + 2 \cdot 10 \cdot 20$ (等加速公式)

$V_{地} = 20$

$\therefore N - mg = \frac{m[0-(-20)]}{0.1}$ 定向上為正



$N - 1 \cdot 10 = \frac{1 \cdot 20}{0.1}$

$N = 210\,N$

單7. F變力　　g取10

$\mu_k = 0.2$
$\mu_s = 0.2$

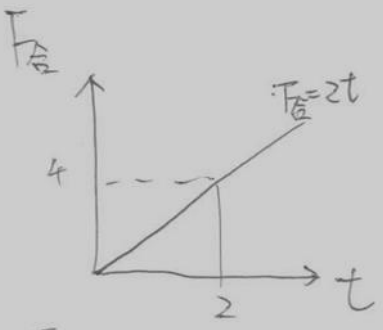
$F = 2t + 1$

物體運動狀態的變化(動量變化)是由"合力"造成的

由於物體會動 ∴ 摩擦力為動摩擦為一定值

$f_k = N \cdot \mu_k = 0.5 \times 10 \times 0.2 = 1\ (N)$

合力與t關係如左圖



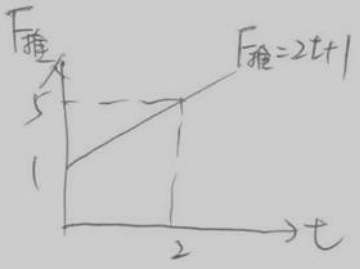
由 $\int_{t_1}^{t_2} F = \Delta \vec{P}$ 知 $\vec{P}_2 - 0 = \frac{2 \times 4}{2} = 4$

$mV_2 = 4 \Rightarrow V_2 = 8\ m/s$

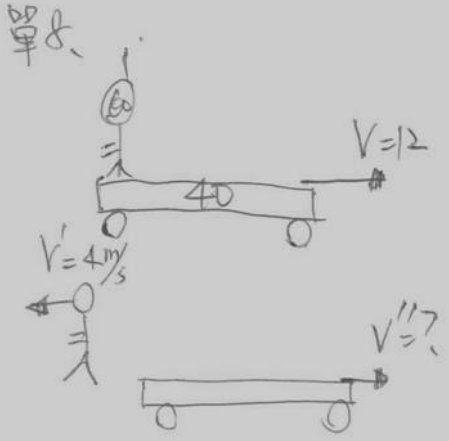
由 $F_{合_2} = ma_2 \Rightarrow a_2 = 8\ m/s^2$

推力的衝量可由 $F_{推}$-t 圖面積得

$\frac{(5+1) \times 2}{2} = 6\ (N \cdot s)$



單8.



由於水平外力=0 (定右為正)

動量守恆

$(60+40) \cdot 12 = 60 \times 4 + 40 \cdot V''$

$V'' = \frac{1440}{40} = 36\ m/s$

單9. 由一開始油與車等速 ∴ 油在向下流出時水平方向依慣性會有相同的初始速度，再依據動量守恆

$(1000+500) \cdot 60 = [1000 + (500-100)] \cdot V + 100 \cdot 60$

$V = 60\ km/hr$

單10.

丙循原路回原拋射點代表 $V_{丙}$ 與爆炸前速度大小相等，方向相反（∵依據運動對稱性，丙運動與未爆物體運動是反向的但同為平拋的運動，且飛行距離同代表速度量值同）

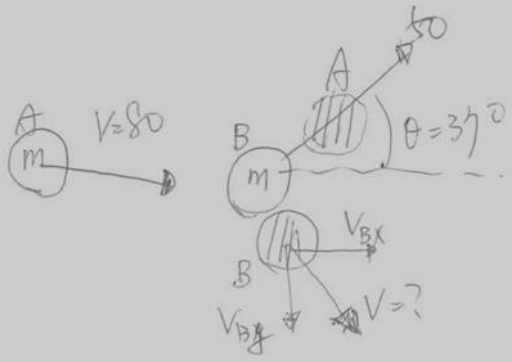
∵若設炮彈在最高點速度為 V，則爆炸後 $V_{丙} = -V$

再據爆炸瞬間動量守恆

$$6mV = -3mV + 0 + 2mV_{甲}$$

$$V_{甲} = \frac{9}{2}V \quad \therefore \frac{V_{甲}}{V_{丙}} = \frac{9}{2}$$

單11.



∵水平面上外力=0（定右、上為正）

∴動量守恆

水平 = $m \cdot 80 = m \cdot 50 \cdot \cos 37° + m \cdot V_{Bx}$

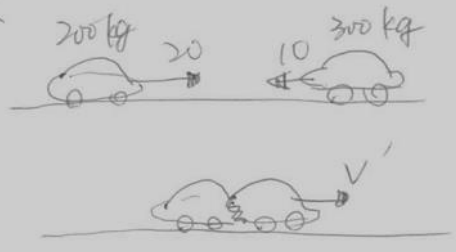
鉛直 = $0 = m \cdot 50 \cdot \sin 37° + m V_{By}$

$$V_{Bx} = \frac{m \cdot 40}{m} = 40\ m/s$$

$$V_{By} = -30\ m/s$$

$$V_B = \sqrt{30^2 + 40^2} = 50\ m/s$$

單12.

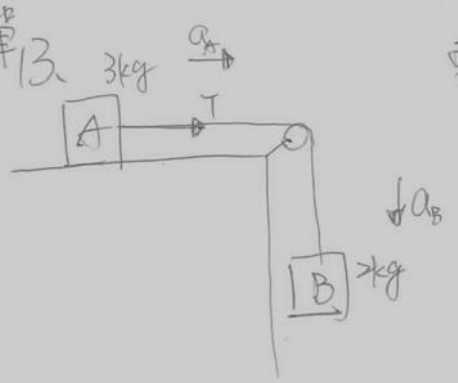


水平外力=0 ⇒動量守恆 （定東為正）

$$200 \cdot 20 + 300(-10) = (200+300)V$$

$$V = \frac{1000}{500} = 2\ m/s \ (向東)$$

單13、

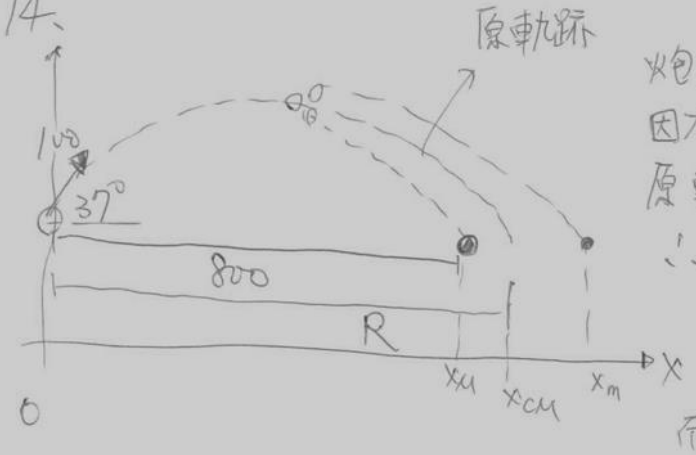


要求 a_{CM} 由加權平均得，要先求出各別 a

看A $\begin{cases} T = 3 \cdot a_A \\ 20 - T = 2 \cdot a_B \\ a_A = a_B \end{cases}$ $\Rightarrow$ $a_A = a_B = 4\ m/s^2$

$$a_{CM} = \frac{3 \cdot 4 \rightarrow + 2 \cdot 4 \downarrow}{3+2} = \frac{\sqrt{12^2+8^2}\ \searrow}{5} = \frac{4\sqrt{13}}{5}\ m/s^2\ \searrow$$

單14、



炮彈爆炸是內力，質心軌跡不變（落地前）因大小碎片同時落地，此時質心也會在原軌跡的地面位置

$\therefore X_{CM} = R = 100 \cdot \cos 37° \cdot T_{飛}$

$= 80 \cdot 2 \cdot \frac{V \sin 37°}{g}$

$= 960\ m$

而 $X_{CM} = \frac{MX_M + m \cdot X_m}{M+m} = \frac{3 \cdot 800 + 1 \cdot X_m}{4} = 960$

$X_m = 1440\ m$

單15、(A) 相對質心，系統總動量和必為零 $\therefore$ (A)錯

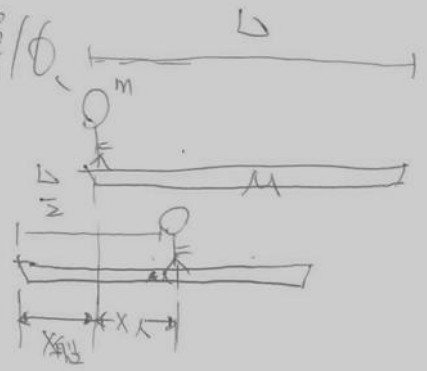
(B) 質心不因為內力而改變運動 $\therefore X_{CM}$ 不動 (B)錯

(C) 質心只受重力可能是直線運動

(D) 

質心可以無質點

單16、



由質心不動（因一開始靜止且外力=0）

由圖知 $X_{船} + X_{人} = \frac{L}{2}$

由 $\Delta X_{CM} = \frac{M(-X_{船}) + m \cdot X_{人}}{M+m} = 0$

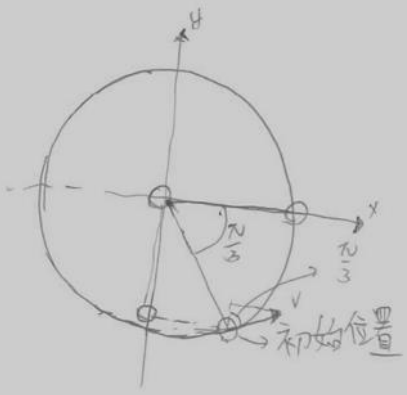
兩式聯立可得 $X_{船} = \frac{m}{M+m} \cdot \frac{L}{2}$

多17、 $X(t) = 10\sin(\pi t - \frac{\pi}{3})$

$R = 10$

$\omega = \pi$ 可以視為鉛直投影

$\theta_0 = -\frac{\pi}{3}$



(A) $T = \frac{2\pi}{\omega} = 2(s)$ ✓

(B) 到平衡點 $t = T \cdot \frac{60}{360} = \frac{2}{6} = \frac{1}{3}(s)$ ✓

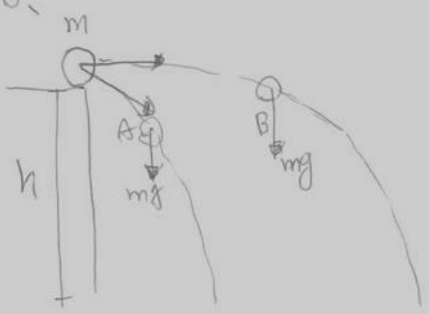
(C) $t=2$ 即物體在初始位置時的狀態（因週期是 2(s)）

$V = r\omega \cdot \cos\frac{\pi}{3} = 10\pi \cdot \frac{1}{2} = 5\pi$ ✓

(D) 端點 a 即最大a 即參考圓之向心加速度 $a = r\omega^2 = 10\pi^2$

(E) $\vec{F} = m\vec{a} = m \cdot (-\omega^2 \vec{x}) = -1 \cdot \pi^2 \vec{x}$

多18、



(A) 拋體中下拋會較早落地 ∴ $t_A < t_B$

(B) 因質量同而飛行中只有重力 ∴ $F_A = F_B = mg$

(C) $\vec{J} = \vec{F} \cdot t$ ∴ $\vec{J}_A < \vec{J}_B$

(D) 落地時兩者把相同位能轉換成動能，而初動能又相同，∴落地動能相同=速度的值同 ∴ $|\vec{P}_A| = |\vec{P}_B|$

(E) $\vec{J} = \Delta\vec{P}$ ∴ $\Delta\vec{P}_A < \Delta\vec{P}_B$

19、

因一開始靜止且同時放手，系統水平外力=0 動量守恆且質心不動

(甲) $0 = M\vec{V}_M + m\vec{V}_m$

$\Rightarrow |\vec{V}_M| = |\vec{V}_m| = m:M$

(丙) $\vec{J} = \Delta\vec{P}$

$\vec{J}_M = M\vec{V}_M$

$\vec{J}_m = m\vec{V}_m$

$\because |M\vec{V}_M| = |m\vec{V}_m|$

$\therefore |\vec{J}_M| = |\vec{J}_m|$

(已) $\Delta X_C = \frac{M\Delta X_M + m\Delta X_m}{M+m} = 0$

$M\Delta\vec{X}_M + m\Delta\vec{X}_m = 0$

$|\Delta\vec{X}_M| : |\Delta\vec{X}_m| = m:M$

20 在質心上觀察 $P_{總}=0$，$X_{CM}=0$

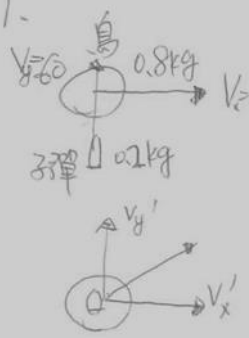
$$\vec{X}_{CM} = \frac{M\vec{X}_M + m\vec{X}_m}{M+m} = 0 \Rightarrow |\vec{X}_M| : |\vec{X}_m| = m:M$$

$P_{總} = P_M + P_m = M\vec{V}_M + m\vec{V}_m = 0$

$\therefore \vec{V}_M = -\frac{m}{M}\vec{V}_m$ (反向)

且 $|\vec{V}_M| : |\vec{V}_m| = m:M$

非1.



(1) 由碰撞瞬間動量守恆

水平 $0.8\times 20 = (0.8+0.2)V_x$

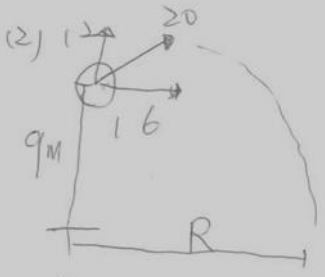
鉛直 $0.2\times 60 = (0.8+0.2)V_y$

$V_x = 16 \Rightarrow V = 20$

$V_y = 12$

$V = 20\ m/s$

(2)



斜拋中 $R = V_x \cdot T_{飛}$

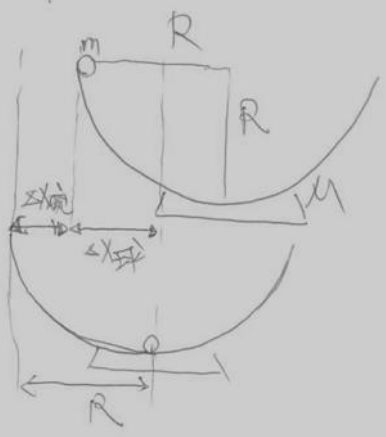
由 $X = V_0 t + \frac{1}{2}gt^2$

$-9 = 12t - 5t^2$

$t = 3$ 或 $-\frac{3}{5}$ 捨

$\therefore R = 16\cdot 3 = 48\ m$

非2



設球位移量值$\Delta X_{球}$，碗位移量值$\Delta X_{碗}$

(1) 由於不受水平外力且一開始靜止

$\therefore \Delta X_{cm} = 0$

$$\frac{m\cdot \Delta X_{球} + M\cdot(-\Delta X_{碗})}{M+m} = 0$$

$$\Rightarrow m(R-\Delta X_{碗}) + M(-\Delta X_{碗}) = 0$$

$$\Delta X_{球} = R - \Delta X_{碗}$$

$$\Delta X_{碗} = \frac{m}{M+m}R \text{ (向左)}$$

(2) 球位移有水平與垂直位移 $Ans = \frac{-m}{M+m}R$

$$\text{水平} = R - \Delta X_{碗} = \frac{M}{M+m}R$$

$$\text{垂直} = -R$$

$$\text{球位移} = \sqrt{(-R)^2 + \left(\frac{M}{M+m}R\right)^2}$$

$$= \frac{R}{M+m}\sqrt{2M^2+2Mm+m^2}$$