Sample problems/calculations - It is strongly encouraged that additional study time be made available to workshop participants for the solving of metabolic calculations. It is suggested that problems 1, 2, 3, 8 & 10 are more focused upon.

METABOLIC CALCULATIONS

PRACTICE PROBLEMS

1. Calculate the MET cost of walking on the treadmill at 2.5 mph/6% grade.

2. Calculate the Kcal expenditure (kcal.min⁻¹) for a 75 kg man performing at the MET load in question #1.

3. How long (minutes) would it take the subject in question #2 to expend the number of kcals in one lb of fat, if they exercised at the MET load from question #1.

4. Calculate the MET cost of running on the treadmill at 6.5 mph/4% grade.

5. Calculate the kcal expenditure (kcal.min⁻¹) for a 62 kg female working at the MET load from question #4.

6. The subject in question #5 needs to lose 10 lbs of Fat. How many 30 minute workouts will she have to complete at the workload from question #4 to accomplish this?

7. A subject has a functional capacity of 5.4 METs. Calculate a workload on the treadmill that would be equal to 65% of the subjects' functional capacity.

8. Calculate the oxygen cost of pedaling (75 rpm) a stationary bicycle (MonarkTM) at a load setting of 3.0 kp for an 85 kg man.

9. Calculate the MET cost of cycling at the workload from question #8, for a 90 kg male.

10. A subject (75 kg weight) has a functional capacity of 9.0 METs. Calculate a workload in watts on the MonarkTM cycle ergometer that would be equal to 70% of this subjects' functional capacity.

11. Calculate the MET cost of arm cranking at a workload of 450 kgm/min for a 80 kg man.

12. Calculate the MET cost of stepping up and down on a 10 inch bench at a step rate of 24 per minute.
APPENDIX B

METABOLIC CALCULATION SOLUTIONS

1. Calculate the MET cost of walking on the treadmill at 2.5 mph/6% grade.

\[
2.5 \text{ mph } \times 26.8 \text{ m.min-1 per mph} = 67.0 \text{ m.min-1}
\]

\[
\text{VO2 ml.kg-1.min-1} = 67.0 \text{ m.min-1} \times 0.1 \text{ ml.kg-1.min-1 per m.min-1} + 0.06 \text{ % grade} \times 67.0 \\
= 67.0 \times 0.1 + 0.06 \times 67.0 \times 1.8 + 3.5
\]

\[
\text{TOTAL VO2 ml.kg-1.min-1} = 17.44 \text{ ml.kg-1.min-1}
\]

\[
\text{METs} = 17.44 / 3.5 = 4.98 \text{ METs} \approx 5.0 \text{ METs}
\]

2. Calculate the Kcal expenditure (kcal.min-1) for a 75 kg man performing at the MET load in question #1.

Kcals are related to the oxygen consumed: 1 liter O2 \( \approx \) 5 kcals

\[
\text{MET load} = 4.98
\]

Need to convert this into an absolute unit of VO2 (independent of BW)

\[
4.98 \text{ METs} \times 3.5 \text{ ml.kg-1.min-1} = 17.4 \text{ ml.kg-1.min-1} \times 75 \text{ kg} = 1305 \text{ ml.min-1}
\]

\[
1305 \text{ ml.min-1} / 1000 = 1.305 \text{ L.min-1}
\]

\[
1.305 \text{ L.min-1} \times 5 \text{ kcals.L O2} = 6.53 \text{ kcals.min-1}
\]

- or -

\[
4.98 \text{ METs} \times 3.5 \left[ 75 \text{ kg/200} \right] = 6.53 \text{ kcals.min-1}
\]

3. How long (minutes) would it take the subject in question #2 to expend the number of kcals in one lb of fat, if they exercised at the MET load from question #1.

1 lb fat \( \approx \) 3500 kcals

\[
\text{at} \ 6.53 \text{ kcals.min-1}
\]

\[
\# \text{ of minutes} = 3500 \text{ kcals.lb-1} / 6.53 \text{ kcals.min-1} = 536 \text{ minutes}
\]

If your RX was 30 minute sessions, 4x week:

\[
536/30 \text{ minutes per session} = 17.9 \text{ sessions : @ 4xwk = 4.5 weeks}
\]
4. Calculate the MET cost of running on the treadmill at 6.5 mph/4% grade.

6.5 mph x 26.8 m.min-1per mph = 174.2 m.min-1

\[
\text{VO2 ml.kg-1.min-1} = 174.2 \text{ m.min-1} \times 0.2 \text{ ml.kg-1.min-1 per m.min-1} + 0.04 \% \text{ grade} \times 174.2 \text{ m.min-1} \times 0.9 \text{ ml.kg-1.min-1 per m.min-1} + 3.5 \text{ ml.kg-1.min-1} \\
\text{VO2 ml.kg-1.min-1} = 174.2 \times 0.2 + 0.04 \times 174.2 \times 0.9 + 3.5 \\
\text{VO2 ml.kg-1.min-1} = 34.8 + 6.27 + 3.5 \\
\text{VO2 ml.kg-1.min-1} = 44.6 \text{ ml.kg-1.min-1} \\
\text{METs} = \frac{44.6}{3.5} = 12.7 \text{ METs}
\]

5. Calculate the kcal expenditure (kcal.min-1) for a 62 kg female working at the MET load from question #4.

Kcals are related to the oxygen consumed: 1 liter O2 ≈ 5 kcals

\[
\text{MET load} = 12.7 \\
\text{Need to convert this into an absolute unit of VO2 (independent of BW)} \\
12.7 \text{ METs} \times 3.5 \text{ ml.kg-1.min-1} = 44.6 \text{ ml.kg-1.min-1} \times 62 \text{ kg} = 2765.2 \text{ ml.min-1} \\
2765.2 \text{ ml.min-1} / 1000 = 2.765 \text{ L.min-1} \\
2.765 \text{ L.min-1} \times 5 \text{ kcals.L O2} = 13.8 \text{ kcals.min-1} \\
\text{-or-} \\
12.7 \text{ METs} \times 3.5 [62 \text{ kg}/200] = 13.78 \text{ kcals.min-1}
\]

6. The subject in question #5 needs to lose 10 lbs of Fat. How many 30 minute workouts will she have to complete at the workload from question #4 to accomplish this?

1 lb fat ≈ 3500 kcals ≈ 10 lbs fat ≈ 35,000 kcals

\[
\text{@ 13.8 kcals.min-1} \times 30 \text{ minutes} = 414 \text{ kcals.session-1} \\
35,000 \text{ kcals}.10 \text{ lb fat-1}/ 414 \text{ kcals.session-1} = 84.5 \text{ sessions} \\
\text{If your RX was 30 minute sessions, 4x week:} \\
84.5 \text{ sessions} : @ 4xwk = 21 \text{ weeks}
\]
7. A subject has a functional capacity of 5.4 METs. Calculate a workload on the treadmill that would be equal to 65% of the subjects' functional capacity.

FC = 5.4 METs; RX = 65% of FC

Training VO2 = 5.4 x .65 = 3.5 METs

You could use a speed and grade combination from the chart in the ACSM Guidelines Appendix, but 

ACSM Equations use units of ml.kg-1.min-1 so convert METs:

3.5 METs x 3.5 ml.kg-1.min-1 = 12.25 ml.kg-1.min-1

Training VO2 = 12.25 ml.kg-1.min-1

Use walking equation with the unknown variable being walking speed. (assume 0% grade)

VO2 12.25 ml.kg-1.min-1 = ??? m.min-1 x 0.1 ml.kg-1.min-1 per m.min-1 + 3.5 ml.kg-1.min-1

12.25 = _____ x 0.1 + 3.5
12.25 - 3.5 = _____ x 0.1
8.75 = _____ x 0.1
8.75/0.1 = 87.5 m.min-1

(87.5 m.min-1/26.8 = 3.3 miles.hr-1)

8. Calculate the oxygen cost of pedaling (75 rpm) a stationary bicycle (Monark TM) at a load setting of 3.0 kp for an 85 kg man.

kg.m.min-1 = kg x meters.rev-1 x RPM

WORKLOAD: kg.m.min-1 = 3 kg x 6 meters.rev-1 x 75 rpm
kg.m.min-1 = 3 x 6 x 75
kg.m.min-1 = 1350

VO2 ml.kg-1.min-1 = kg.m.min-1 x 1.8 ml.min-1per kg.m.min-1 / kg BW + 7
ml.kg-1.min-1 = 1350 x 1.8 / 85 kg + 7
ml.kg-1.min-1 = 2430 / 85 + 7
ml.kg-1.min-1 = 28.59 + 7
VO2 ml.kg-1.min-1 = 35.59
9. Calculate the MET cost of cycling at the workload from question #8, for a 90 kg male.

\[ VO_2 \, \text{ml.kg}^{-1}.\text{min}^{-1} = \text{kg.m.min}^{-1} \times 1.8 \, \text{ml.min}^{-1}\text{per kg.m.min}^{-1} / \text{kg BW} + 7 \]

\[ ml.kg^{-1}.min^{-1} = 1350 \times 1.8 / 90 + 7 \]

\[ ml.kg^{-1}.min^{-1} = 2430 / 90 + 7 \]

\[ ml.kg^{-1}.min^{-1} = 27 + 7 \]

\[ VO_2 \, \text{ml.kg}^{-1}.\text{min}^{-1} = 34 \]

10. A subject (75 kg weight) has a functional capacity of 9.0 METs. Calculate a workload in watts on the MonarkTM cycle ergometer that would be equal to 70% of this subjects' functional capacity.

FC = 9.0 METs; RX = 70% of FC

Training VO2 = 9.0 x .70 = 6.3 METs

ACSM cycling equation uses units of ml..min-1 so convert METs:

\[ 6.3 \, \text{METs} \times 3.5 \, \text{ml.kg}^{-1}.\text{min}^{-1} = 22.1 \, \text{ml.kg}^{-1}.\text{min}^{-1} \]

Training VO2 = 22.1 ml.kg-1.min-1

Use leg cycling equation with the unknown variable being kg.m.min-1

\[ 22.1 \, \text{ml.kg}^{-1}.\text{min}^{-1} = \text{kg.m.min}^{-1} \times 1.8 \, \text{ml.min}^{-1}\text{per kg.m.min}^{-1} / (\text{kg BW}) + 7 \]

\[ 22.1 - 7 = \text{kg.m.min}^{-1} \times 1.8 \, \text{ml.min}^{-1}\text{per kg.m.min}^{-1} / (75) \]

\[ 15.1 = \text{kg.m.min}^{-1} \times 1.8 / 75 \]

\[ 15.1 \times 75 = \text{kg.m.min}^{-1} \times 1.8 \]

\[ 1132.5 / 1.8 = \text{kg.m.min}^{-1} \]

\[ 629.16 = \text{kg.m.min}^{-1} \]

LOAD Setting in watts:

\[ \text{Watts} = 629.16 / 6.1 \]

\[ \text{Watts} = 103.14 \]
11. Calculate the MET cost of arm cranking at a workload of 450 kgm/min for a 80 kg man.

\[
VO2 \text{ ml.kg-1.min-1} = kg.m.min-1 \times 3 \text{ ml.min-1 per kg.m.min-1} / \text{kg BW} + 3.5
\]
\[
ml.kg-1.min-1 = 450 \times 3 / 80 \text{ kg} + 3.5
\]
\[
ml.kg-1.min-1 = 1350 / 80 + 3.5
\]
\[
ml.kg-1.min-1 = 16.875 + 3.5
\]
\[
VO2 \text{ ml.kg-1.min-1} = 20.375
\]
\[
\text{METs} = 20.375 / 3.5 = 5.82
\]

12. Calculate the MET cost of stepping up and down on a 10 inch bench at a step rate of 24 per minute.

\[
10'' \times 2.54 = 25.4 \text{ cm} = 0.254 \text{ meters}
\]

**HORIZONTAL COMPONENT:**

\[
VO2 \text{ ml.kg-1.min-1} = 24 \text{ steps.min-1} \times 0.2 \text{ ml.kg-1.min-1 per step.min-1}
\]
\[
VO2 \text{ ml.kg-1.min-1} = 4.8
\]

**VERTICAL COMPONENT:**

\[
VO2 \text{ ml.kg-1.min-1} = 0.254 \text{ meters} \times 24 \text{ steps.min-1} \times 1.33 \times 1.8
\]
\[
VO2 \text{ ml.kg-1.min-1} = 0.254 \times 24 \times 1.33 \times 1.8
\]
\[
VO2 \text{ ml.kg-1.min-1} = 14.6
\]

**TOTAL VO2 = HC + VC + REST**

\[
VO2 \text{ ml.kg-1.min-1} = 4.8 + 14.6 + 3.5
\]
\[
= 22.9
\]
\[
\text{METs} = 22.9 / 3.5 = 6.5 \text{ METs}
\]