HUMAN EVOLUTION

Purpose
To determine some of the advantages of becoming bipedal.
1. To measure the amount of the sun's radiation which falls on bipedal and quadrupedal forms.
2. To determine the amount of wind available for cooling at 60cm and 100cm above ground level.
3. To measure the advantages of losing body hair and sweating.

Activity 1
1. Make the following measurements of your partner.

Head
- a Width (ear to ear, but excluding the ears themselves)
- b Breadth (back to front but not nose)
- c Length (top to shoulders)

Torso
- d Width (side to side)
- e Breadth (back to front)
- f Length (shoulder to crotch)

Arms
- g Diameter
- h Length

Legs
- i Diameter (just above knee)
- j Length (crotch to sole of feet)

2. Draw the top, side and front view on graph paper and count the squares on each. Work out the actual area of your body visible from above, from the side and from the front.

3. Now use the same figures to draw a quadruped. Average the lengths of the arms and legs.

Alternatively use the following table first for bipeds then for quadrupeds.

Top

Head	a x b	
Shoulders	(d-a) x e	
total		

Front

Face	a x c	
Torso	d x f	
Arms	2(g x h)	
Legs	2(i x j)	
total		

Side

Head	b x c	
Torso	e x f	
Legs	i x j	
total		

4. Now calculate the area exposed to the sun for top and front and top and side for each 10° above the horizon.

5. Calculate the strength of the sun for each 10° above the horizon. When the sun is directly overhead (90°) and there is no cloud the energy received is 225 watts per square metre.

Make up a table for bipeds and another for quadrupeds with the following columns. The first column is the angle (a) of the sun above the horizon.
   1. Top area
   2. Side area
   3. Front area
   4. Power of sun
   5. Energy received on top and side
   6. Energy received on top and front
   7. Average energy received

a	1	2	3	4	5	6	7
10°							
20°							
30°							
40°							
50°							
60°							
70°							
80°							
Noon 90°							
average							

Activity 2

1. Use an anemometer to measure the wind speed at 60cm and 100cm above ground level in an open area. Get an average over several minutes.

2. At the same time record the temperature at those heights both with a dry thermometer and with one with a damp tissue around the bulb.

Set up a table like this

	Temperature °C	
	Dry thermometer	Wet thermometer
Still air		
Moving air		

3. Record the temperatures shown by the two thermometers
4. Now wait 5 minutes and record the temperatures again.
5. What are the advantages of sweating and standing on two feet?

Teacher's Section

Requirements

2 Thermometers

Tissue paper

Wind speed meter (anemometer). This is not vital.

Notes

Students will need to use trigonometry to find the surface area that at a given time of day is exposed to the sun. To calculate the sun's power assume it is maximum at midday and decreases to zero at dawn and depends on the thickness of atmosphere it has had to penetrate. Ignore the curvature of the earth.

Energy received on top (t) and side (s)

$$= (t \times Sin\ a + s \times Cos\ a\ ) \times 225 \times Sin\ a$$

Energy received on top (t) and front (s)

$$= (t \times Sin\ a + f \times Cos\ a) \times 225 \times Sin\ a$$

The last sin a is an approximate reduction due to the thickness of the atmosphere the sun's rays must pass through.

Alternatively a spreadsheet can be set up to do all the calculations.

The cooling effect of the wind must be done outside and on a day when there is some wind. Do not use a fan, fans always warm the air slightly and do not reproduce natural conditions.

Make sure the water you use for damping the tissue is at outside air temperature.

A rectangular block of wood stood on its end and a torch will help students understand the calculations needed.

Results

At midday when the sun is most powerful, the heat received by a biped is less than a quadruped. The wind speed will be greater at 1.0m than nearer the ground. The evaporation from the damp thermometer bulb will reduce the temperature by about 5°C if there is some wind. So standing upright and sweating can significantly cool the body.

Time

One hour for measurements

Cost
(Anemometer £105. This just makes Activity II better but it is not necessary)

Credit
Based on ideas in the BBC Horizon programme "Some like it hot"