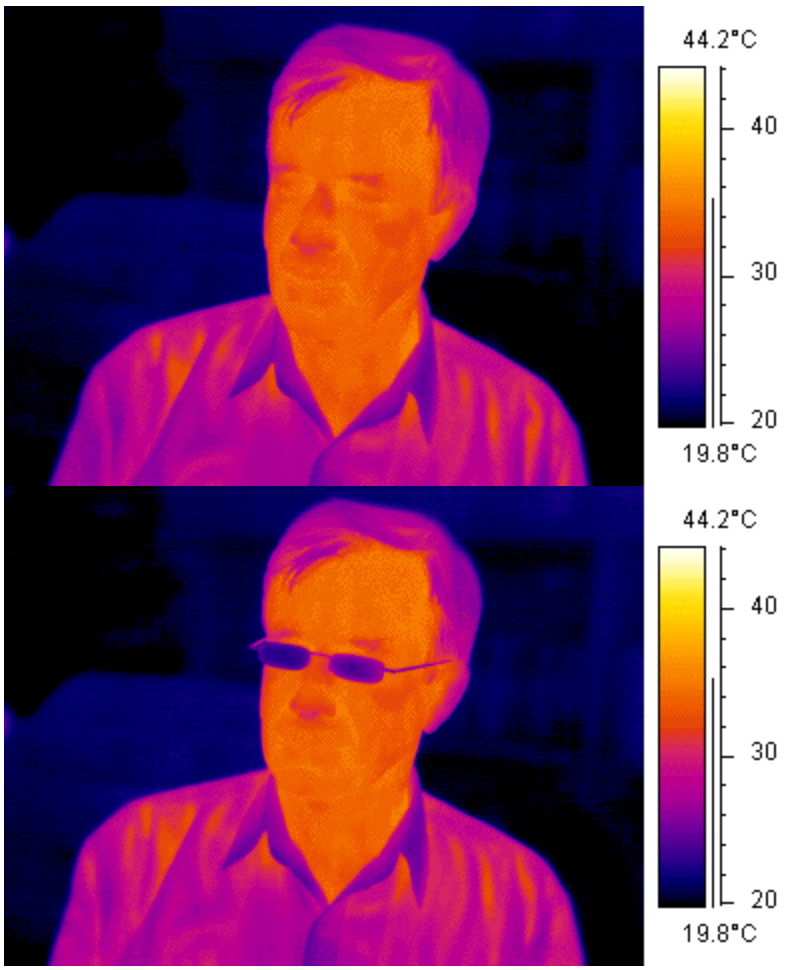
Thermal radiation and how clothes work

How do clothes work? How do they affect our thermal radiation? How do they help keep us warm in winter and cool in summer? This page uses a thermal image to help answer these questions. For more background, see Black body radiation and the electromagnetic spectrum.

Thermal cameras and imaging systems respond to infra-red radiation. When they are suitably calibrated for a property of surfaces called the emissivity, they can produce images of the surface temperatures of bodies. These pictures were taken thus. (First, a note of **warning:** false colour is used in the display, as shown in the scales at right. There is no simple relation between the wavelengths of the colours used in the display and those of the infrared radiation. For example, note that red is used for a hotter temperature, and therefore shorter average wavelength, than blue.)



From these pictures, we can deduce that both clothes and hair act as insulators: the hottest parts of the image are on the side of the neck where the neck is partially protected by the collar. But the collar itself is quite cold, because here there are two thickness of cloth with an air space between them. Note that the shirt is hottest in places where it is single thickness and touching the body. This tells you something interesting about clothes: the fabric of clothes does not provide much insulation: it is the air trapped between you and the fabric (or inside the fabric of parkas, sweaters etc)

that provides the insulation. Hair—even eyebrows—helps hold air in place and so provides some insulation.

The slightly lower temperature of nose and ears is in part determined by blood circulation. Together with fingers and toes, these are regions with high surface area:volume ratios and so they are effective at losing heat. When we are cold, the circulation to these parts is restricted so that we don't lose too much heat from them.

The glasses, which are reading glasses, not sunglasses, are cool, in the thermal sense at least. We also see that, while they are transparent to visible light, they don't transmit much infra-red: otherwise we should see the warm skin behind them.

You might think that the difference in temperature between the skin (about 32 °C = 305 K) and the hair or clothes (about 29 °C = 302 K) is not large: it is less than one percent. However in keeping warm, what is important is the radiation and conduction exchange with the environment. The heat radiated and conducted from the environment would balance that lost by the body if it were at the environmental temperature, here about 20 °C. In less comfortable thermal environments, clothes can make a much larger difference.

http://www.animations.physics.unsw.edu.au/jw/thermal-radiation.htm