Information

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Office hour: Thursday 14:00-16:00

Attentions

1. Textbook, download the pdf version from QQ group.

2. Grading Policy: Homework (10%); In-class Test (10%);

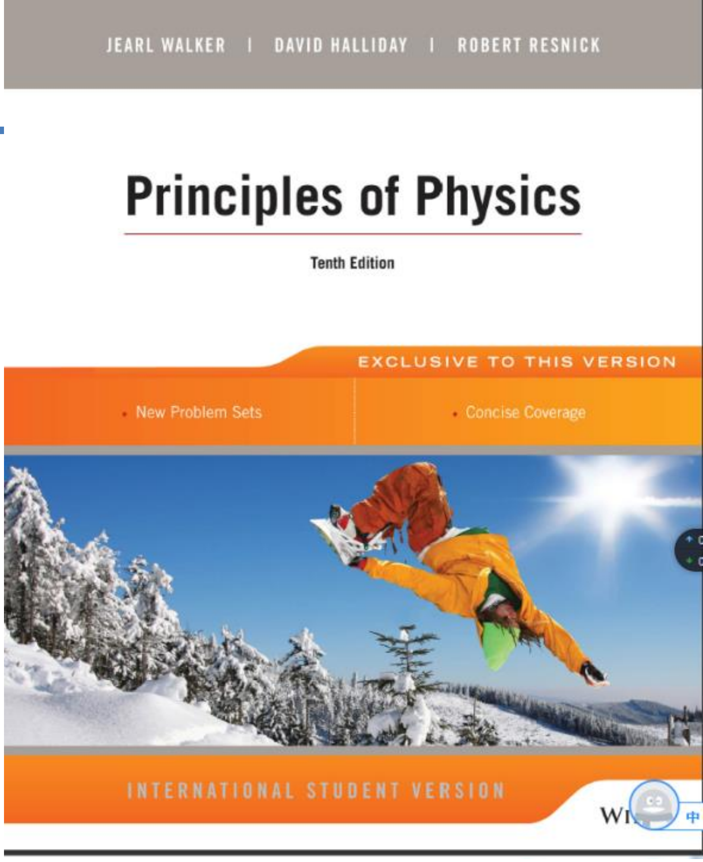
Mid-term Exam (40%); Final Exam (40%).

3. Mid-term Exam: 18th November 9：00~11：00 am

Chapter 1- Chapter 12

4. Prepare a calculate. Homework, exams need it!

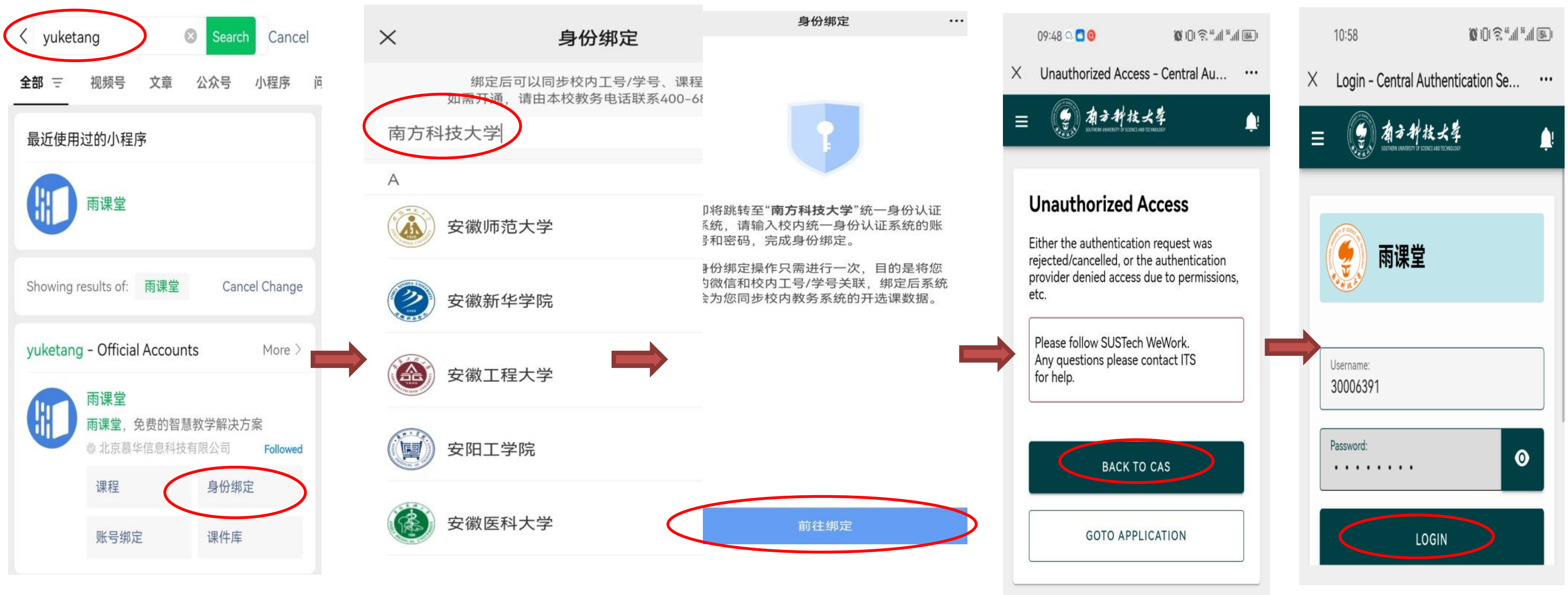
5. Homework attentions:



1. 每章布置的作业题号对应于本班群文件里的电子版教材（第十版，封面如图），务必一定要使用本群官方发布的第十版电子版教材。目前流传了几个版本的教材，其他任何版本的题目（problem）都与此官方版本不同，若做了其他版本的题目，可能会导致做错题目而得0分！！。
2. 通过Blackboard提交作业（拍照后生成一个pdf文件提交）
3. 作业必须手写，作业开头写清姓名，学号，班级，章节；
4. 题目题号需要写清楚（不用抄题），作业必须写过程（过程可参照sample problem的解答过程）；
5. 作业在截止期限前交到Blackboard，正常计分，过了截止期限48小时内提交，分数以50%计入，过了截止期限48小时后不计分。如有特殊情况请过假的同学 (走请假流程有假条) 需要在请假结束后的三天内将作业交上来，正常计分)。

Prepare for In-class Test

1. We use Yuketang to do the in-class test
2. First we need to binding Yuketang by following the steps :



1) Search Yuketang in wechat

3) Search “南方科技大学”

4) Click the icon “前往绑定”

5) BACK TO CAS

6) LOGIN

2) Chose “身份绑定” in Official Accounts

Review- Multiplying Vectors

Scalar Product (dot product 点乘）

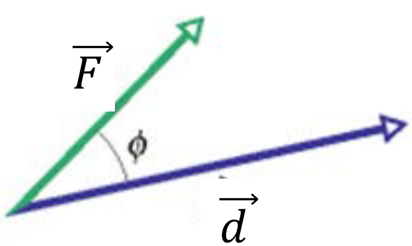
$$\boxed{\vec{a}\cdot\vec{b} = ab\cos\phi}$$ **A scalar**

$$\vec{a}\cdot\vec{b} = (a_x\,\hat{i} + a_y\,\hat{j} + a_z\,\hat{k})\cdot(b_x\,\hat{i} + b_y\,\hat{j} + b_z\,\hat{k}),$$

$$\vec{a}\cdot\vec{b} = a_x\,b_x + a_y\,b_y + a_z\,b_z,$$

$$W = Fd \rightarrow W = \vec{F}\cdot\vec{d} = Fd\cos\phi$$

$$P = Fv \rightarrow P = \vec{F}\cdot\vec{v} = Fv\cos\phi$$



Vector Product (cross product 叉乘）

$$\boxed{\vec{c} = \vec{a}\times\vec{b}}$$ **A vector**

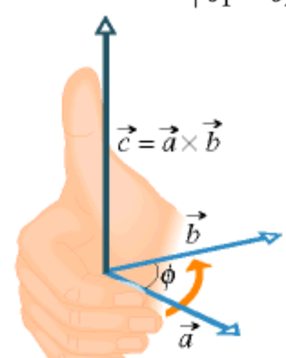
Magnitude: $ab\sin\phi$

Direction: Right-hand rule

$$\vec{a}\times\vec{b} = (a_x\hat{i} + a_y\hat{j} + a_z\hat{k})\times(b_x\hat{i} + b_y\hat{j} + b_z\hat{k}),$$

$$\vec{a}\times\vec{b} = (a_yb_z - b_ya_z)\hat{i} + (a_zb_x - b_za_x)\hat{j} + (a_xb_y - b_xa_y)\hat{k}.$$

$$\mathbf{a}\times\mathbf{b} = (a_2b_3 - a_3b_2)\mathbf{i} + (a_3b_1 - a_1b_3)\mathbf{j} + (a_1b_2 - a_2b_1)\mathbf{k}$$
$$= \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$



Lorenz force : $\vec{F} = q\vec{v}\times\vec{B}$

Magnitude : $F = qvB\sin\phi$

Torque: $\vec{\tau} = \vec{r}\times\vec{F}$

Problem- Multiplying Vectors

$$\vec{A} = 2.00\hat{i} + 3.00\hat{j} - 4.00\hat{k}$$

$$\vec{B} = -3.00\hat{i} + 4.00\hat{j} + 2.00\hat{k}$$

$$\vec{C} = 7.00\hat{i} - 8.00\hat{j}$$

$$3\vec{C}\cdot(2\vec{A}\times\vec{B}) = ?$$

$$\hat{i}\times\hat{j} = \hat{k}$$

$$\hat{j}\times\hat{k} = \hat{i}$$

$$\hat{k}\times\hat{i} = \hat{j}$$

$$2\vec{A}\times\vec{B} = (4.00\hat{i} + 6.00\hat{j} - 8.00\hat{k})\times(-3.00\hat{i} + 4.00\hat{j} + 2.00\hat{k})$$

$$= 16\hat{k} - 8\hat{j} + 18\hat{k} + 12\hat{i} + 24\hat{j} + 32\hat{i} = 44\hat{i} + 16.00\hat{j} + 34.00\hat{k}$$

$$2\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & 6 & -8 \\ -3 & 4 & 2 \end{vmatrix} = 44\hat{i} + 16.00\hat{j} + 34.00\hat{k}$$

$$3\vec{C}\cdot(2\vec{A}\times\vec{B}) = (21.00\hat{i} - 24.00\hat{j})\cdot(44\hat{i} + 16.00\hat{j} + 34.00\hat{k})$$

$$= 21\times 44 - 24\times 16 = 540$$

Review—Derivative (velocity)

Function : $f(x)$ and Variable: x

$$x \to x + \Delta x$$

$$f(x) \to f(x + \Delta x)$$

Derivative of function f at x:

$$\boxed{\frac{df}{dx} = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x}}$$

Example:

Position: x and variable t: x=x(t)

$t \longrightarrow t+\Delta t$

$x \longrightarrow x+\Delta x$

Derivative of $x(t)$ at t:

$$\boxed{\frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{(x(t+\Delta t)) - x(t)}{\Delta t}}$$

$$x = \frac{1}{2}at^2, find \ \frac{dx}{dt}$$

$$\frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{\frac{1}{2}a(t+\Delta t)^2 - \frac{1}{2}at^2}{\Delta t} = \lim_{\Delta t \to 0} \frac{at\Delta t + \frac{1}{2}a\Delta t^2}{\Delta t} = at = v$$

Review--(Definite) Integral

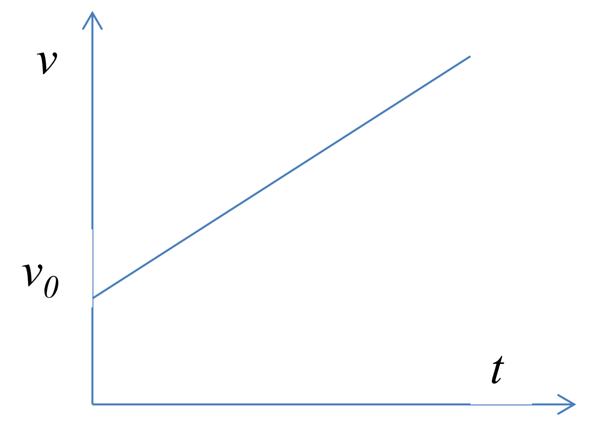
$$\int_a^b f(x)dx = \lim_{\Delta x \to 0} \sum_i f(\xi_i)\Delta x_i$$

$$\int_a^b f(t)dt = \lim_{\Delta t \to 0} \sum_i f(t_i)\Delta t_i$$

$$\frac{df}{dt} = f'(t) \Rightarrow df = f'(t)dt \ (dt : \Delta t \to 0)$$

$$x = f(t), f'(t) = \frac{df}{dt} = v \Rightarrow dx = vdt$$

$$\Rightarrow \int_{x_0}^{x} dx = \int_{t_0}^{t} vdt \qquad (v = v_0 + at)$$



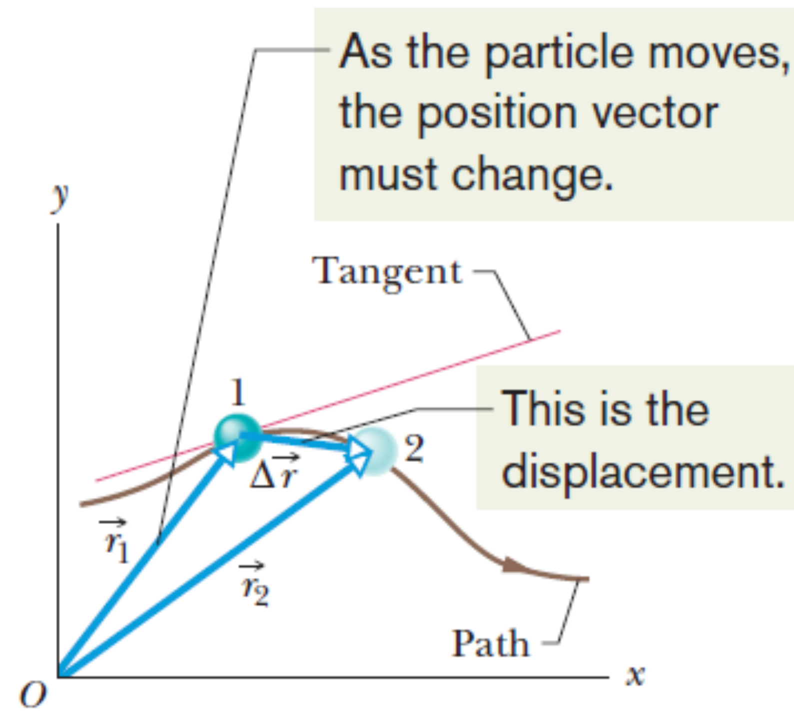
Newton-Leibniz formula:

$$If\ f(x) = F'(x)\ ,\ \text{then} \quad \int_a^b f(x)\mathrm{d}x = F(x)|_a^b = F(b) - F(a) \qquad \int f(x)dx = F(x) + C$$

Review--Quantities in Kinematics

$$\vec{v} = \frac{d\vec{r}}{dt} \Rightarrow \vec{r}_f - \vec{r}_i = \int_i^f d\vec{r} = \int_i^f \vec{v}dt$$

$$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v}_f - \vec{v}_i = \int_i^f d\vec{v} = \int_i^f \vec{a}dt$$



for one dimension:

$$v = \frac{dx}{dt},\ x_f - x_i = \int_i^f vdt$$

$$a = \frac{dv}{dt},\ v_f - v_i = \int_i^f adt$$

如何如何与参考系变换

Problem 1 of Chapter 1~4

Two particles move along an x axis. The position of particle 1 is given by $x = 6.00t^2 + 3.00t + 2.00$ (in meters and seconds); the acceleration of particle 2 is given by $a = -8.00t$ (in meters per second squared and seconds) and, at $t = 0$, its velocity is 15 m/s. When the velocities of the particles match, what is their velocity?

Solution 1 of Chapter 1~4

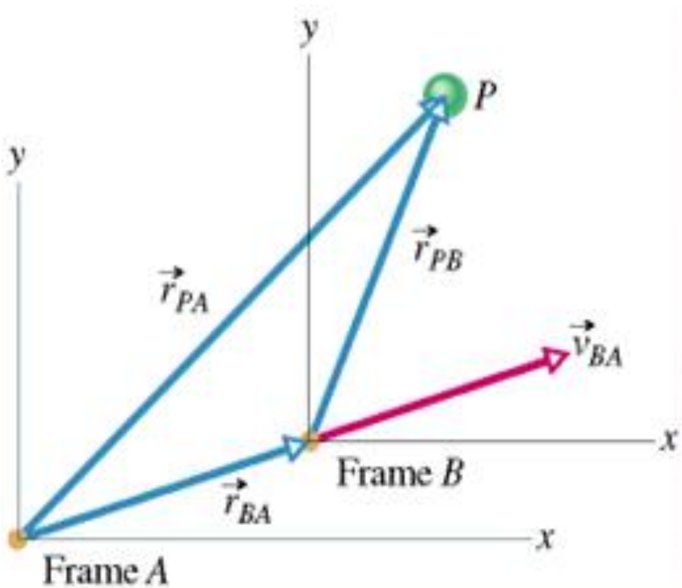
To solve this problem, we note that velocity is equal to the time derivative of a position function, as well as the time integral of an acceleration function, with the integration constant being the initial velocity. Thus, the velocities of particles can be written as:

$$v_1 = \frac{dx}{dt} = \frac{d}{dt}\left(6.00t^2 + 3.00t + 2.00\right) = 12.0t + 3.00$$

$$v_2 = v_{20} + \int a_2 dt = 15.0 + \int (-8.00t)dt = 15.0 - 4.00t^2.$$

$$v_1 = v_2 \Rightarrow 12.0t + 3.00 = 15.0 - 4.00t^2 \Rightarrow 4.00t^2 + 12.0t - 12.0 = 0$$
$$\Rightarrow v_1 = v_2 = 12.5 \text{ m/s}$$

Review - Relative Motion



$$\vec{r}_{PA} = \vec{r}_{PB} + \vec{r}_{BA}$$

$$\vec{v} = \frac{d\vec{r}}{dt} \Rightarrow \vec{v}_{PA} = \vec{v}_{PB} + \vec{v}_{BA}$$

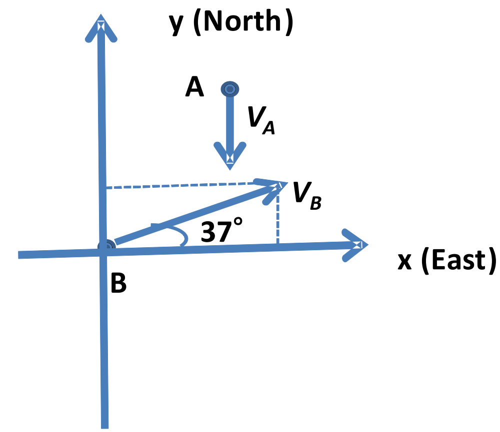
$$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{a}_{PA} = \vec{a}_{PB} + \vec{a}_{BA}$$

If $\vec{v}_{BA}$ is a constant, then $\vec{a}_{BA} = 0$

(Galileo transformation)

Problem 2 of Chapter 1~4

Ship A is located 4.0 km north and 2.5 km east of ship B . Ship A has a velocity of 22 km/h toward the south, and ship B has a velocity of 40 km/h in a direction 37° north of east.



(a) What is the velocity of A relative to B in unit-vector notation with $\hat{i}$ toward the east?

(b) Write an expression (in terms of unit-vector notation) for the position of A relative to B as a function of t, where $t = 0$ when the ships are in the positions described above.

Solution 2 of Chapter 1~4

- Here, the subscript W refers to the water.
- (a) We have $\overrightarrow{v_{AW}} = \overrightarrow{v_{AB}} + \overrightarrow{v_{BW}}$, so that

$$\overrightarrow{v_{AW}} = -22\hat{\jmath}$$

$$\overrightarrow{v_{BW}} = 40cos37°\hat{\imath} + 40sin37°\hat{\jmath}$$

$$\overrightarrow{v_{AB}} = (-32\,km/h)\hat{\imath} - (46\,km/h)\hat{\jmath}$$

- (b) Since the velocity-components are constant , so (with lengths in kilometers and time in hours.)

$$\vec{r}_{AB} = \vec{r}_0 + \vec{v}_{AB}t = (2.5 - 32t)\ \hat{\mathrm{i}}\ + (4.0 - 46t)\ \hat{\mathrm{j}}$$

Review - Projectile Motion

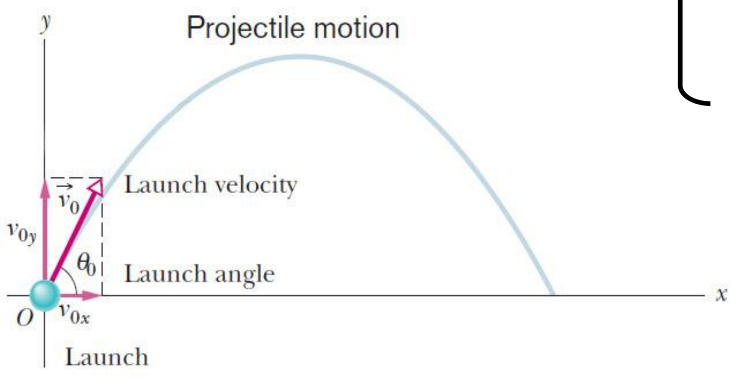
Projectile Motion

Horizontal: Motion at a constant velocity:

$$x - x_0 = v_0 t \cos\theta_0.$$

Vertical: Free-fall motion (a_y = -g)

$$\begin{cases} y - y_0 = v_{0y} t - \frac{1}{2} g t^2 = (v_0 \sin\theta_0)\, t - \frac{1}{2} g t^2 \\ v_y = v_0 \sin\theta_0 - g t \\ v_y^2 = (v_0 \sin\theta_0)^2 - 2g\,(y - y_0) \end{cases}$$



Trajectory: $$y = (\tan\theta_0)\, x - \frac{g\, x^2}{2\,(v_0 \cos\theta_0)^2}$$

Horizontal Range: $$R = \frac{2v_0^2}{g} \sin\theta_0 \cos\theta_0 = \frac{v_0^2}{g} \sin 2\theta_0$$ **($y=y_0$)**

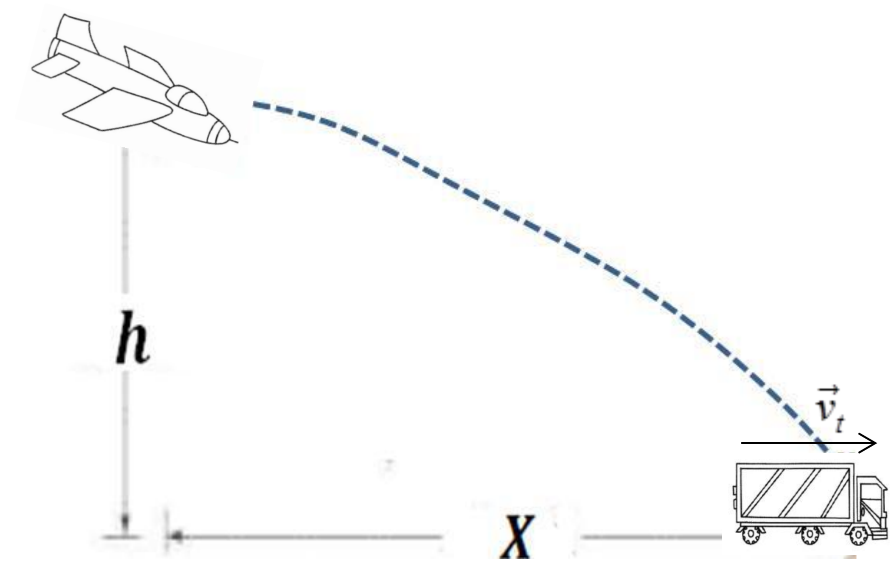
Problem 3 of Chapter 1~4

A fighter plane, at height h = 200m, wants to **release** shells to a truck which is below and at a horizontal distance X = 400m. The plane driving with a constant speed and the horizontal component of its velocity is 60m/s. The air resistance can be neglected and **the truck is moving with a constant speed v_t = 20m/s.**

What is the velocity of the plane so that the shell can precisely strike the truck?

What is the velocity of the shell just before it hit the truck?

The horizontal range of the shell?



Solution 3 of Chapter 1~4

Solution: Let's choose up and right as the positive directions.

For the Horizontal direction: $v_x t = X \Rightarrow t = X / v_x$

v_x=40*m/s* is the *x*-component of the velocity of the plane relative to the truck.

$t = X / v_x$=(400m) / (40m/s) = 10s

For the Vertical direction:

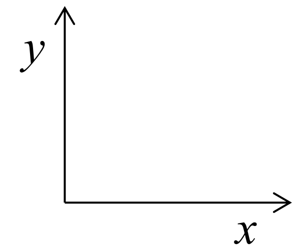
$$y - y_0 = v_{y0}t - \frac{1}{2}gt^2 \Rightarrow -200 = v_{y0}(10) - \frac{1}{2}(5)(100) \Rightarrow v_{y0} = 30\text{m/s}$$

$$v_y - v_{y_0} = -gt \Rightarrow v_y - v_{y_0} = -gt \Rightarrow v_y = 30 - 100 = -70\text{m/s}$$

Plus means the velocity is vertical up and minus means vertical down

Solution 3 of Chapter 1~4

So the velocity of the plane is :



$$\vec{v}_0 = (60\ m/s)\vec{i} + (30\ m/s)\vec{j}$$

$$v_0 = 67.1\ m/s \quad \text{and} \quad \tan\theta = \frac{v_y}{v_x} = 1/2 \Rightarrow \theta = 26.5°$$

The velocity of the shell just before it hit the truck:

$$\vec{v}_f = (60m/s)\vec{i} - (70m/s)\vec{j}$$

Horizontal range:

$$R = v_{x0}t = 2v_{x0}v_{y0}/g = 360m$$

It is different from the horizontal distance between lunched point and landed point, which is

$$D = v_{x0}t' = v_{x0}(v_{y0}/g + v_{yf}/g) = 600m$$