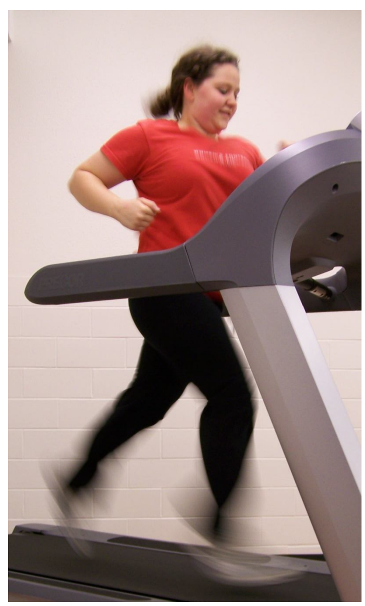
Treadmill Running & Metabolic Equations

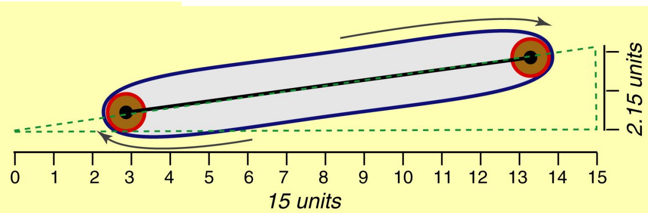
Treadmill Walking and Running



Treadmill Walking and Running

UNM

$$\text{Speed}\,[m/\text{min}] = \frac{\text{belt length}\,[m] \times \text{belt revolutions}\,[number]}{\text{time}\,[\text{min}]}$$



rise = 2.15 units ; run = 15 units
2.15 / 15 = 0.1433
= 14.33%

treadmill angle (σ) ; tan σ = rise / run
= 2.15 / 15.0
= 0.1433
σ = inverse tan (0.1433)
= 8.1568^{o}

%grade	tan σ	Angle (°)
1	0.01	0.57
2	0.02	1.15
3	0.03	1.72
4	0.04	2.29
5	0.05	2.86
6	0.06	3.43
7	0.07	4.00
8	0.08	4.57
9	0.09	5.14
10	0.10	5.70
11	0.11	6.08
12	0.12	6.84
13	0.13	7.40
14	0.14	7.97
15	0.15	8.53
16	0.16	9.09
17	0.17	9.65
18	0.18	10.20
19	0.19	10.76
20	0.20	11.31

$\text{treadmill angle}\,[^\circ] = \sigma;\ \sin\sigma = rise/hypotenuse;\ \sigma = \text{inverse}\sin\times(rise/hypotenuse);$

$\tan\sigma = rise/run$

$if\ \sigma = 5^\circ;\ \text{then}\ \tan\sigma = 0.0875;\ \%\text{grade} = \tan\sigma\times 100 = 8.75\% = 1:11.43\ \text{slope ratio}$

UNM

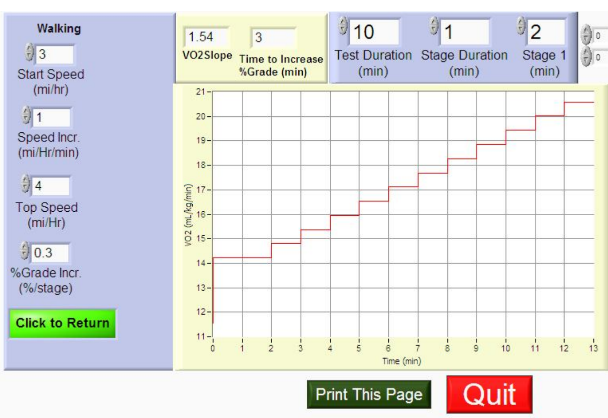
Metabolic Energy Demand Is Quantified by Whole Body Oxygen Consumption (VO_2)

Douglas Bag Collection of Expired Air

VO2 units	System	Equation
		(horizontal + vertical + resting)
Treadmill Walking		
mL/kg/min	metric	(km/hr x 1.6667) + ((%grade/100) x km/hr x 30) + 3.5
mL/kg/min	imperial	(mi/hr x 2.6834) + ((%grade/100) x mi/hr x 48.3) + 3.5
Treadmill Running		
mL/kg/min	metric	(km/hr x 3.3333) + ((%grade/100) x km/hr x 15) + 3.5
mL/kg/min	imperial	(mi/hr x 5.3668) + ((%grade/100) x mi/hr x 24.15) + 3.5
Cycle Ergometry		
mL/min (ACSM)	Watts	0 + (Watts x 12.236) + (3.5 x kg body mass)
mL/min (ACSM)	kgm/min	0 + (kgm/min x 2) + (3.5 x kg body mass)
mL/min (Latin)	Males	0 + ((Watts x 11.624) + 260) + (3.5 x kg body mass)
mL/min (Latin)	Females	0 + ((Watts x 9.7892) + 205) + (3.5 x kg body mass)
Arm Ergometry		
mL/min	Watts	0 + (kgm/min x 18.354) + (3.5 x kg body mass)
mL/min	metric	0 + (kgm/min x 3) + (3.5 x kg body mass)
Bench Stepping		
mL/kg/min	metric	(steps/min x 0.35) + (step ht cms x steps/min x 0.02394) + 0
mL/kg/min	imperial	(steps/min x 0.35) + (step ht inches x steps/min x 0.06081) + 0

ACSM equations from ACSM. Guidelines for exercise testing and prescription. 4th Edition. Lea & Febiger. Philadelphia. 1991.
Latin equations from Latin RW, Berg KE, Smith P, Tolle R, Woodby-Brown S. Validation of a cycle ergometry equation for predicting steady-rate VO2. ***Med Sci Sports Exerc*** 1993;25(8):970-4.

Exercise Increases Muscle and Whole Body Energy Demand In a Predictable Manner



Time	Speed	%Grade	rev/min	kg Load	Watts	estVO2
0	3	0	0	0	0	11.54
2	4	0	0	0	0	14.22
3	4	0.3	0	0	0	14.8
4	4	0.6	0	0	0	15.38
5	4	0.9	0	0	0	15.96
6	4	1.2	0	0	0	16.54
7	4	1.5	0	0	0	17.11
8	4	1.8	0	0	0	17.69
9	4	2.1	0	0	0	18.27
10	4	2.4	0	0	0	18.85
11	4	2.7	0	0	0	19.43
12	4	3	0	0	0	20.01
13	4	3.3	0	0	0	20.59
14	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

1. Click on an exercise mode to call up the protocol controls on the left.
2. Manipulate the protocol controls to get the desired protocol.
3. Based on text content, remember you want a protocol with a consistent linear trend in predicted VO2, a VO2 slope that is not too large (< 5 mL/kg/min/min), and attains a VO2 that is sufficient to meet your subject's anticipated fitness in approximately 8 to 10 min.

Calculations

What is the steady state VO_2 for the following?

1. Walking at 4.5 mi/hr at 3.5 %grade.
2. Running at 10.5 mi/hr at 0 %grade
3. Cycling at 300 Watts for an 81 kg male (cadence independent)
4. Cycling at 2.75 kg at 80 rev/min for a 70 kg female (cadence dependent)
5. Running at 9.4 mi/hr at 10 %grade

Answers

1. Walking at 4.5 mi/hr at 3.5 %grade = 23.2 mL/kg/min
2. Running at 10.5 mi/hr at 0 %grade = 59.9 mL/kg/min
3. Cycling at 300 Watts for an 81 kg male (cadence independent)

   = 4.03 L/min
4. Cycling at 2.75 kg at 80 rev/min for a 70 kg female (cadence dependent)

   = 2.56 L/min
5. Running at 9.4 mi/hr at 10 %grade = 76.6 mL/kg/min

Breath-By-Breath Data Processing: Processing Program and Excel