

College Physics

Volume 1

With an Integrated Approach to Forces and Kinematics
(Fourth Edition)

物理学卷1 (力学和热学)

(英文改编版·原书第4版)
(医学、生物等专业适用)

艾伦·詹巴蒂斯塔 (Alan Giambattista) (康奈尔大学)

(美) 贝蒂·麦卡锡·理查森 (Betty McCarthy Richardson) (康奈尔大学) 著

罗伯特·C. 理查森 (Robert C. Richardson) (康奈尔大学)

刘兆龙 改编

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UNIT CONVERSIONS

Length

1 in = 2.540 cm
 1 cm = 0.3937 in
 1 ft = 30.48 cm
 1 m = 39.37 in = 3.281 ft
 1 mi = 5280 ft = 1.609 km
 1 km = 0.6214 mi
 1 ly = 9.461×10^{15} m

Time

1 yr = 365.24 d = 3.156×10^7 s
 1 d = 24 h = 1440 min = 8.640×10^4 s

Speed

1 mi/h = 1.467 ft/s
 = 1.609 km/h = 0.4470 m/s
 1 km/h = 0.2778 m/s
 = 0.6214 mi/h = 0.9113 ft/s
 1 ft/s = 0.3048 m/s = 0.6818 mi/h
 1 m/s = 3.281 ft/s = 3.600 km/h = 2.237 mi/h

Volume

1 L = 1000 cm³ = 10⁻³ m³
 1 cm³ = 0.06102 in³ = 1 mL = 1×10^{-6} m³
 1 m³ = 1×10^6 cm³ = 35.31 ft³
 1 gal = 3.785 L

Mass

1 kg = 1000 g
 1 u = 1.6605×10^{-27} kg

Force

1 N = 0.2248 lb (pound used as force unit)
 1 lb = 4.448 N (pound used as force unit)

Energy

1 J = 0.7376 ft·lb = 6.242×10^{18} eV
 1 ft·lb = 1.356 J
 1 cal = 4.186 J
 1 Btu = 1055 J
 1 kW·h = 3.600 MJ
 1 eV = 1.602×10^{-19} J

Mass-Energy Equivalents

1 u = 931.494 MeV/c²
 = 1.492×10^{-10} J/c²

Power

1 W = 1 J/s
 1 hp = 550 ft·lb/s = 745.7 W
 1 Btu/h = 0.2931 W

Pressure

1 Pa = 1 N/m² = 1.450×10^{-4} lb/in²
 1 atm = 0.1013 MPa = 14.70 lb/in²
 1 lb/in² = 6.895×10^3 Pa
 1 mm Hg = 1.333×10^2 Pa
 1 in Hg = 3.386×10^3 Pa

Angle

1 rad = 57.30°
 1° = 0.01745 rad
 360° = 2π rad
 1 rad/s = 9.549 rpm
 1 rpm = 0.1047 rad/s

SI PREFIXES

Power	Prefix	Symbol
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ⁻¹	deci	d
10 ⁻²	centi	c
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p
10 ⁻¹⁵	femto	f

SI DERIVED UNITS

Quantity	Units			Equivalents
Force	newton	N	J/m	kg·m/s ²
Energy	joule	J	N·m	kg·m ² /s ²
Power	watt	W	J/s	kg·m ² /s ³
Pressure	pascal	Pa	N/m ²	kg/(m·s ²)
Frequency	hertz	Hz	cycle/s	s ⁻¹
Electric charge	coulomb	C		A·s
Electric potential	volt	V	J/C	kg·m ² /(A·s ³)
Electric resistance	ohm	Ω	V/A	kg·m ² /(A ² ·s ³)
Capacitance	farad	F	C/V	A ² ·s ⁴ /(kg·m ²)
Magnetic field	tesla	T	N·s/(C·m)	kg/(A·s ²)
Magnetic flux	weber	Wb	T·m ²	kg·m ² /(A·s ²)
Inductance	henry	H	V·s/A	kg·m ² /(A ² ·s ²)

USEFUL PHYSICAL DATA

Standard temperature (T of STP)	$0^{\circ}\text{C} = 273.15\text{ K}$
Standard pressure (P of STP)	$1\text{ atm} = 101.325\text{ kPa}$
Water	
Density (4°C)	$\rho_w = 1.000 \times 10^3\text{ kg/m}^3$
Heat of fusion	$L_f = 333.7\text{ kJ/kg}$
Heat of vaporization	$L_v = 2256\text{ kJ/kg}$
Specific heat capacity	$c = 4.186\text{ kJ/(kg}\cdot\text{K)}$
Index of refraction	$n_w = 1.33$
Speed of sound in air (20°C , 1 atm)	343 m/s
Speed of sound in air (at STP)	331 m/s
Density of dry air (at STP)	1.29 kg/m^3
Molar mass of air	28.98 g/mol
Molar volume of ideal gas (at STP)	$2.241 \times 10^{-2}\text{ m}^3/\text{mol}$

THE GREEK ALPHABET

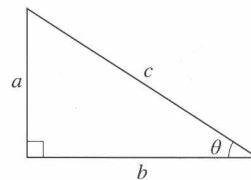
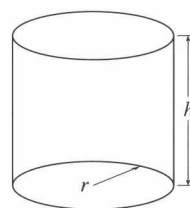
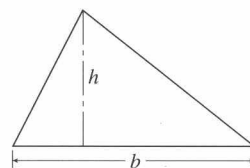
Alpha	A	α	Nu	N	ν
Beta	B	β	Xi	Ξ	ξ
Gamma	Γ	γ	Omicron	O	o
Delta	Δ	δ	Pi	Π	π
Epsilon	E	ϵ	Rho	P	ρ
Zeta	Z	ζ	Sigma	Σ	σ
Eta	H	η	Tau	T	τ
Theta	Θ	θ	Upsilon	Y	υ
Iota	I	ι	Phi	Φ	ϕ
Kappa	K	κ	Chi	X	χ
Lambda	Λ	λ	Psi	Ψ	ψ
Mu	M	μ	Omega	Ω	ω

ASTROPHYSICAL DATA

	Earth	Moon	Sun
Mass	$5.974 \times 10^{24}\text{ kg}$	$7.349 \times 10^{22}\text{ kg}$	$1.987 \times 10^{30}\text{ kg}$
Mean radius	$6.371 \times 10^6\text{ m}$	$1.737 \times 10^6\text{ m}$	$6.96 \times 10^8\text{ m}$
Mean density	$5.515 \times 10^3\text{ kg/m}^3$	$3.350 \times 10^3\text{ kg/m}^3$	$1.41 \times 10^3\text{ kg/m}^3$
Orbital period	365.24 d	27.3 d	
Period of rotation	23.9345 h	27.3 d	about 26 d
Surface temperature	288 K	$125\text{ K} - 375\text{ K}$	5800 K
Surface gravitational field	9.80 N/kg	1.62 N/kg	274 N/kg
Mean distance from Earth		$3.845 \times 10^8\text{ m}$	$1.50 \times 10^{11}\text{ m}$

MATHEMATICAL REVIEW

Area of a circle of radius r	$A = \pi r^2$
Circumference of a circle	$C = 2\pi r$
Surface area of a sphere	$A = 4\pi r^2$
Volume of a sphere	$V = \frac{4}{3}\pi r^3$
Area of a triangle	$A = \frac{1}{2}bh$
Surface area of right circular cylinder of radius r and height h	$A = 2\pi rh + 2\pi r^2$
Volume of the same cylinder	$V = \pi r^2 h$
Pythagorean theorem	$c^2 = a^2 + b^2$
Trigonometric relations	$\sin \theta = a/c$ $\cos \theta = b/c$ $\tan \theta = \frac{a}{b} = \frac{\sin \theta}{\cos \theta}$



Quadratic equation

$$\text{If } ax^2 + bx + c = 0, x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Need more help with your math? Go to www.aleks.com for individualized, specific math help on just those math areas you need to get through your physics course!

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 Speed of a downhill skier, Ex. 6.3
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Everyday Life

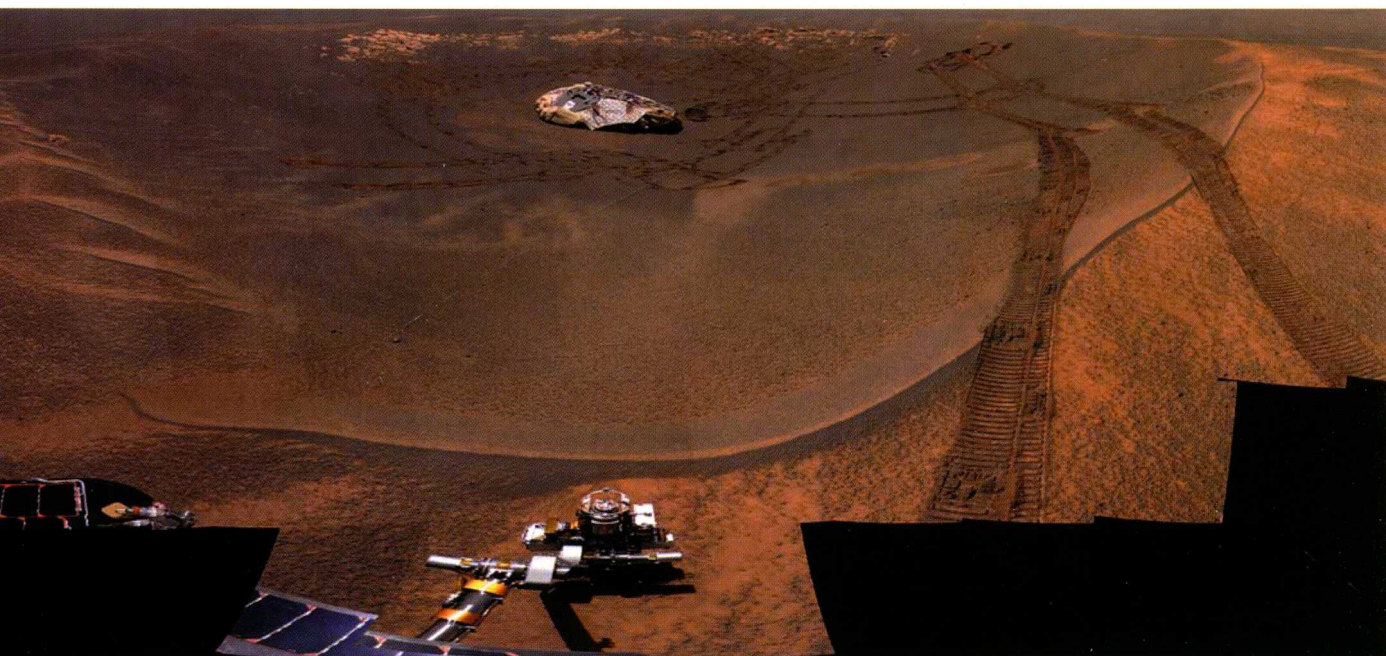
Hauling a crate up to a third-floor window, Ex. 4.2
 Circular motion of a DVD, Sec. 5.1
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Work done on a potter's wheel, Ex. 8.5
Climbing a ladder on a slippery floor, Ex. 8.7
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Sound from a loudspeaker, Sec. 12.1
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Wind instruments, Sec. 12.4
Tuning a piano, Sec. 12.7
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Double-paned windows, Ex. 14.10
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 P:4,5,11,24,34,54. (7) CQ:1,7; P:1,8,16,24,44. (8) CQ;
 2,7;MC:1;P:6-8,10,11,18,19,28. (9)
 CQ:7;P:2,3,11,19,21,22,25,29. (10) CQ:2;P:1,19,37.
 (11) CQ:1-3;MC:2,3;P:2,5,8,9,26-30,32-34,37,39. (12)
 MC:1,2,5; P:11-14,19,21-23,27,28,32,35;
 R&S:1,2,5,8,9.(13)CQ:10;P:23,54.(14)CQ:3,6,9,10;M
 C:3;P:7,14-18,22,24,31,33-35,37,41.(15)CQ:1,3,4,6,7;
 P:15,16,20,22,39;R&S:6,9,10.(17)CQ:2;P:34.(18)CQ:
 1,2,5,7;P:1,15,30,31,34,44,49,57,59;R&S:11;
 MCAT:2-13.(19)CQ:5.(20)CQ:9;P:17.(21)P:1.(22)
 P:6,7,30.(23)P:4,8,9.

PHYSICAL CONSTANTS

Quantity	Symbol	Value
Universal gravitational constant	G	$6.674 \times 10^{-11} \text{ m}^3/(\text{kg}\cdot\text{s}^2)$
Speed of light in vacuum	c	$2.998 \times 10^8 \text{ m/s}$
Elementary charge	e	$1.602 \times 10^{-19} \text{ C}$
Planck's constant	h	$6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
		$4.136 \times 10^{-15} \text{ eV}\cdot\text{s}$
	$\hbar = h/(2\pi)$	$1.055 \times 10^{-34} \text{ J}\cdot\text{s}$
		$6.582 \times 10^{-16} \text{ eV}\cdot\text{s}$
Universal gas constant	R	$8.314 \text{ J}/(\text{mol}\cdot\text{K})$
Avogadro's number	N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
Boltzmann constant	k_B	$1.381 \times 10^{-23} \text{ J/K}$
		$8.617 \times 10^{-5} \text{ eV/K}$
Coulomb force constant	$k = 1/(4\pi\epsilon_0)$	$8.988 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
Permittivity of free space (electric constant)	ϵ_0	$8.854 \times 10^{-12} \text{ C}^2/(\text{N}\cdot\text{m}^2)$
Permeability of free space (magnetic constant)	μ_0	$4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$
Electron mass	m_e	$9.109 \times 10^{-31} \text{ kg}$
		$0.000\,548\,580 \text{ u}$
Electron rest energy	$m_e c^2$	0.5110 MeV
Proton mass	m_p	$1.673 \times 10^{-27} \text{ kg}$
		$1.007\,276\,5 \text{ u}$
Proton rest energy	$m_p c^2$	938.272 MeV
Neutron mass	m_n	$1.675 \times 10^{-27} \text{ kg}$
		$1.008\,664\,9 \text{ u}$
Neutron rest energy	$m_n c^2$	939.565 MeV
Compton wavelength of electron	λ_C	$2.426 \times 10^{-12} \text{ m}$
Stefan-Boltzmann constant	σ	$5.670 \times 10^{-8} \text{ W}/(\text{m}^2\cdot\text{K}^4)$
Rydberg constant	R	$1.097 \times 10^7 \text{ m}^{-1}$
Bohr radius of hydrogen atom	a_0	$5.292 \times 10^{-11} \text{ m}$
Ionization energy of hydrogen atom	$-E_1$	13.61 eV



Chapter 1 绪论

火星探测器“机遇号”回望其位于火星表面“鹰坑”中的着陆器。之前，一个简单的错误导致了“火星气候轨道器”失踪，如何避免犯同样的错误呢？

Chapter 2 力

旅行者1号空间探测器拍摄的木星的一个卫星Io的照片。旅行者1号是怎样不靠引擎的驱动，高速飞行30多年，到达了距太阳170多亿公里的地方呢？



Chapter 2 插图

足球运动员的脚与球接触时，两者间存在作用力。

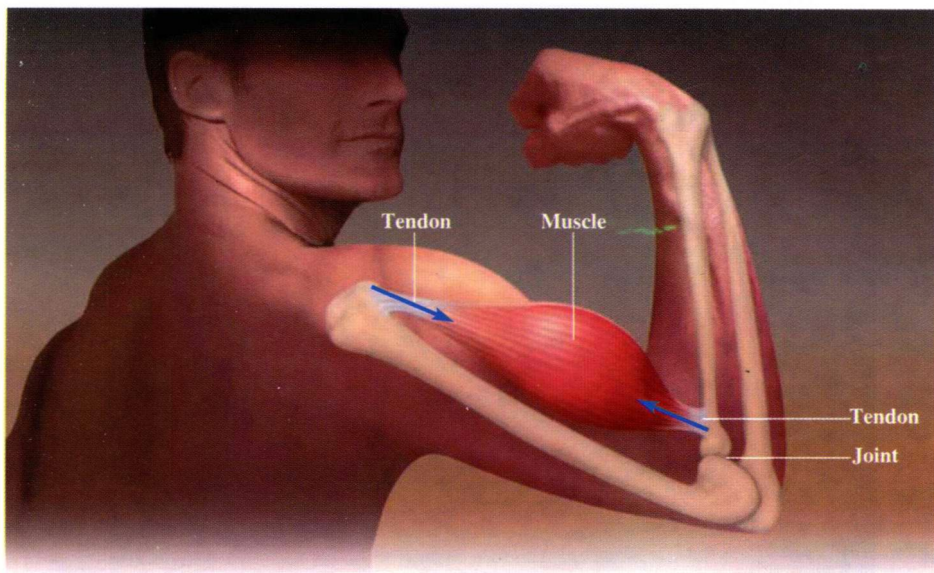


图2.10

肌肉的收缩，增加了肌腱的张力，肌腱还对骨骼施加力。

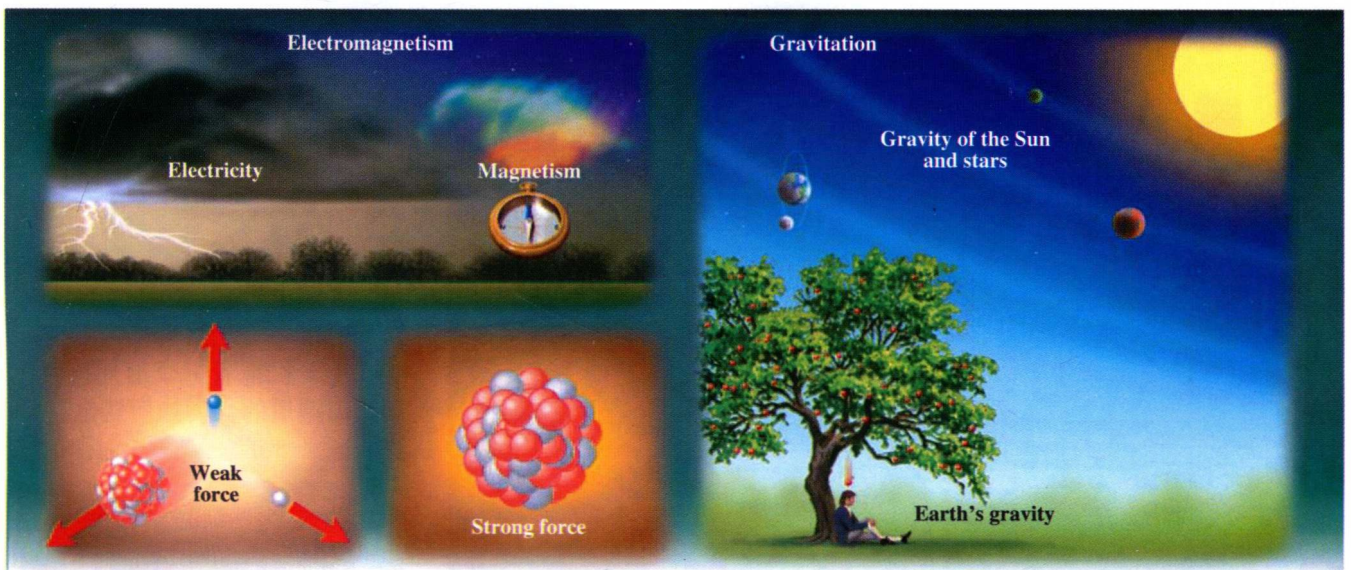


图2.13 四种基本力



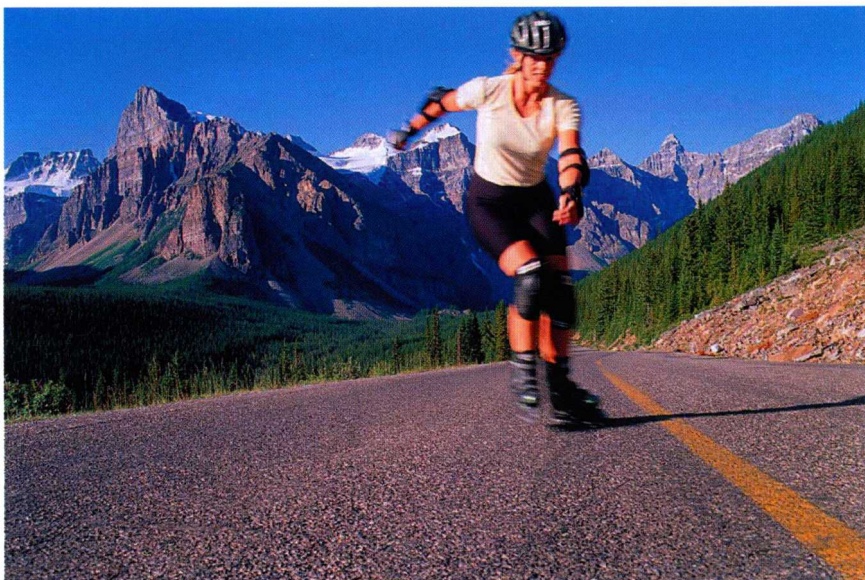
Chapter 3

加速度与牛顿第二运动定律

非洲狮子的最高奔跑时速与水牛的几乎相同，那么它是怎样捕捉到水牛的呢？

例题3.5图

轮滑冲山坡者。



Chapter 4

加速度为常量的运动

小飞机拖着一个滑翔机时，其起飞跑道的长度如何变化？

图4.14

挖掘到蚌以后，海鸥把它带到高处再抛掉，试图摔碎它的壳。





Chapter 5 圆周运动

链球运动员必须在柄上施加多大的力才能使重锤旋转？



图5.25

电影《2001太空漫游》中的旋转空间站。

Chapter 6 能量守恒

袋鼠能够以15m/s或更高的水平速度跳跃前行，连续跳起到2.8m左右的高度，这一绝技背后的秘密是什么？



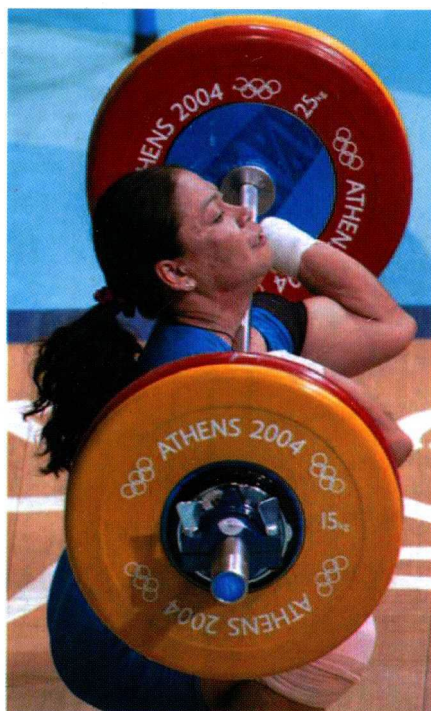


图6.2

存储在食物中的化学能使举重运动员将杠铃举过她的头顶。



Chapter 6 Problem 42图

尼亚加拉大瀑布。



Chapter 7 动量

汽车发生碰撞后，事故调查员通常要测量路面上滑痕的长度。事故调查员如何使用这些信息推测汽车碰撞前的速度呢？

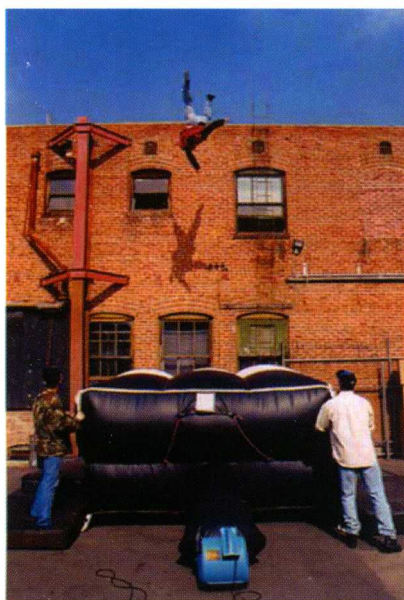
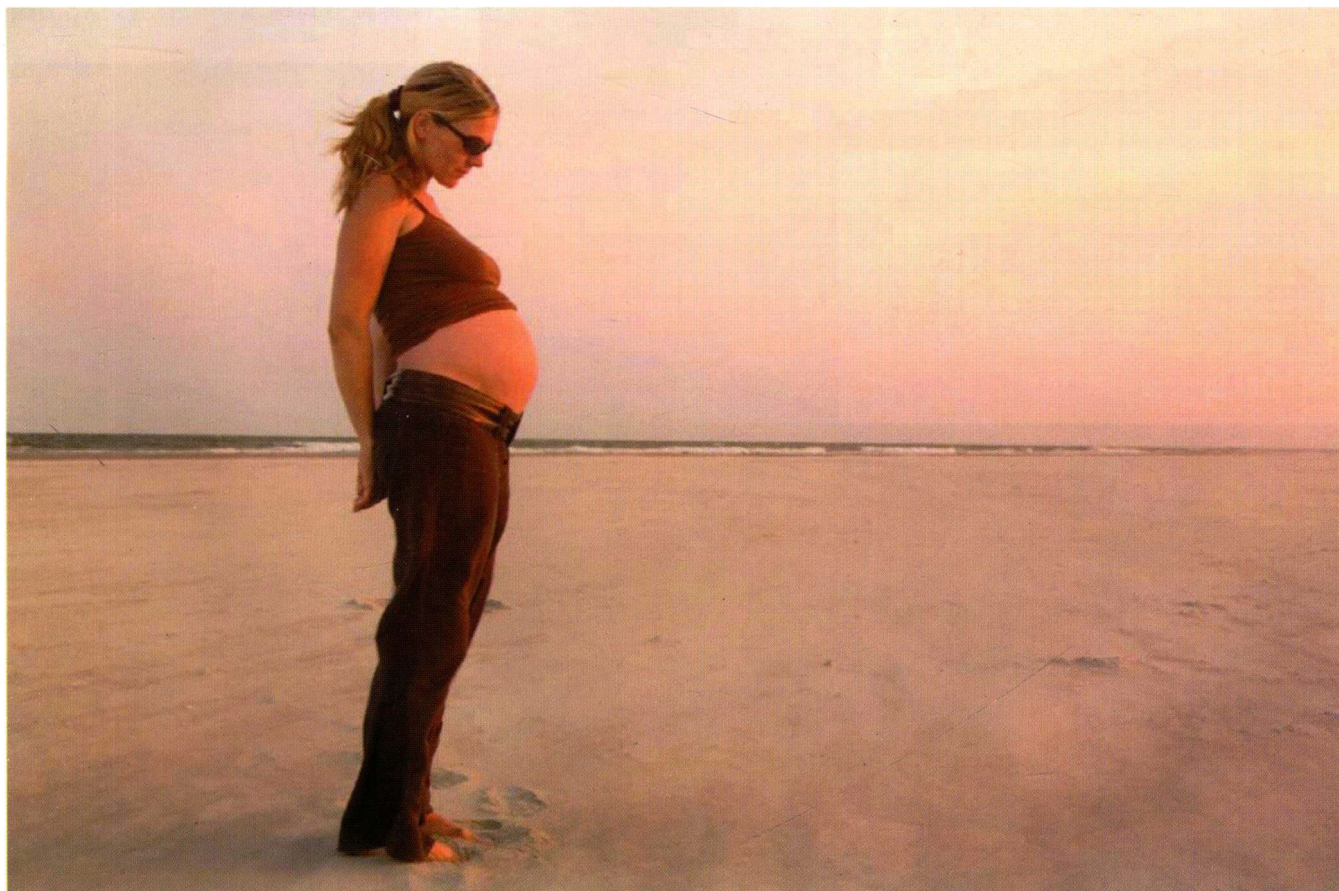


图7.3 空气垫保证了特技替身演员的安全。



图7.10 鱿鱼靠虹吸管向外排水推动自身前进。



Chapter 7 Problem 17图

妇女怀孕后，身体的质心位置发生了变化。



Chapter 8 力矩与角动量

十字支撑是体操运动中一个极其困难的动作，对力量的要求达到了难以置信程度。为什么这个动作需要如此大的力量呢？

图8.15
举腿练习。

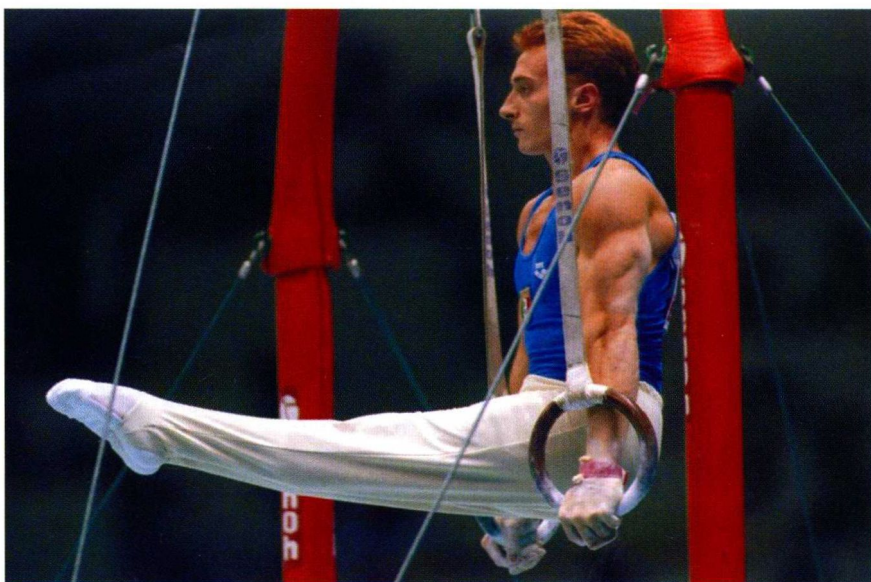
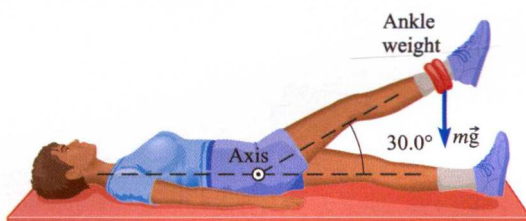


图8.27

运动员做吊环屈体动作时，质心的位置在何处？