作业务必自己抄一遍后再拍照上传，用文档图片上传后果自负。作业尽早提交，老师会尽快批改的，得分也会高一些。如果拖到期末补交普遍得分不高，附上源文档方便查看，如有数据看不清请对照源文档。

University Physics A(1) 2019

Worksheet #2

Problems

(1) [1.X.111]An object with mass 1.6 kg has momentum 0, 0, 4 kg · m/s.

(a) What is the magnitude of the momentum?

(b) What is the unit vector corresponding to the momentum?

(c) What is the speed of the object?

(2) [2.X.5] A hockey puck initially has momentum . It slides along the ice, gradually slowing down, until it comes to a stop.

(a) What was the impulse applied by the ice to the hockey puck?

(b) It took 3 seconds for the puck to come to a stop. During this time interval, what was the net force on the puck by the ice and the air (assuming that this force was constant)?

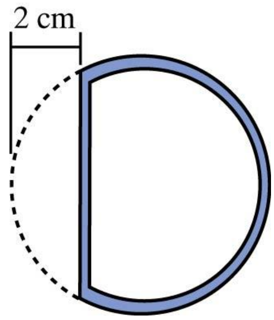
(3) [2.P.39]Suppose that you are navigating (导航) a spacecraft far from other objects. The mass of the spacecraft is 1.5×10^5 kg. The rocket engines (火箭发动机) are shut off, and you're moving with a constant velocity of $<0,20,0>$ km/s. As you pass the location $<12,15,0>$ km you briefly (短时间地) fire side thruster rockets, so that your spacecraft experiences a net force of $<6.4\times10^4,0,0>$ N for 3.4 s. The ejected gases (喷出来的气体) have a mass that is small compared to the mass of the spacecraft. You then continue coasting (moving at a constant speed) with the rocket engines turned off.

(a) Use the Momentum Principle to predict where you will be an hour later.

(b) What approximations or simplifying assumptions did you have to make in your analysis? Think about the choice of system: what are the surroundings that exert external forces on your system?

(4) [2.P.61] You have probably seen a basketball player throw the ball to a teammate at the other end of the court, 30 m away. Estimate a reasonable initial angle for such a throw, and then determine the corresponding initial speed. [Use the Momentum Principle and the definition of average velocity. Include a diagram. Mention any approximations you make.]

(5) [2.P.69] A tennis ball has a mass of 0.057 kg. A professional tennis player hits the ball hard enough to give it a speed of 50 m/s. The ball hits a wall and bounces back with almost the same speed (50 m/s). As indicated in the figure below, high-speed photography shows that the ball is crushed 2 cm (0.02 m) at the instant when its speed is momentarily zero, before rebounding.



Making the very rough approximation that the large force that the wall exerts on the ball is approximately constant during contact, determine the approximate magnitude of this force. (*Hint*: Think about the approximate amount of time it takes for the ball to come momentarily to rest.)

2020. 第二周作业

(1) (a) $|\vec{P}|=\sqrt{P_x^2+P_y^2+P_z^2}=\sqrt{0^2+0^2+4^2}\ kg\cdot m/s=4\ kg\cdot m/s$

(b) $\hat{p}=\frac{\vec{P}}{|\vec{P}|}=\frac{(0,0,4)}{4}=(0,0,1)$

(c) 由 $|\vec{P}|=m|\vec{V}|$，得：$|\vec{V}|=\frac{|\vec{P}|}{m}=\frac{4}{1.6}\ m/s=2.5\ m/s$

(2) (a) 由题知：冰球初动量为 $\vec{P_1}=(0,2,0)\ kg\cdot m/s$

因为冰球最后停止，则末动量 $\vec{P_2}=(0,0,0)\ kg\cdot m/s$

所以冰对冰球的冲量 $\Delta\vec{P}=\vec{P_2}-\vec{P_1}=(0,-2,0)\ kg\cdot m/s$

(b) 由动量定理：$\Delta\vec{P}=\vec{F}\cdot\Delta t$ 即 $\vec{F}=\frac{\Delta\vec{P}}{\Delta t}=\frac{(0,-2,0)}{3}\ N$

$$=(0,-\frac{2}{3},0)\ N$$

(3) 设初动量为 $\vec{P_1}$，末动量为 $\vec{P_2}$ 由动量守恒有：

(a) $\vec{P_2}=\vec{P_1}+\vec{F}\cdot\Delta t=(1.5\times10^5)\times(0,2\times10^4,0)+(6\times10^4,0,0)\times3.4$

$$=(2.04\times10^5,3\times10^9,0)\ kg\cdot m/s$$

又 $\vec{P_2}=m\vec{v}$，即 $\vec{v}=\frac{\vec{P_2}}{m}=\frac{(2.04\times10^5,3\times10^9,0)}{1.5\times10^5}=(1.36,2\times10^4,0)\ m/s$

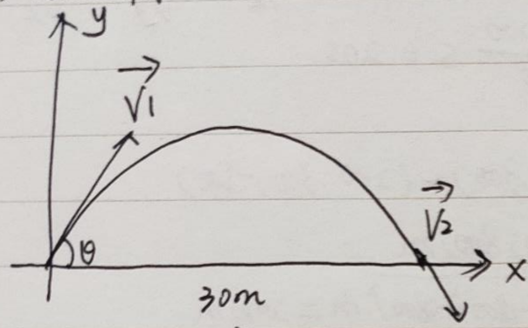
所以 $\vec{r}_末=\vec{r}_初+\vec{v}\cdot\Delta t$

$$=(12,15,0)\times10^3+(1.36,2\times10^4,0)\times3600$$

$$=(16.9\times10^3,7.2\times10^7,0)\ m$$

(b) 忽略了火箭所~~载燃~~载的燃料重量，火箭受地球引力且最终作匀速运动。

(4) 由题画图:



设球初速度为 $\vec{V_1}$，末速度为 $\vec{V_2}$. $\Delta x = 30m$. 忽略空气阻力.

由动量原理: $\Delta \vec{p} = \vec{F}\cdot\Delta t = m\cdot\Delta\vec{v}$.

因为在x方向上, ~~球~~ 球作匀速运动. 设x方向上球的初速度为 V_{x1}，末速度为 V_{x2} ∵ $\bar{V}_x = \frac{V_{x1}+V_{x2}}{2} = V_{x1}$

则 $\Delta x = \bar{V}_{x1}\cdot\Delta t$ 即 $\Delta t = \frac{\Delta x}{V_{x1}}$ · ①

在y方向上: $\Delta P_y = (-mg)\Delta t$ 设y方向上球的初速度为 V_{y1}，末速度为 V_{y2}. 则 $\Delta P_y = (-mg)\Delta t = mV_{y2} - mV_{y1}$

即 $V_{y2} = V_{y1} - g\Delta t$. ∵ $\bar{V}_y = \frac{V_{y1}+V_{y2}}{2} = V_{y1} - g\Delta t$

又 $\Delta y = \bar{V}_y\cdot\Delta t = (V_{y1} - g\Delta t)\cdot\Delta t$ 已知 $\Delta y = 0$.

∴ $0 = (V_{y1} - \frac{1}{2}g\Delta t)\Delta t$ 得: $V_{y1} = \frac{1}{2}g\Delta t$ ②

①代入②得: $V_{y1} = \frac{1}{2}g\frac{\Delta x}{V_{x1}}$ ∵ $V_{y1} = |\vec{V_1}|\sin\theta$, $V_{x1} = |\vec{V_1}|\cdot\cos\theta$

∴ $|\vec{V_1}| = \sqrt{\frac{g\cdot\Delta x}{2\sin\theta\cos\theta}} = \sqrt{\frac{g\cdot\Delta x}{\sin 2\theta}}$ 将 $\Delta X = 30m$ 代入.

θ	30°	45°	60°
V_1	18.4m/s	17.1m/s	18.4m/s

(5) 在x方向上: 因为 $\bar{v} = \frac{V_{初}+V_{末}}{2} = \frac{0+(-50)}{2}m/s = -25m/s$

又 $\bar{v} = \frac{\Delta x}{\Delta t}$. 所以 $\Delta t = \frac{\Delta x}{\bar{v}} = \frac{-0.02}{-25}s = 8\times10^{-4}s$

由动量原理: $F = \frac{\Delta P}{\Delta t} = \frac{0 - 0.057\times(-50)}{8\times10^{-4}}N$

$= 3560N$