University Physics

Name：Liu Fengyan（刘凤艳)

Office： 数理楼3303

Tel： 67392201-202

Email: Liufengyan@bjut.edu.cn

Public mail

bj_dbl_physics@163.com

Password

physics

Please remember it!

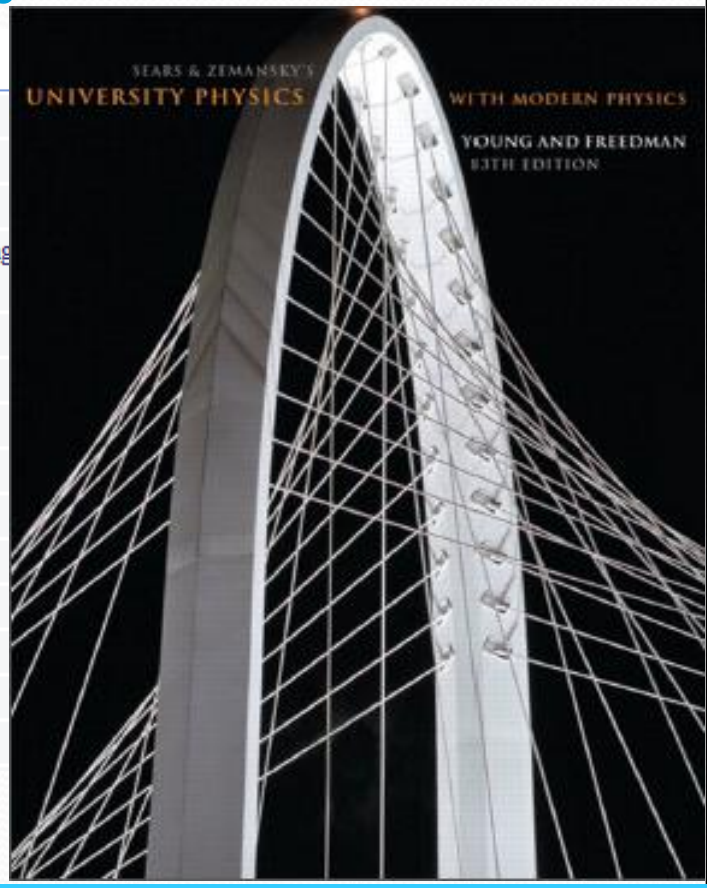
Textbook

Homemade textbook

- **Reference 《University Physics》**

标准格式 | SFX

Book Number	000084205
ISBN	9787111326755 (set)
Main Entry	Young, Hugh D.
Title	Sears and Zemansky's university physics with modern physics / Hugh D. Young 罗杰 A. 费里德曼著.
Descr.	2 v. (1551 p., [47] p.) : ill. ; 28 cm.
Series	(时代教育. 国外高校优秀教材精选)
Gen. Note	Includes index.
Subject - Lib.Cong.	Physics.
Add.Entry	Freedman, Roger A.
	Ford, A. Lewis.
	Sears, Francis Weston, 1898-
Holdings	所有单册及光盘
Call number	O4/51-12//



Educational requirements

- **Homework**

  1.The homework must be completed in English.

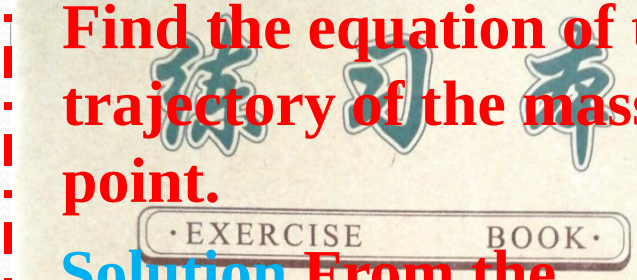
  2.To receive full credit, the homework must be completed and handed in on every Thursday.

  3. Prepare two exercise books.

Exercise 1.2 Assume

$$\vec{r} = 4t^2\vec{i} + (2t+3)\vec{j}\,(\mathrm{m})$$

Find the equation of the trajectory of the mass point.



Solution From the equation of motion we know

$$\begin{cases} x = 4t^2 \\ y = 2t+3 \end{cases}$$

Eliminating *t*, we get the equation of the trajectory

$$x = (y-3)^2$$

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153711	1	15371101	李子鉴
	2	15371102	刘泽一兰
	3	15371103	俞浩东
	4	15371104	刘子璇
	5	15371105	洪筱涵
	6	15371106	杜鑫
	7	15371107	于高远
	8	15371108	赵培一
	9	15371109	崔豪楠
	10	15371110	孙铁睿
	11	15371111	邓子达
	12	15371112	刘谦
	13	15371113	范朋远
	总结	15371114	穆子麒
	总结	15371115	邱园竣

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153711	1	15371116	杨为钦
	2	15371117	王梓儒
	3	15371118	谢勇杰
	4	15371119	蒋栋杰
	5	15371120	赵钊
	6	15371121	汪清远
	7	15371122	王国鑫
	8	15371123	高源
	9	15371124	王小涵
	10	15371125	唐国钦
	11	15371126	王知恒
	12	15371127	姜璨辉
	13	15371128	王晨
	总结	15371129	胥懋庸

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153712	1	15371201	谭祖雄
	2	15371202	田宇平
	3	15371203	马越
	4	15371204	李宇楠
	5	15371205	赵啟皓
	6	15371206	刘宛莹
	7	15371207	王婷跃
	8	15371208	韩沛奇
	9	15371209	李晓琳
	10	15371210	沈郝阳
	11	15371211	荆可心
	12	15371212	王基宇
	13	15371213	原朝
	总结	15371214	刘云鹤
	总结	15371215	郑旭航

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153712	1	15371216	陈佳文
	2	15371217	庞博
	3	15371218	刘健
	4	15371219	沈志宏
	5	15371220	苏燮阳
	6	15371221	赵超逸
	7	15371222	文加图
	8	15371223	崔正浩
	9	15371224	于莹
	10	15371225	田晓阳
	11	15371226	夏子豪
	12	15371227	李依蒙
	13	15371228	张彧鹏
	总结	15371229	姜钧城

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153713	1	15371301	李潇
	2	15371302	张晶程
	3	15371303	魏恺
	4	15371304	陈思钰
	5	15371305	王端
	6	15371306	户胜涛
	7	15371307	刘妍
	8	15371308	胡栩杉
	9	15371309	陈子宜
	10	15371310	郭振宁
	11	15371311	纪小艺
	12	15371312	吕林虹
	13	15371313	回仕奇
	总结	15371314	王志鹏
	总结	15371315	蓝禹童

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153713	1	15371316	张之陶
	2	15371317	孙绍时
	3	15371318	王子涵
	4	15371319	叶家玮
	5	15371320	刘政
	6	15371321	吴彬熙
	7	15371322	张鹏飞
	8	15371323	李牧青
	9	15371324	位非
	10	15371326	文豪
	11	15371327	叶玉龙
	12	15371328	孙浩洋
	13	15371329	李雪婧
	总结	15371330	郑泠若

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153721	1	15372101	龚令华
	2	15372102	王亦凯
	3	15372103	魏源
	4	15372104	牛亦然
	5	15372105	冯泽琛
	6	15372106	董乐辉
	7	15372107	洪冲达
	8	15372108	曹燕飞
	9	15372109	王涛
	10	15372111	李俏俏
	11	15372112	白厚源
	12	15372113	陶宁
	13	15372114	汪茂樽
	总结	15372115	宋达熙
	总结	15372116	于璐
	总结	15372117	苗雨驰

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153721	1	15372118	孙兢谦
	2	15372119	白婧
	3	15372120	朱学涵
	4	15372122	王添弘
	5	15372123	陈金
	6	15372124	周婷
	7	15372125	王泽宇
	8	15372126	吴亦锟
	9	15372127	陈逸伦
	10	15372128	于天宇
	11	15372130	刘滔文
	12	15372132	廖琴
	13	15372133	魏亦劼
	总结	15372134	姚陈真
	总结	15372135	陈羿骁

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153722	1	15372201	吴瑀
	2	15372202	甘启萌
	3	15372203	杜威
	4	15372204	王飞鸿
	5	15372205	李锐智
	6	15372206	陈子豪
	7	15372207	陈绍文
	8	15372208	姚健菁
	9	15372209	郭乐宁
	10	15372210	黄琚
	11	15372211	张馨以
	12	15372212	张雪松
	13	15372213	林健
	总结	15372214	王瑞
	总结	15372215	毕诗旋
	总结	15372216	邹孝玮
	总结	15372217	黄泽凯

班级 Class	周次	BJUT学号 Student No.	姓名 Name
153722	1	15372218	王品
	2	15372219	马天嘉
	3	15372220	周佳慧
	4	15372221	任博忱
	5	15372222	李美璇
	6	15372223	苏立梓
	7	15372224	蔡亦华
	8	15372225	周宣
	9	15372226	杨丽婷
	10	15372227	赖苡立
	11	15372228	李雨承
	12	15372229	孙力
	13	15372230	党雪琪
	总结	15372231	郭亚兰
	总结	15372232	田征雨
	总结	15372233	张钦源
	总结	15372234	许坤华

Educational requirements

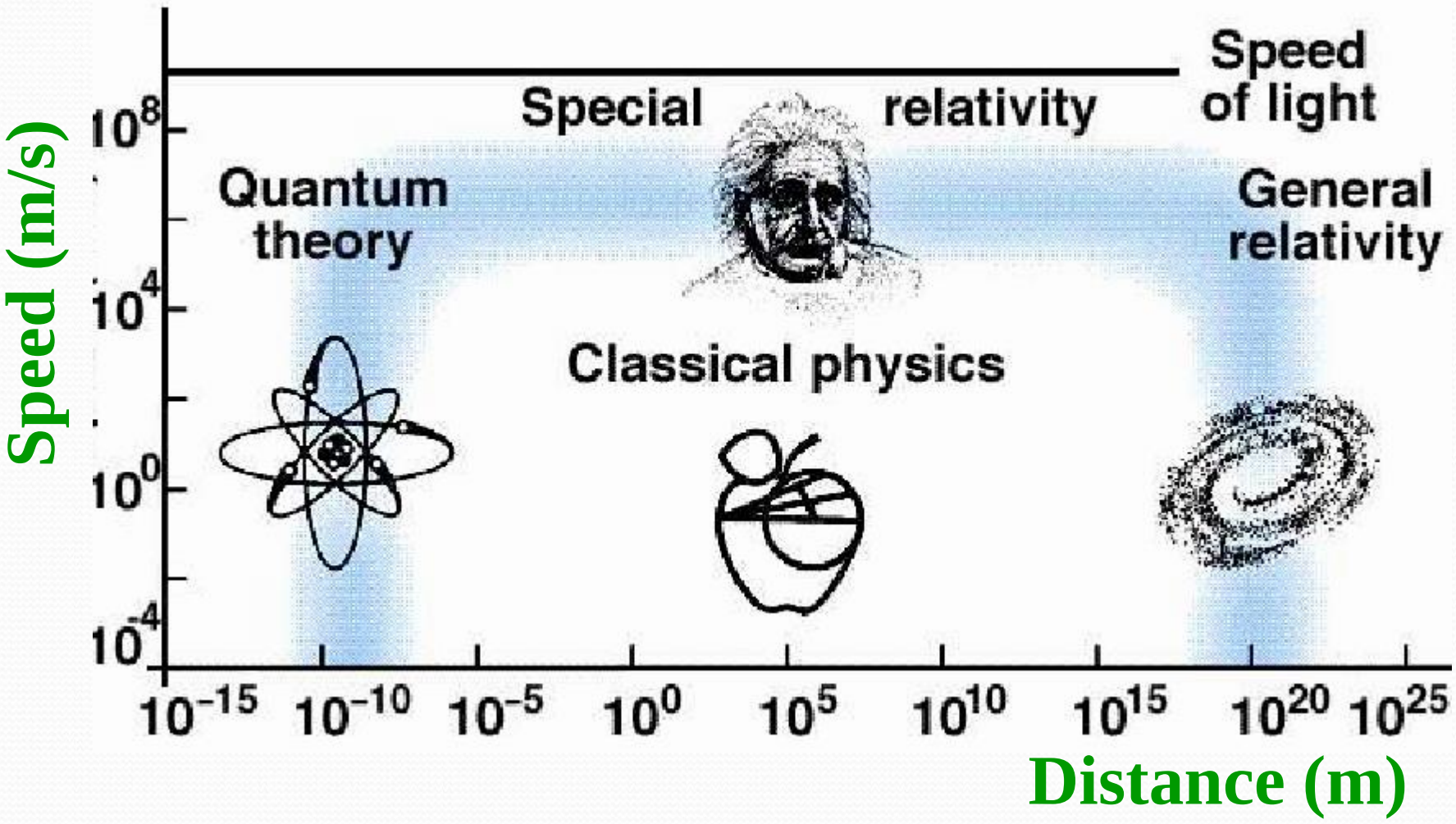
- **Final grade**

  Your final grade for Physics will be based on your total score on all the components of the course. The total possible score is 100 points, broken down as follows:

Final exam	70
homework correcting	10(5+5)
Homework	10
Attendance	10

What is Physics?

- **Physics** is the science that investigates the fundamental concepts of matter, energy, and space, and the relationships among them.
- **Physics** is the most basic of the sciences, underpinning (基础) all other disciplines(科目) of science, medicine, and engineering.
- **Physicists** are problem solvers, often meeting new challenges and developing new theories.


Speed (m/s)
Speed of light
Special relativity
Quantum theory
General relativity
Classical physics
10^{8}
10^{4}
10^{0}
10^{-4}
10^{-15} 10^{-10} 10^{-5} 10^{0} 10^{5} 10^{10} 10^{15} 10^{20} 10^{25}
Distance (m)

Where might I work as a physicist?

A strong physics background prepares you for almost any occupation that involves science or engineering.

Scientific Method

Underlying all scientific investigation are the guiding principles of the Scientific Method.

- **Statement of problem**
- **Observation: data collection**
- **Hypothesis: proposed explanation**
- **Experimental testing**
- **Acceptance or rejection of hypothesis**

How Do I Study Physics?

Preparation and hard work are key to any successful learning endeavor. But a major factor not often mentioned is organization.

Timely Learning

- **Timely learning is efficient learning. It is better to study an hour each day than to cram on weekends.**

- **After each lecture, use your next free period to reinforce your understanding.**

- **If you wait until the weekend, you must devote valuable time just rebuilding the information.**

Outside the Classroom

- **Learning is rarely completed in class. To reinforce teaching, you must work problems on your own as soon after class as possible.**

- **Try first, seek help if necessary, review examples, work with others. Working problems is the primary way to learn.**

Accuracy or Precision(精确度):

Measurements are, at best, approximate(近似的). An uncertainty(不确定度) is indication of the accuracy (or precision) in a measurement. It depends on the accuracy (or precision) of the measuring instrument(测量仪器) and how well the instrument can be read.

21.6cm with an uncertainty of 1mm (0.1cm) is written as

21.6cm ± 0.1cm

central value ± uncertainty

Significant figures (s.f.)有效数字

When we give a numerical value to a physical quantity, we already assume a certain degree of uncertainty. This uncertainty is indicated by the number of digits with which the quantity is given:

2.00m (3 s.f.): means we know the value lies between 2.05m and 1.95m

2.000m (4 s.f.): means we know the value lies between 2.005m and 1.995m

One should not report a result to more significant figures than are given in the part of the input having the fewest number of significant figures!

Units and Dimension (单位和量纲)

- **All things in classical mechanics can be expressed in terms of the fundamental dimensions:**

  Length [L] Mass [M] Time [T]

- **The dimension of any physical quantity in mechanics is some algebraic combination of [L], [T] and [M]**

$$[L^q T^r M^s]$$

where q, r, s can be positive integers, negative integers or fractional powers(分数次幂).

Example1 What are the dimensions of speed and force?

The dimension of speed is [L / T]

The dimension of force is [ML / T^2]

But dimensions are not units!

Different units describing the same physical quantity are of the same dimension. So to set up a unit system we require definitions of units for length, time and mass.

In 1791 French scientists established units for length, time and mass.

Meter(m) one ten-millionth(10^{-7}) of the distance between the equator(赤道) and the North Pole(北极) .

Second(s) 1/86400 of a mean solar day.

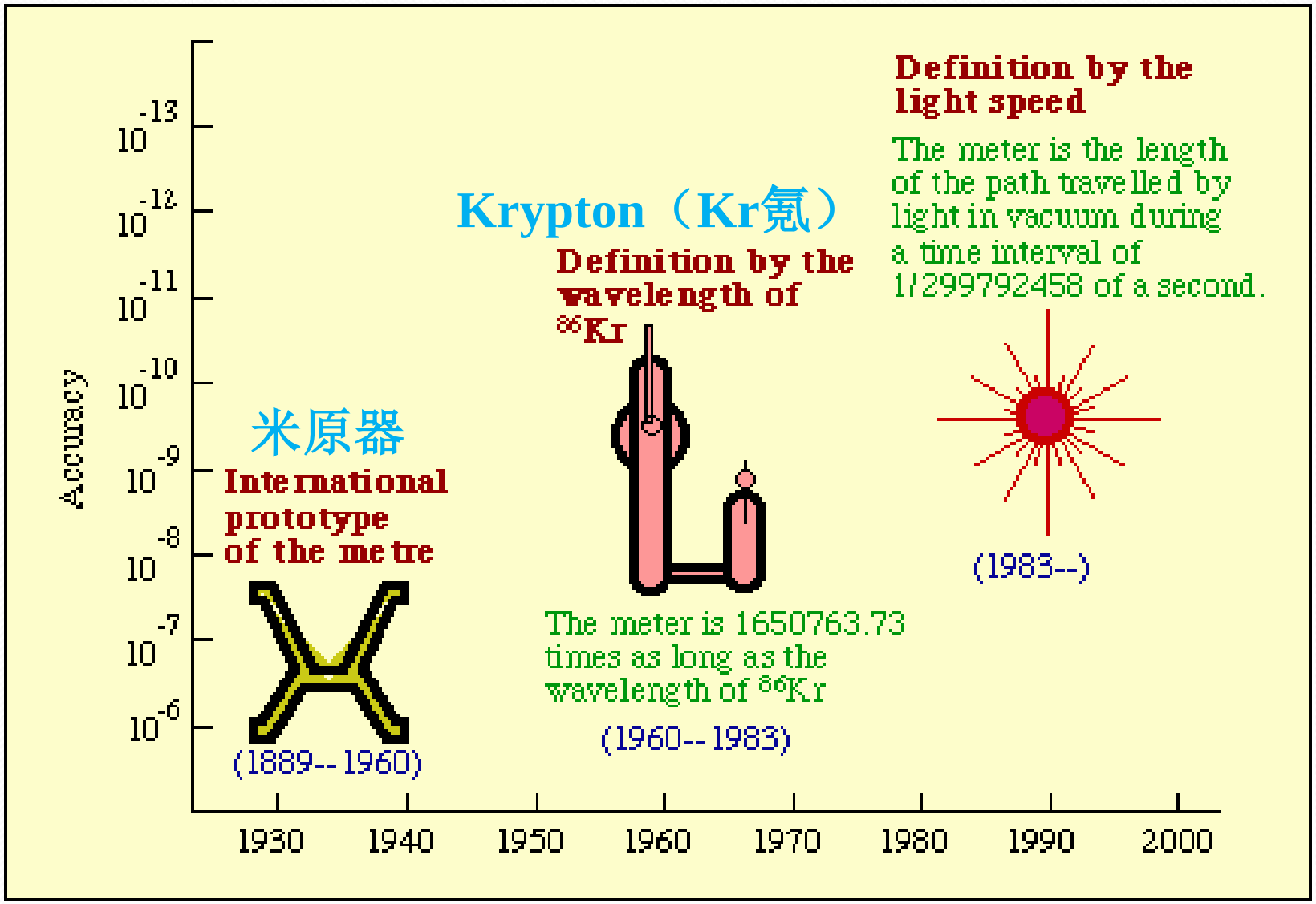
Kilogram (kg) the mass of certain amount of water.

Later (in 1960), the SI(International System) was adopted. It is also called metric system (公制) or mks system.

SI base units:

- **Unit of length (meter 米)**
- **Unit of mass (kilogram 千克)**
- **Unit of time (second 秒)**
- **Unit of electric current (ampere 安培)**
- **Unit of thermodynamic temperature热力学温度、开氏温度、绝对温度 (kelvin开尔文)**
- **Unit of amount of substance (mole 摩尔)**
- **Unit of luminous intensity (光照度) (candela 坎德拉)**

SI unit of length (meter)



SI unit of time (second)

- **1791: 1/86400 of a solar day.**
- **1967: 9,192,631,770 periods of a certain vibration of a cesium(铯) atom(^{133}Cs).**

SI unit of mass (kilogram)

Originally the mass of one liter of water under certain specific conditions of temperature and pressure.

Since 1901: mass of a particular cylinder of Platinum-Iridium (Pt-Ir,铂-铱) alloy kept in France.

Example 2: The period P of a swinging pendulum depends only on the length of the pendulum l and the acceleration of gravity g. Which of the following formulas for P *could* be correct ?

Given: l has dimension of length (L) and g has dimension of (L / T^2).

(a) $P = 2\pi(lg)^2$ (b) $P = 2\pi\dfrac{l}{g}$ (c) $P = 2\pi\sqrt{\dfrac{l}{g}}$

Solution The left hand side P has units of time (T). Try the first equation

$$\left(L \cdot \frac{L}{T^2}\right)^2 = \frac{L^4}{T^4} \neq T$$ **Not Right !**

For the second equation

$$\frac{L}{\frac{L}{T^2}} = T^2 \neq T$$ **Not Right !**

For the third equation

$$\sqrt{\frac{L}{\frac{L}{T^2}}} = \sqrt{T^2} = T$$ **This has the correct units!!**

This must be the answer!!

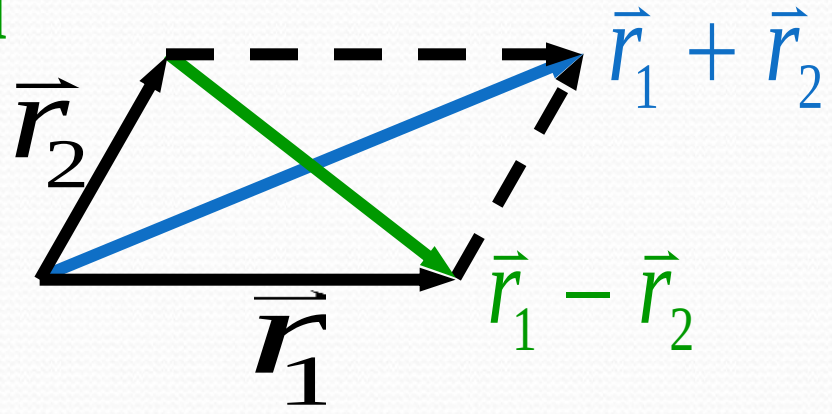
Distance	Length (m)
Radius of visible universe	1×10^{26}
To Andromeda Galaxy(仙女座星系)	2×10^{22}
Earth to Sun	1.5×10^{11}
Radius of Earth	6.4×10^{6}
Sears Tower（西尔斯塔--美国芝加哥的一座大厦）	4.5×10^{2}
Football field	1.0×10^{2}
Tall person	2×10^{0}
Thickness of paper	1×10^{-4}
Wavelength of blue light	4×10^{-7}
Diameter of hydrogen atom(氢原子直径)	1×10^{-10}
Diameter of proton(质子直径)	1×10^{-15}

Interval	Time (s)
Age of universe	5×10^{17}
Age of Grand Canyon（大峡谷）	3×10^{14}
32 years	1×10^{9}
One year	3.2×10^{7}
One hour	3.6×10^{3}
Light travel from Earth to Moon	1.3×10^{0}
One cycle of guitar string	2×10^{-3}
One cycle of FM radio wave	6×10^{-8}
Lifetime of neutral pi meson（π介子）	1×10^{-16}
Lifetime of top quark	4×10^{-25}

Object	Mass (kg)
Milky Way Galaxy （银河系）	4×10^{41}
Sun	2×10^{30}
Earth	6×10^{24}
Boeing 747	4×10^{5}
Car	1×10^{3}
Student	7×10^{1}
Dust particle	1×10^{-9}
Top quark	3×10^{-25}
Proton	2×10^{-27}
Electron	9×10^{-31}
Neutrino （中微子）	1×10^{-38}

Vector Operation(矢量运算)

- **Vector addition and subtraction（矢量加减法）**
  - **Geometric method**



  - **Algebraic method**

$$\vec{r}_1 = x_1\vec{i} + y_1\vec{j} + z_1\vec{k}$$

$$\vec{r}_2 = x_2\vec{i} + y_2\vec{j} + z_2\vec{k}$$

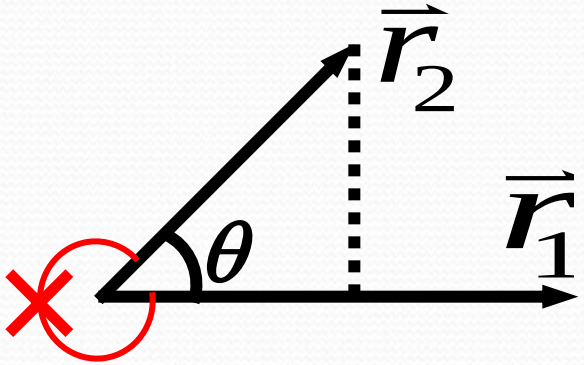
$$\vec{r}_1 \pm \vec{r}_2 = (x_1 \pm x_2)\vec{i} + (y_1 \pm y_2)\vec{j} + (z_1 \pm z_2)\vec{k}$$

➢Products of vectors(矢量的积)

➢ Scalar product标积 (or dot product点积)

Definition

$$\vec{r}_1 \cdot \vec{r}_2 = r_1 r_2 \cos\theta$$



Notes:

① θ≤π

②**The two vectors perpendicular to each other**

$$\vec{r}_1 \cdot \vec{r}_2 = 0 \Leftrightarrow \vec{r}_1 \perp \vec{r}_2$$

By components

Assume

$$\vec{r}_1 = x_1\vec{i} + y_1\vec{j} + z_1\vec{k}$$

$$\vec{r}_2 = x_2\vec{i} + y_2\vec{j} + z_2\vec{k}$$

Then

$$\vec{r}_1 \cdot \vec{r}_2 = x_1x_2 + y_1y_2 + z_1z_2$$

Example2

$$(\vec{i} + 2\vec{j} + 3\vec{k}) \cdot (2\vec{i} - \vec{j})$$

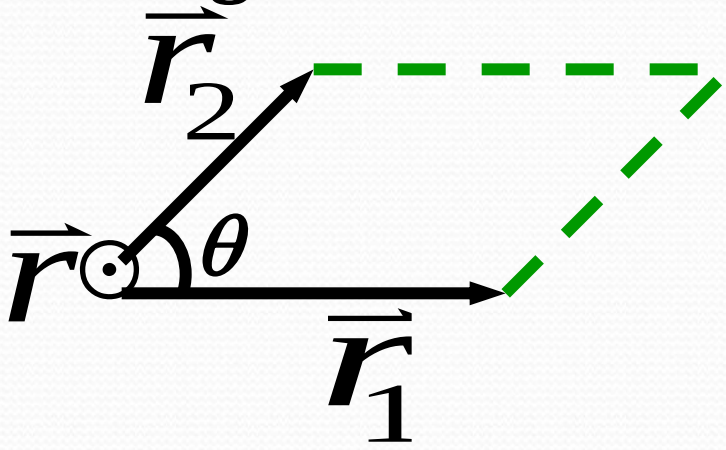
$$= 1 \times 2 + 2 \times (-1)$$

$$= 0$$

➢ Vector product 矢积(or cross product叉积)

Definition

$$\vec{r}_1 \times \vec{r}_2 = \vec{r}\begin{cases}\text{magnitude: } r_1 r_2 \sin\theta \\ \text{direction: right hand rule}\end{cases}$$



Notes:

① $\theta \le \pi$

②**The two vectors parallel to each other**

$$\vec{r}_1 \times \vec{r}_2 = 0 \Leftrightarrow \vec{r}_1 // \vec{r}_2$$

③ $\vec{a} \times \vec{b} = -(\vec{b} \times \vec{a})$

By components

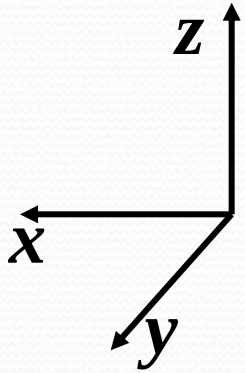
$$\vec{r}_1 \times \vec{r}_2 = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \end{vmatrix}$$

Example3

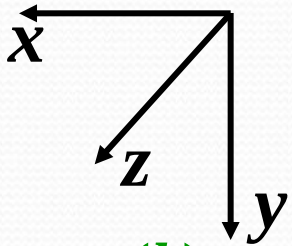
$$(\vec{i} + 2\vec{j}) \times (\vec{i} - 3\vec{k})$$

$$= -6\vec{i} + 3\vec{j} - 2\vec{k}$$

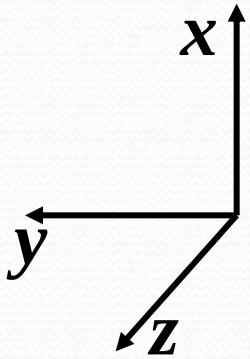
Which is NOT a right-handed coordinate system?



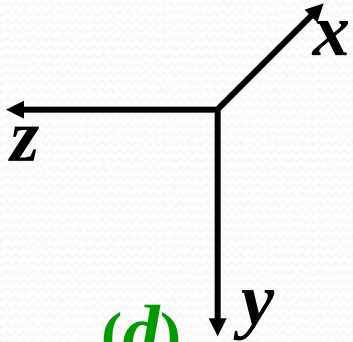
(a)



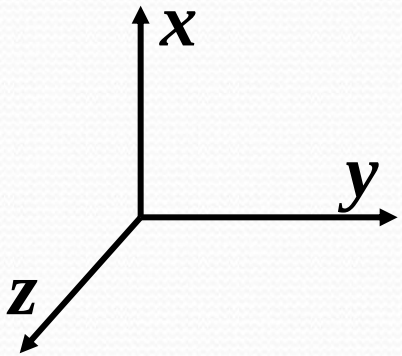
(b)



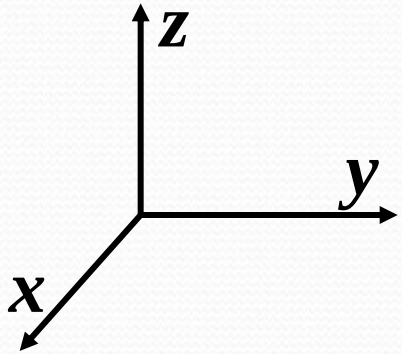
(c)



(d)



(e)



(f)

See you next time!