Chapter 5 ***Force and Motion – I***

引起此危險的強迫作用之物理為何？

05. We denote the two forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$. According to Newton's second law, $\boldsymbol{F}_1 + \boldsymbol{F}_2 = m\boldsymbol{a}_1$, so $\boldsymbol{F}_2 = m\boldsymbol{a}_1 - \boldsymbol{F}_1$. (**a**) In unit vector notation $\boldsymbol{F}_1 = (20.0\,\text{N})\mathbf{i}$ and

$$\vec{a} = -(12.0\sin 30.0°\,\text{m/s}^2)\,\hat{\mathrm{i}} - (12.0\cos 30.0°\,\text{m/s}^2)\,\hat{\mathrm{j}}$$
$$= -(6.00\,\text{m/s}^2)\,\hat{\mathrm{i}} - (10.4\,\text{m/s}^2)\,\hat{\mathrm{j}}.$$

Therefore,

$$\vec{F}_2 = (2.00\,\text{kg})(-6.00\,\text{m/s}^2)\,\hat{\mathrm{i}} + (2.00\,\text{kg})(-10.4\,\text{m/s}^2)\,\hat{\mathrm{j}} - (20.0\,\text{N})\,\hat{\mathrm{i}} = (-32.0\,\text{N})\,\hat{\mathrm{i}} + (-20.8\,\text{N})\,\hat{\mathrm{j}}.$$

(**b**) The magnitude of $\boldsymbol{F}_2$ is

$$|\vec{F}_2| = \sqrt{F_{2x}^2 + F_{2y}^2} = \sqrt{(-32.0)^2 + (-20.8)^2} = 38.2\ (\text{N}).$$

(**c**) The angle that $\boldsymbol{F}_2$ makes with the positive x axis is found from

$$\tan\theta = (F_{2y}/F_{2x}) = (-20.8)/(-32.0) = 0.656\ .$$

Consequently, the angle is either 33.0° or 33.0° + 180° = 213°. Since both the x and y components are negative, the correct result is 213°. An alternative answer is 213° – 360° = –147°.

06. We note that $m\boldsymbol{a} = (-16\ \text{N})\mathbf{i} + (12\ \text{N})\mathbf{j}$. With the other forces as specified in the problem, then Newton's second law gives the third force as

$$\vec{F}_3 = m\vec{a} - \vec{F}_1 - \vec{F}_2 = (-34\text{N})\,\hat{\mathrm{i}} + (-12\ \text{N})\,\hat{\mathrm{j}}.$$

11. (**a**) From the fact that T_3 = 9.8 N, we conclude the mass of disk D is 1.0 kg. Both this and that of disk C cause the tension T_2 = 49 N, which allows us to conclude that disk C has a mass of 4.0 kg. The weights of these two disks plus that of disk B determine the tension T_1 = 58.8 N, which leads to the conclusion that m_B = 1.0 kg. The weights of all the disks must add to the 98 N force described in the problem; therefore, disk A has a mass 4.0 kg. (**b**) m_B = 1.0 kg, as found in part (a). (**c**) m_C = 4.0 kg, as found in part (a). (**d**) m_D = 1.0 kg, as found in part (a).

18. Some assumptions (not so much for realism but rather in the interest of using the given information efficiently) are needed in this calculation: we assume the fishing line and the path of the salmon are horizontal. Thus, the weight of the fish contributes only (via Eq. 5-12) to information about its mass ($m = W/g$ = 8.7 kg). Our $+x$ axis is in the direction of the salmon's velocity (away from the fisherman), so that its acceleration ("deceleration") is negative-valued and the force of tension is in the $-x$ direction: $\boldsymbol{T} = -T\mathbf{i}$. We use Eq. 2-16 and SI units (noting that v = 0).

$$v^2 - v_0^2 = 2a\Delta x \Rightarrow a = -v_0^2/(2\Delta x)$$
$$= -2.8^2/(2\times 0.11) = -36\ (\text{m/s}^2).$$

Assuming there are no significant horizontal forces other than the tension, Eq. 5-1 leads to

$$\vec{T} = m\vec{a} \quad \Rightarrow \quad T\,\hat{\mathrm{i}} = (8.7\ \text{kg})(-36\ \text{m/s}^2)\,\hat{\mathrm{i}},$$

which results in $T = 3.1\times 10^2$ N.

19. (**a**) The acceleration is $a = F/m$ = 20 N/ 900 kg = 0.022 m/s^2. (**b**) The distance traveled in 1 day (= 86400 s) is $s = (½)at^2 = (½)(0.022\,\text{m/s}^2)(86400\,\text{s})^2 = 8.3\times 10^7$ m. (**c**) The speed it will be traveling is given by

$$v = at = (0.022\ \text{m/s}^2)(86400\ \text{s}) = 1.9\times 10^3\ \text{m/s}.$$

20. The stopping force $\boldsymbol{F}$ and the path of the passenger are horizontal. Our $+x$ axis is in the direction of the passenger's motion, so that the passenger's acceleration ("deceleration") is negative-valued and the stopping force is in the $-x$ direction: $\boldsymbol{F} = -F\mathbf{i}$. We use Eq. 2-16 and SI units (noting that v_0 = 53(1000/3600) = 14.7 m/s and v = 0).

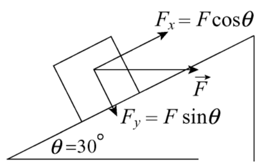
$$v^2 - v_0^2 = 2a\Delta x \quad \Rightarrow \quad a = -v_0^2/(2\Delta x) =$$
$$-14.7^2/(2\times 0.65) = -167\ (\text{m/s}^2).$$

Assuming there are no significant horizontal forces other than the stopping force, Eq. 5-1 leads to

$$\vec{F} = m\vec{a} \quad \Rightarrow \quad F\,\hat{\mathrm{i}} = (41\ \text{kg})(-167\ \text{m/s}^2)\,\hat{\mathrm{i}},$$

which results in $F = 6.8\times 10^3$ N.

24. We resolve this horizontal force into appropriate components. (**a**) Newton's second law applied to the x axis produces



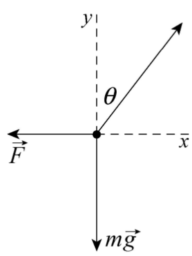
$$F\cos\theta - mg\sin\theta = ma.$$

For a = 0, this yields F = 566 N. (**b**) Applying Newton's second law to the y axis (where there is no acceleration), we have

$$F_N - F\sin\theta - mg\cos\theta = 0,$$

which yields the normal force $F_N = 1.13\times 10^3$ N.

31. The solutions to parts (a) and (b) have been combined here. The free-body diagram is shown below, with the tension of the string $\boldsymbol{T}$, the force of gravity $m\boldsymbol{g}$, and the force of the air $\boldsymbol{F}$. Our coordinate system is shown. Since the sphere is motionless the net force on it is zero, and the x and the y components of the eqs are:



$$T\sin\theta - F = 0$$

and $$T\cos\theta - mg = 0,$$

where θ = 37°. We answer the questions in the reverse order. Solving $T\cos\theta - mg = 0$ for the tension, we obtain

$$T = mg/\cos\theta = (3.0\times 10^{-4})(9.8)/\cos 37° = 3.7\times 10^{-3}\ (\text{N}).$$

Solving $T\sin\theta - F = 0$ for the force of the air:

$$F = T\sin\theta = (3.7\times 10^{-3})\sin 37° = 2.2\times 10^{-3}\ (\text{N}).$$

39. (**a**) The links are numbered from bottom to top. The forces on the bottom link are the force of gravity $m\boldsymbol{g}$, downward, and the force $\boldsymbol{F}_{2\text{on}1}$ of link 2, upward. Take the positive direction to be upward. Then Newton's second law for this link is $F_{2on1} - mg = ma$. Thus, $F_{2on1} = m\,(a+g)$

$$= (0.100\,\text{kg})(2.50\,\text{m/s}^2 + 9.80\,\text{m/s}^2) = 1.23\ \text{N}.$$

(**b**) The forces on the second link are the force of gravity $m\boldsymbol{g}$, downward, the force $\boldsymbol{F}_{1on2}$ of link 1, downward, and the force $\boldsymbol{F}_{3on2}$ of link 3, upward. According to Newton's third law $\boldsymbol{F}_{1on2}$ has the same magnitude as $\boldsymbol{F}_{2on1}$. Newton's second law for the second link is $F_{3on2} - F_{1on2} - mg = ma$, so

$$F_{3on2} = m(a+g) + F_{1on2} = (0.100\ \text{kg})$$
$$(2.50\ \text{m/s}^2 + 9.80\ \text{m/s}^2) + 1.23\ \text{N} = 2.46\ \text{N}.$$

(**c**) Newton's second law for link 3 is $F_{4on3} - F_{2on3} - mg = ma$, so

$$F_{4on3} = m(a+g) + F_{2on3} = (0.100\ \text{N})$$
$$(2.50\ \text{m/s}^2 + 9.80\ \text{m/s}^2) + 2.46\ \text{N} = 3.69\ \text{N},$$

where Newton's third law implies $F_{2on3} = F_{3on2}$ (since these are magnitudes of the force vectors).
(**d**) Newton's second law for link 4 is $F_{5on4} - F_{3on4} - mg = ma$, so

$$F_{5on4} = m(a+g) + F_{3on4} = (0.100\ \text{kg})$$
$$(2.50\ \text{m/s}^2 + 9.80\ \text{m/s}^2) + 3.69\ \text{N} = 4.92\ \text{N},$$

where Newton's third law implies $F_{3on4} = F_{4on3}$. (**e**) Newton's second law for the top link is $F - F_{4on5} - mg = ma$, so

$$F = m(a+g) + F_{4on5} = (0.100\ \text{kg})(2.50\ \text{m/s}^2$$
$$+ 9.80\ \text{m/s}^2) + 4.92\ \text{N} = 6.15\ \text{N},$$

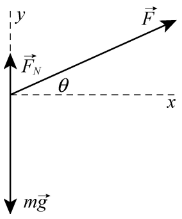
where $F_{4on5} = F_{5on4}$ by Newton's third law. (**f**) Each link has the same mass and the same acceleration, so the same net force acts on each of them:

$$F_{net} = ma = (0.100\ \text{kg})(2.50\ \text{m/s}^2) = 0.250\ \text{N}.$$

41. The force diagram (not to scale) for the block is shown below. $\boldsymbol{F}_N$ is the normal force exerted by the floor and $m\boldsymbol{g}$ is the force of gravity. (**a**) The x component of Newton's second law is $F\cos\theta = ma$, where m is the mass of the block and a is the x component of its acceleration. We obtain

$$a = F\cos\theta/m = (12.0)\cos 25.0°/5.00 = 2.18\ (\text{m/s}^2).$$

This is its acceleration provided it remains in contact with the floor. Assuming it does, we find the value of F_N (and if F_N is positive, then the assumption is true but if F_N is negative then the block leaves the floor). The y component of Newton's second law becomes



$$F_N + F\sin\theta - mg = 0,$$

so $F_N = mg - F\sin\theta = (5.00)(9.80)$
$- (12.0)\sin 25.0° = 43.9\ (\text{N}).$

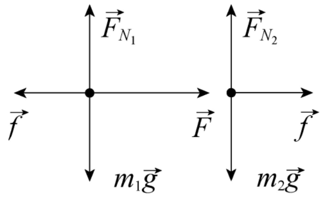
Hence the block remains on the floor and its acceleration is $a = 2.18\,\text{m/s}^2$. (**b**) If F is the minimum force for which the block leaves the floor, then $F_N = 0$ and the y component of the acceleration vanishes. The y component of the second law becomes

$$F\sin\theta - mg = 0 \quad \Rightarrow$$
$$F = mg/\sin\theta = (5.00)(9.80)/\sin 25.0° = 116\ (\text{N}).$$

(**c**) The acceleration is still in the x direction and is still given by the equation developed in part (a):

$$a = F\cos\theta/m = (116)\cos 25.0°/5.00 = 21.0\ (\text{m/s}^2).$$

43. The free-body diagrams for part (a) are shown below. $\boldsymbol{F}$ is the applied force and $\boldsymbol{f}$ is the force exerted by block 1 on block 2. We note that $\boldsymbol{F}$ is applied directly to block 1 and that block 2 exerts the force $-\boldsymbol{f}$ on block 1 (taking Newton's third law into account). (**a**) Newton's second law for block 1 is $F - f = m_1 a$, where a is the acceleration. The second law for block 2 is $f = m_2 a$. Since the blocks move together they have the same acceleration and the same symbol is used in both eqs. From the second eq. we obtain the expression $a = f/m_2$, which we substitute into the first eq. to get $F - f = m_1 f/m_2$. Therefore,



$$f = F\,m_2/(m_1+m_2) = (3.2)(1.2)/(2.3+1.2) = 1.1\ (\text{N}).$$

(**b**) If $\boldsymbol{F}$ is applied to block 2 instead of block 1 (and in the opposite direction), the force of contact between the blocks is

$$f = F\,m_1/(m_1+m_2) = (3.2)(2.3)/(2.3+1.2) = 2.1\ (\text{N}).$$

(**c**) We note that the acceleration of the blocks is the same in the two cases. In part (a), the force f is the only horizontal force on the block of mass m_2 and in part (b) f is the only horizontal force on the block with $m_1 > m_2$. Since $f = m_2 a$ in part (a) and $f = m_1 a$ in part (b), then for the accelerations to be the same, f must be larger in part (b).

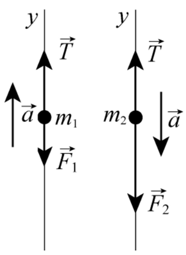
47. The free-body diagrams for m_1 and m_2 are shown in the figures below. The only forces on the blocks are the upward tension $\boldsymbol{T}$ and the downward gravitational forces $\boldsymbol{F}_1 = m_1\boldsymbol{g}$ and $\boldsymbol{F}_2 = m_2\boldsymbol{g}$. Applying Newton's second law, we obtain:

$$T - m_1 g = m_1 a \quad \text{and} \quad m_2 g - T = m_2 a\ ,$$

which can be solved to yield

$$a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right)g.$$

Substituting the result back, we have



$$T = \left(\frac{2m_1 m_2}{m_2 + m_1}\right)g.$$

(**a**) With $m_1 = 1.3$ kg and $m_2 = 2.8$ kg, the acceleration becomes

$$a = \frac{2.8 - 1.3}{2.8 + 1.3}(9.8) = 3.6\ (\text{m/s}^2)$$

(**b**) Similarly, the tension in the cord is

$$T = \frac{2(1.3)(2.8)}{1.3 + 2.8}(9.8) = 17\ (\text{N}).$$

49. We take $+y$ to be up for both the monkey and the package. (**a**) The force the monkey pulls downward on the rope has magnitude F. According to Newton's third law, the rope pulls upward on the monkey with a force of the same magnitude, so Newton's second law for forces acting on the monkey leads to $F - m_m g = m_m a$,
where m_m is the mass of the monkey and a_m is its acceleration. Since the rope is massless $F = T$ is the tension in the rope. The rope pulls upward on the package with a force of magnitude F, so Newton's second law for the package is

$$F + F_N - m_p g = m_p a_p ,$$

where m_p is the mass of the package, a_p is its acceleration, and F_N is the normal force exerted by the ground on it. Now, if F is the minimum force required to lift the package, then $F_N = 0$ and $a_p = 0$. According to the second law eq. for the package, this means $F = m_p g$. Substituting $m_p g$ for F in the eq. for the monkey, we solve for a_m:

$$a_m = \frac{F - m_m g}{m_m} = \frac{(m_p - m_m)}{m_m} g = \frac{15-10}{10}(9.80) = 4.9\ (\text{m/s}^2)$$

(**b**) As discussed, Newton's second law leads to $F - m_p g = m_p a_p$ for the package and $F - m_m g = m_m a_m$ for the monkey. If the acceleration of the package is downward, then the acceleration of the monkey is upward, so $a_m = -a_p$. Solving the first eq. for F

$$F = m_p(g + a_p) = m_p(g - a_m)$$

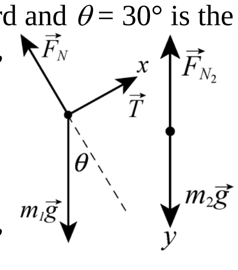
and substituting this result into the second eq., we solve for a_m:

$$a_m = \frac{(m_p - m_m)}{m_p + m_m} g = \frac{15-10}{15+10}(9.80) = 2.0\ (\text{m/s}^2).$$

(**c**) The result is positive, indicating that the acceleration of the monkey is upward. (**d**) Solving the second law equation for the package, we obtain

$$F = m_p(g - a_m) = (15)(9.80 - 2.0) = 120\ (\text{N}).$$

51. The free-body diagram for each block is shown below. T is the tension in the cord and $\theta = 30°$ is the angle of the incline. For block 1, we take the $+x$ direction to be up the incline and the $+y$ direction to be in the direction of the normal force $\boldsymbol{F}_N$ that the plane exerts on the block. For block 2, we take the $+y$ direction to be down. In this way, the accelerations of the two blocks can be represented by the same symbol a, without ambiguity. Applying Newton's second law to the x and y axes for block 1 and to the y axis of block 2, we obtain



$$T - m_1 g \sin\theta = m_1 a, \quad F_N - m_1 g \cos\theta = 0,$$

and $$m_2 g - T = m_2 a ,$$

respectively. The first and third of these equations provide a simultaneous set for obtaining values of a and T. The second eq. is not needed in this problem, since the normal force is neither asked for nor is it needed as part of some further computation (such as can occur in formulas for friction).
(**a**) We add the first and third eqs. above:

$$m_2 g - m_1 g \sin\theta = m_1 a + m_2 a.$$

Consequently, we find

$$a = \frac{m_2 - m_1 \sin\theta}{m_1 + m_2} g = \frac{2.30 - 3.70 \sin 30.0^\circ}{3.70 + 2.30}(9.80)$$
$$= 0.735\ (\text{m/s}^2).$$

(**b**) The result for a is positive, indicating that the acceleration of block 1 is indeed up the incline and that the acceleration of block 2 is vertically down.
(**c**) The tension in the cord is

$$T = m_1(a + g\sin\theta) = (3.70)(0.735 + 9.80 \times \sin 30.0°)$$
$$= 20.8\ (\text{N}).$$

53. The forces on the balloon are the force of gravity $m\boldsymbol{g}$ (down) and the force of the air $\boldsymbol{F}_a$ (up). We take the $+y$ to be up, and use a to mean the *magnitude* of the acceleration (which is not its usual use in this chapter). When the mass is M (before the ballast is thrown out) the acceleration is downward and Newton's second law is $F_a - Mg = M(-a)$. After the ballast is thrown out, the mass is $M - m$ (where m is the mass of the ballast) and the acceleration is upward. Newton's second law leads to $F_a - (M-m)g = (M-m)a$. The previous eq. gives $F_a = M(g-a)$, and this plugs into the new eq. to give

$$M(g-a) - (M-m)g = (M-m)a \quad \Rightarrow \quad m = \frac{2Ma}{g+a}.$$

67. The $+x$ axis is "uphill" for $m_1 = 3.0$ kg and "downhill" for $m_2 = 2.0$ kg (so they both accelerate with the same sign). The x components of the two masses along the x axis are given by $w_{1x} = m_1 g \sin\theta_1$ and $w_{2x} = m_2 g \sin\theta_2$, respectively. Applying Newton's second law, we obtain

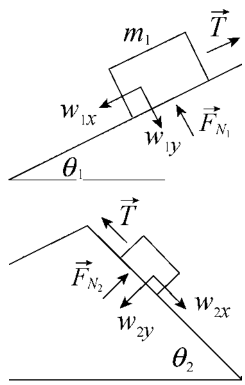
$$T - m_1 g \sin\theta_1 = m_1 a \quad \text{and} \quad m_2 g \sin\theta_2 - T = m_2 a.$$

Adding the two eqs. allows us to solve for the acceleration:

$$a = \frac{m_2 \sin\theta_2 - m_1 \sin\theta_1}{m_1 + m_2} g$$

$$T = \frac{m_1 m_2 (\sin\theta_1 + \sin\theta_2)}{m_1 + m_2} g .$$

With $\theta_1 = 30°$ and $\theta_1 = 60°$, we have $a = 0.45$ m/s^2. This value is plugged back into either of the two eqs to yield the tension $T = 16$ N.



Ex.3-1, Pb. 5-45.
(如發現錯誤煩請告知 jyang@mail.ntou.edu.tw, Thanks.)

•有關基本作用力，請參閱補充資料。

重點整理－第 5 章 力與運動—I

牛頓運動定律 •第一定律(慣性定律)--加利略：“**一旦物體有了一個速度，除非有任何因素使它加速或減速，否則它將不會減速。**” **慣性**：物體有阻止其運動狀態改變之傾向(定性地)。第一定律：**“當一物體不受外力作用時，永遠保持靜止或等速度的運動狀態。”**數學式：If $\vec{F}=0$, then $\vec{v}$= constant. 此定律使我們知道什麼叫作“**力**”。**力**：凡是能改變物體的運動狀態(即速率或方向)之作用，或使物體的運動狀態發生變化的因素。**力是一“向量”**，並遵循**疊加原理**。•第二定律(原始敘述)：“**物體動量的時變率等於作用於其上之力**”，或 $\vec{F}=d\vec{P}/dt$。第二定律：“**作用於一物體之合力等於此物體的質量與其加速度的乘積。**” 或 $\vec{F}=m\,\vec{a}$。(這暗示我們先有力才有加速度)注意：第二定律不能敘述為“**質量乘以加速度等於力**”，因這相當是“力之定義”。•**第三定律**：“**二物體交互作用時，第一物體施於第二物體的作用力 $\vec{F}_{21}$ 與第二物體施於第一物體的作用力 $\vec{F}_{12}$ 兩者大小相等，但方向相反。**”或 $\vec{F}_{12}=-\vec{F}_{21}$。作用力與反作用力之特殊關係：(***a***)同時存在及同時消失。(***b***)二者分別作用於“**不同的**”物體。(***c***)二者應同時量度。•**慣性參考系**：牛頓運動定律能成立的座標系稱之；否則為非慣性的。

•**自由體圖**：為只考慮單一物體之分解圖，而物體以點或概圖表示，晝上外部作用力，並疊畫與定出座標系統之方向以簡化問題。•**系統**：兩個或以上物體的集合。

•**質量**：為物體內稟性質(物體含物質之量，亦表示物體之慣性)，其使物體加速度與引起此加速度之淨力有關聯，**質量為一純量**。

一些特殊之力 •**重力F_g**：物體所受其它物體所施引力之總和；當物體只受地球作用時，其力方向指向地心或向下指向地面。重力為$\boldsymbol{F}_g = m\boldsymbol{g}$，式中$m$為物體質量，而$\boldsymbol{g}$為自由下落加速度。

•**重量W**：平衡作用於物體之重力所需的向上之力大小，物體重量與其質量m的關係為$W = mg$。

•**正向力F_N**：當物體壓迫某表面時，此表面對其施一作用力稱之；**正向力永遠垂直表面**。

•**摩擦力 f**：當物體於某表面滑動或欲滑動時，其所受之作用力稱之；**摩擦力永遠平行表面**。在無摩擦表面時，摩擦力可忽略。

張力T：當繩索於**張力**作用下，此繩索兩端拉引物體；此拉力係沿著繩索從接觸點指向物體；對無質量或質量可忽略之繩索，其兩端拉力大小相等；甚至若繩索沿無質量、無摩擦滑輪環繞運動時，亦然。

•**動力學解題通則**(程序/策略)：一複雜力學系統很難分析，但把各組成份子(物體)分解隔離並確認作用在其上之力，就較易分析。其步驟如下：•1.對問題繪一大的且簡潔的圖形以表示物理情況(系統)。•2.分解隔離你所要的物體。•3.對隔離物體繪一**自由體圖**，畫出所有作用其上之力。請勿包含未作用於其上之力(可設想你為該物體，試問什麼力是環境作用在你身上，假如不能確認力之來源或媒介，就不要包含它)。•4.對自由體圖擇一方便的(慣性)參考系，(如軸之方向如與質點之加速度平行的話，動力學為最清楚的。)將質點位在原點，沿各軸分解作用力，被分解之力就不要保留。•5.以分量形式，列出第二定律 $\Sigma_i F_{ix} = m_i a_{ix}$, $\Sigma_i F_{iy} = m_i a_{iy}$, $\Sigma_i F_{iz} = m_i a_{iz}$。•6.對未知數(待解之量)解分量方程式。•7.檢查答案的合理性—(***a***)負號可有明顯的理由嗎？或表示之前的錯誤或不對的假設；(***b***)檢查因次對否？(***c***)試各變數之極值，取極值時可對應較簡單的情況，或許答案已經知道！

Newtonian mechanics,牛頓力學; body,物體; system,系統; dimension,因次; mass,質量; massless,無質量的; force,力; net/resultant force,淨/合力; principle of superposition,疊加原理; gravitational force,重力; weight,重量; normal force,正向力; tension,張力; frictional force,摩擦力; frictionless,無摩擦的; inertial reference frame,慣性參考系; free-body diagram,自由體圖; bosun = boatswain,掌帆長, cantaloupe,甜瓜; nose-down,朝下; puck,橡皮圓盤; pulley,滑輪; quarterback,四分衛, salami,香腸; sag,下垂; sap,急拉斷裂; scale,秤/天平; sunjam,太陽推進; sun jacht,太陽帆, taut,張緊的; tug-of-war,拔河; takeoff illusion,起飛幻覺; vestibular,(內耳)前庭的,

牛頓：(a) “**假如我能比別人稍有智慧的話，那是因為我站在巨人的肩膀上！**” (Newton said: “If I have been able to see a little farther than other men, it is because I have stood on the shoulders of giants.”) (b) “我不知道世人是怎麼看我的，但是在我自己看來，我只不過像個在海邊玩耍的孩子，為不時撿到一塊比較光滑的石子，一只比較漂亮的貝殼而喜悅，然而真理的大海在我面前，我卻一點也沒發現。”