SAFE RETURN DOUBTFUL: WEEK 1 PART II

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SUMMARY

1. Warm-up: the idea of a supply depot
    - Assuming a depot exists
    - Creating a depot
2. More practice with force of friction
    - Force and work
    - Coefficients of friction
    - Energy in types of food
    - Power consumption
3. **Lecture: My expeditions to Moore's Bay, Antarctica**

WARM-UP

Returning to the equation for force and work:

$$Work = Force \times distance \tag{1}$$

- If you pull with 100 Newtons of force for 10 km, how much work is being done?
- If you expend 1000 J of energy by pulling with 10 Newtons of force, how far did you go?

Returning to the equation for force and work:

$$Work = Force \times distance \tag{2}$$

- Now assume that there is a *depot* 10 km ahead. How much energy is required to pull with 1000 N to get there? What if there is another 10^6 J (one million) Joules of energy there? How much farther could you travel if you consumed it?
- Suppose that the depot supplies have 100 kg of mass, and the coefficient of friction is 0.1 on the snow. How much energy would it take to drag the depot food 10 km to creat the depot? Recall that $F_f = \mu m g$, and $g = 9.81$ m/s^2.

MORE PRACTICE WITH THE FORCE OF FRICTION, AND HUMAN ENERGIES

Food component	Energy density[17]	
	kJ/g	kcal/g
Fat	37	9
Ethanol (drinking alcohol)	29	7
Proteins	17	4
Carbohydrates	17	4
Organic acids	13	3
Polyols (sugar alcohols, sweeteners)	10	2.4
Fibre	8	2

Figure 1: Summary of food energy.

MORE PRACTICE WITH THE FORCE OF FRICTION, AND HUMAN ENERGIES

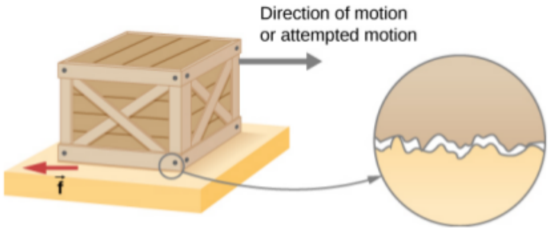

Figure 6.10 Frictional forces, such as $\vec{\mathbf{f}}$, always oppose motion or attempted motion between objects in contact. Friction arises in part because of the roughness of the surfaces in contact, as seen in the expanded view.

Figure 2: Summary of friction.

Magnitude of Kinetic Friction

The magnitude of kinetic friction $f_{\mathbf{k}}$ is given by

$$f_{\mathbf{k}} = \mu_{\mathbf{k}} N, \quad (6.2)$$

where $\mu_{\mathbf{k}}$ is the coefficient of kinetic friction.

Figure 3: Equation of friction.

System	Static Friction μ_s	Kinetic Friction μ_k
Rubber on dry concrete	1.0	0.7
Rubber on wet concrete	0.5-0.7	0.3-0.5
Wood on wood	0.5	0.3
Waxed wood on wet snow	0.14	0.1
Metal on wood	0.5	0.3
Steel on steel (dry)	0.6	0.3
Steel on steel (oiled)	0.05	0.03
Teflon on steel	0.04	0.04
Bone lubricated by synovial fluid	0.016	0.015
Shoes on wood	0.9	0.7
Shoes on ice	0.1	0.05
Ice on ice	0.1	0.03
Steel on ice	0.4	0.02

Table 6.1 Approximate Coefficients of Static and Kinetic Friction

Figure 4: Sumary of friction coefficients.

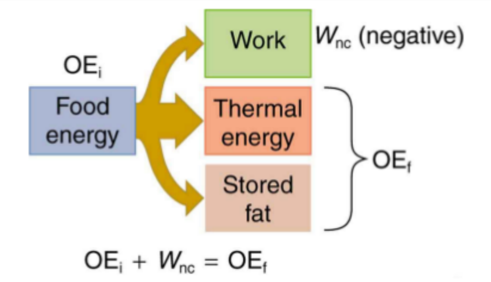

Figure 5: Sumary of human power consumption.

Table 7.4 Basal Metabolic Rates (BMR)

Organ	Power consumed at rest (W)	Oxygen consumption (mL/min)	Percent of BMR
Liver & spleen	23	67	27
Brain	16	47	19
Skeletal muscle	15	45	18
Kidney	9	26	10
Heart	6	17	7
Other	16	48	19
Totals	85 W	250 mL/min	100%

Figure 6: Sumary of human power consumption, part 2.

Table 7.5 Energy and Oxygen Consumption Rates[2] (Power)

Activity	Energy consumption in watts	Oxygen consumption in liters O_2/min
Sleeping	83	0.24
Sitting at rest	120	0.34
Standing relaxed	125	0.36
Sitting in class	210	0.60
Walking (5 km/h)	280	0.80
Cycling (13–18 km/h)	400	1.14
Shivering	425	1.21
Playing tennis	440	1.26
Swimming breaststroke	475	1.36
Ice skating (14.5 km/h)	545	1.56
Climbing stairs (116/min)	685	1.96
Cycling (21 km/h)	700	2.00
Running cross-country	740	2.12
Playing basketball	800	2.28
Cycling, professional racer	1855	5.30
Sprinting	2415	6.90

Figure 7: Sumary of human power consumption, part 3.

Figure 8: Inuits: did you try ice, my friend?