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 mph x 26.8 m.min-1per mph = 67.0 m.min-1

VO2 ml.kg-1.min-1 = 67.0 m.min-1 x 0.1 ml.kg-1.min-1per m.min-1 + 0.06 % grade x 67.0 m.min-1 x 1.8 ml.kg-1.min-1 per m.min-1 +3.5 ml.kg-1.min-1
VO2 ml.kg-1.min-1 = 67.0 x 0.1 + 0.06 x 67.0 x 1.8 + 3.5
VO2 ml.kg-1.min-1 = 6.7 + 7.24 + 3.5
TOTAL VO2 ml.kg-1.min-1 = 17.44 ml.kg-1.min-1

METs = 17.44 / 3.5 = 4.98 METs ≈ 5.0 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 ≈ 5 kcals

MET load = 4.98

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

4.98 METs x 3.5 ml.kg-1.min-1 = 17.4 ml.kg-1.min-1 x 75kg = 1305 ml.min-1

1305 ml.min-1 / 1000 = 1.305 L.min-1

1.305 L.min-1 x 5 kcals.L O2 = 6.53 kcals.min-1

-or-

4.98 METs x 3.5 [75 kg/200] = 6.53 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 ≈ 3500 kcals

@ 6.53 kcals.min-1

# of minutes = 3500 kcals.1 lb fat-1/ 6.53 kcals.min-1 = 536 minutes

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

536/30 minutes per session = 17.9 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

VO2 ml.kg-1.min-1 = 174.2 m.min-1 x 0.2 ml.kg-1.min-1per m.min-1 + 0.04 % grade x 174.2 m.min-1 x 0.9 ml.kg-1.min-1 per m.min-1 + 3.5 ml.kg-1.min-1
VO2 ml.kg-1.min-1 = 174.2 x 0.2 + 0.04 x 174.2 x 0.9 + 3.5
VO2 ml.kg-1.min-1 = 34.8 + 6.27 + 3.5
VO2 ml.kg-1.min-1 = 44.6 ml.kg-1.min-1

METs = 44.6 / 3.5 = 12.7 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

MET load = 12.7

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

12.7 METs x 3.5 ml.kg-1.min-1 = 44.6 ml.kg-1.min-1 x 62kg = 2765.2 ml.min-1

2765.2 ml.min-1 / 1000 = 2.765 L.min-1

2.765 L.min-1 x 5 kcals.L O2 = 13.8 kcals.min-1

-or-

12.7 METs x 3.5 [62 kg/200] = 13.78 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?

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

@ 13.8 kcals.min-1 x 30 minutes = 414 kcals.session-1

35,000 kcals.10 lb fat-1/ 414 kcals.session-1 = 84.5 sessions

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

84.5 sessions : @ 4xwk = 21 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-1per 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 (MonarkTM) 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.

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 / 90 kg + 7
ml.kg-1.min-1 = 2430 / 90 + 7
ml.kg-1.min-1 = 27 + 7
VO2 ml.kg-1.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 METs x 3.5 ml.kg-1.min-1 = 22.1 ml.kg-1.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 ml.kg-1.min-1	= kg.m.min-1 x 1.8 ml.min-1per kg.m.min-1 / (kg BW) + 7
22.1 - 7	= kg.m.min-1 x 1.8 ml.min-1per kg.m.min-1 / (75)
15.1	= kg.m.min-1 x 1.8 / 75
15.1 * 75	= kg.m.min-1 x 1.8
1132.5/1.8	= kg.m.min-1
629.16	= kg.m.min-1

LOAD Setting in watts:

Watts = 629.16 / 6.1

Watts = 103.14

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

VO2 ml.kg-1.min-1 = kg.m.min-1 x 3 ml.min-1per kg.m.min-1 / kg BW + 3.5
ml.kg-1.min-1 = 450 x 3 / 80 kg + 3.5
ml.kg-1.min-1 = 1350 / 80 + 3.5
ml.kg-1.min-1 = 16.875 + 3.5
VO2 ml.kg-1.min-1 = 20.375
METs ?? = 20.375 / 3.5
METs ?? = 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" x 2.54 = 25.4 cm = 0.254 meters

HORIZONTAL COMPONENT:

VO2 ml.kg-1.min-1 = 24 steps.min-1 x 0.2 ml.kg-1.min-1per step.min-1
VO2 ml.kg-1.min-1 = 4.8

VERTICAL COMPONENT:

VO2 ml.kg-1.min-1 = 0.254 meters x 24 steps.min-1 x 1.33 x 1.8
VO2 ml.kg-1.min-1 = 0.254 x 24 x 1.33 x 1.8
VO2 ml.kg-1.min-1 = 14.6

TOTAL VO2 = HC + VC + REST

VO2 ml.kg-1.min-1 = 4.8 + 14.6 + 3.5
= 22.9

METS = 22.9 / 3.5 = 6.5 METs