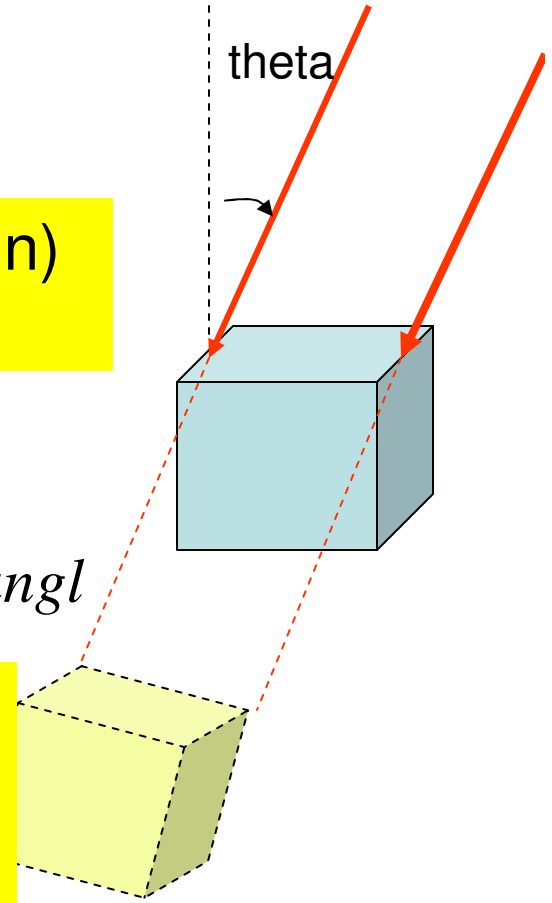
1) Solar radiation (SUMMARY);

2) A simple earth energy balance model

abc to solar energy

1) Calculate the power per unit area or **I**;

$$I(\theta) = \frac{P}{A} = I(0)\cos\theta; \quad I(0) = S.$$



2) The total power P and energy generated E(in) over time t;

$$P = S \times \cos\theta \times A; \quad E_{in} =< P > \times t.$$

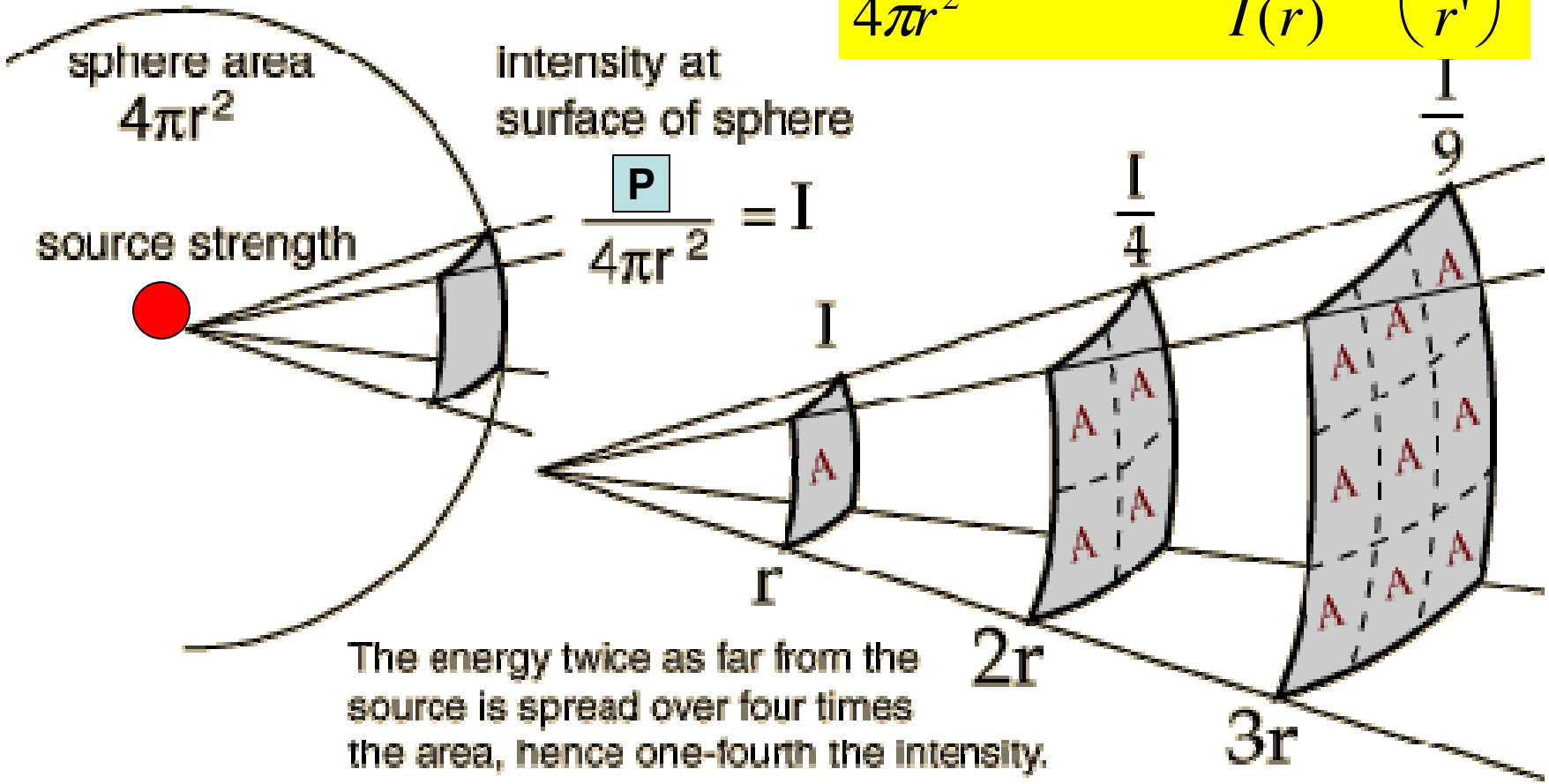
$$S: \quad solar \quad const. \quad A: \quad area; \quad \theta: incident \quad angl$$

3) How long (t') can the energy be used to power a device (a light or an electric fan etc) with P(out) Watts?

$$E_{out} = P_{out} \times t' = E_{in}.$$

I (power per unit area) versus distance

$$\frac{P}{4\pi r^2} = I(r) \Rightarrow \frac{I(r')}{I(r)} = \left(\frac{r}{r'}\right)^2$$



http://hyperphysics.phy-astr.gsu.edu/hbase/forces/isq.html

Q1

Mastering physics problems are

1) too easy;
2) too difficult;
3) ok.

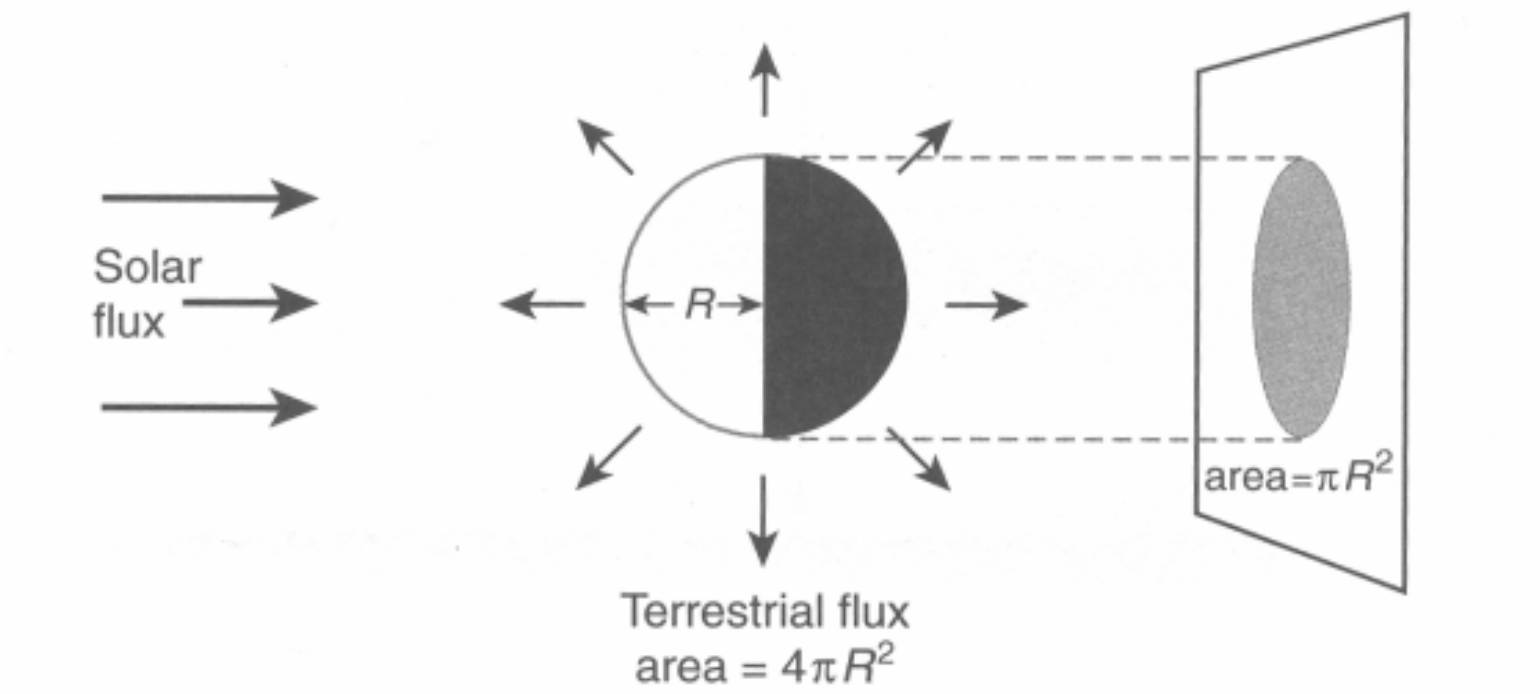
Q2

Tutorial problems, I have been able to work out

1) Less than 30% of them;
2) 30% - 60%;
3) 60% - 80%;
4) more than 80%.

Power of the incoming radiation

$$P_{in} = (1\text{-}A)\, S\, \pi\, R_{Earth}^2$$

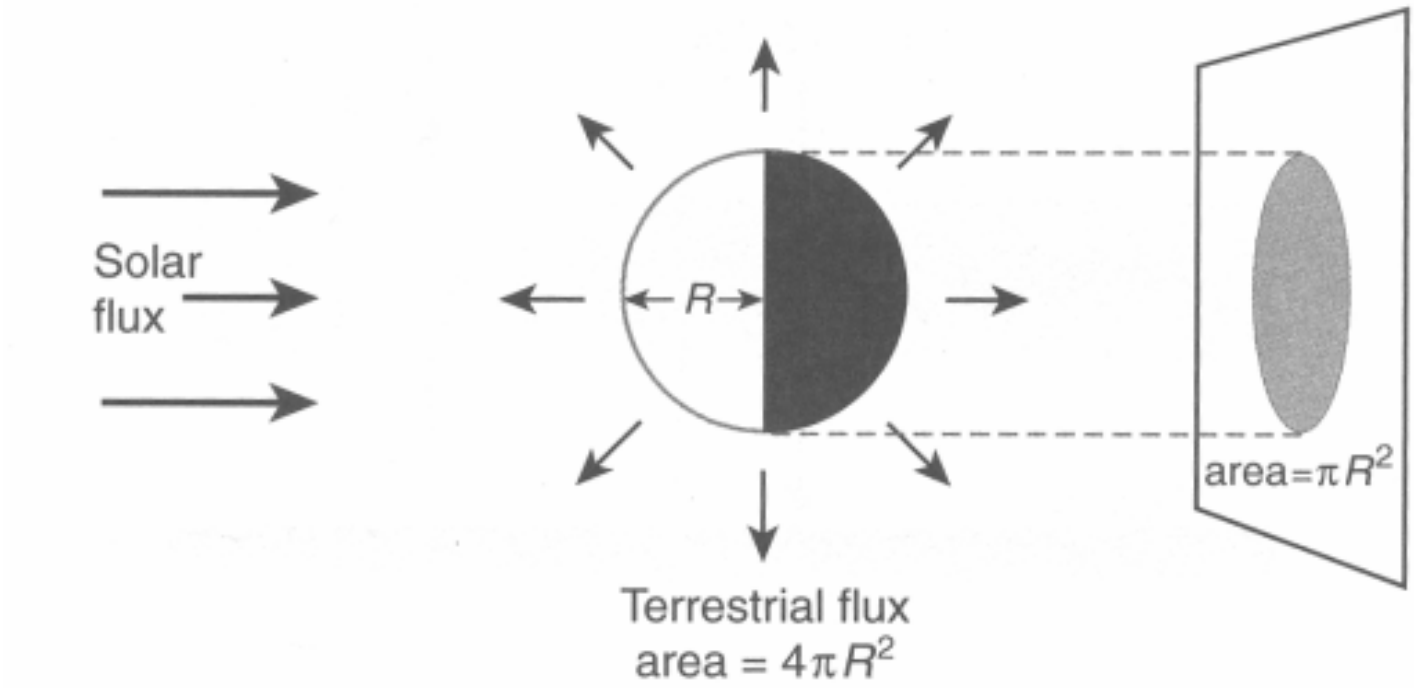


Example from Roland B. Stull, Meteorology for Scientist and Engineers

Radiation of the Earth

- $P_{out} = \sigma S_{urface}\ T_{Earth}^{4}$

$S_{urface} = 4\ \pi\ R_{Earth}^{2}$



Earth Energy Balance Equation

A Simple model: $P_{in} = P_{out}$

$$P_{in} = (1-A)\, S\, \pi\, R_{Earth}^2$$

$$P_{out} = 4\pi\, R_{Earth}^2\, \sigma\, T_{Earth}^4$$

Q1

$T^4_{Earth} = (1-A)\, S / 4\, \sigma$

$= (1- 0.3)\ 1367\ W/m^2/(4 \cdot 5.67 \cdot 10^{-8}\ W/m^2K^4)$

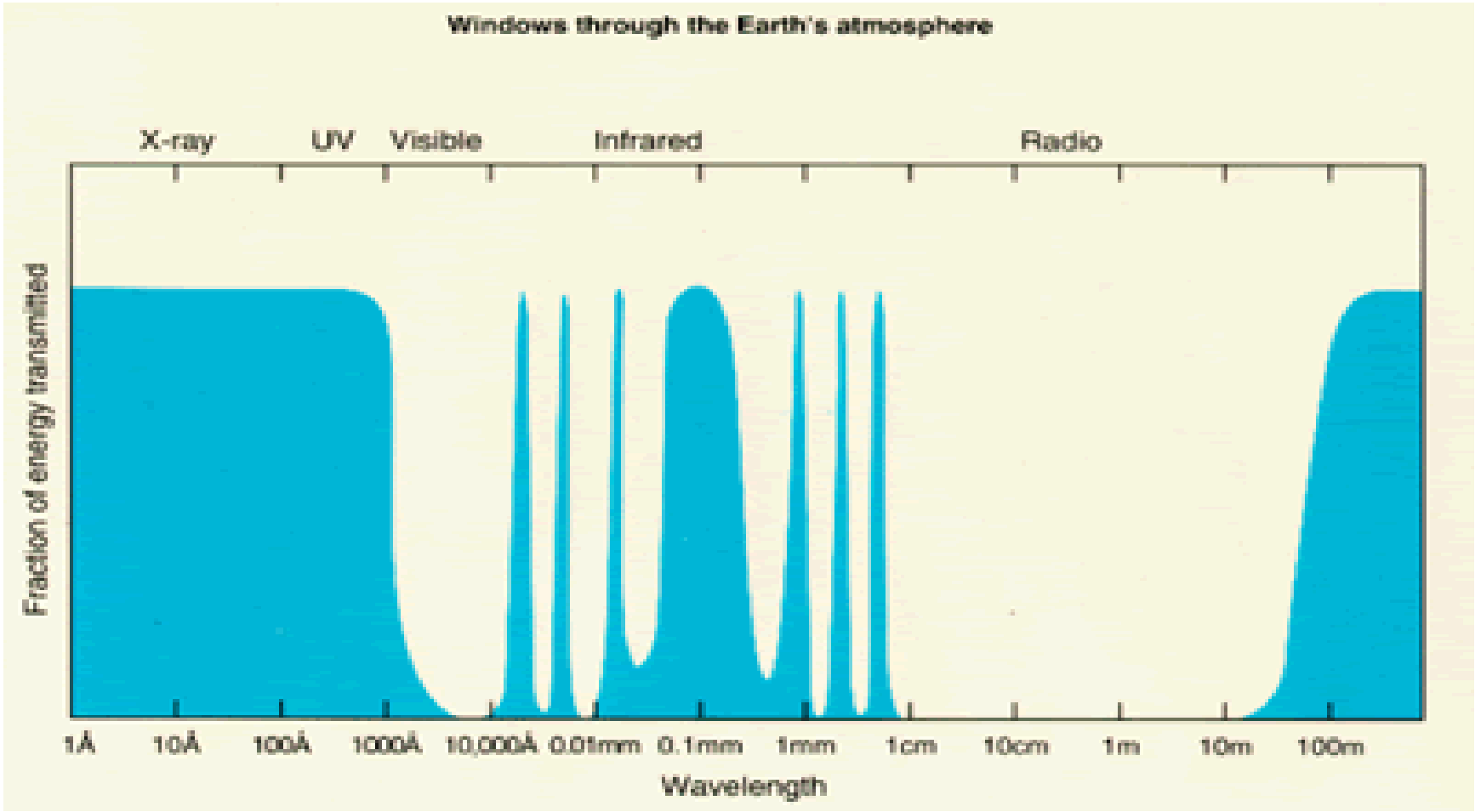
The earth temperature according to this model is

1) -100 C;
2) -18 C;
3) 30 C;
4) 100C.

- So we actually obtained a temperature of the Earth as seen from far away – the temperature of the atmosphere, not the surface temperature!!

- What are the effects of atmosphere ??

Atmospheric Absorption



- From: http://www.everythingweather.com/atmospheric-radiation/absorption.shtml

Earth Energy Budget Sheet

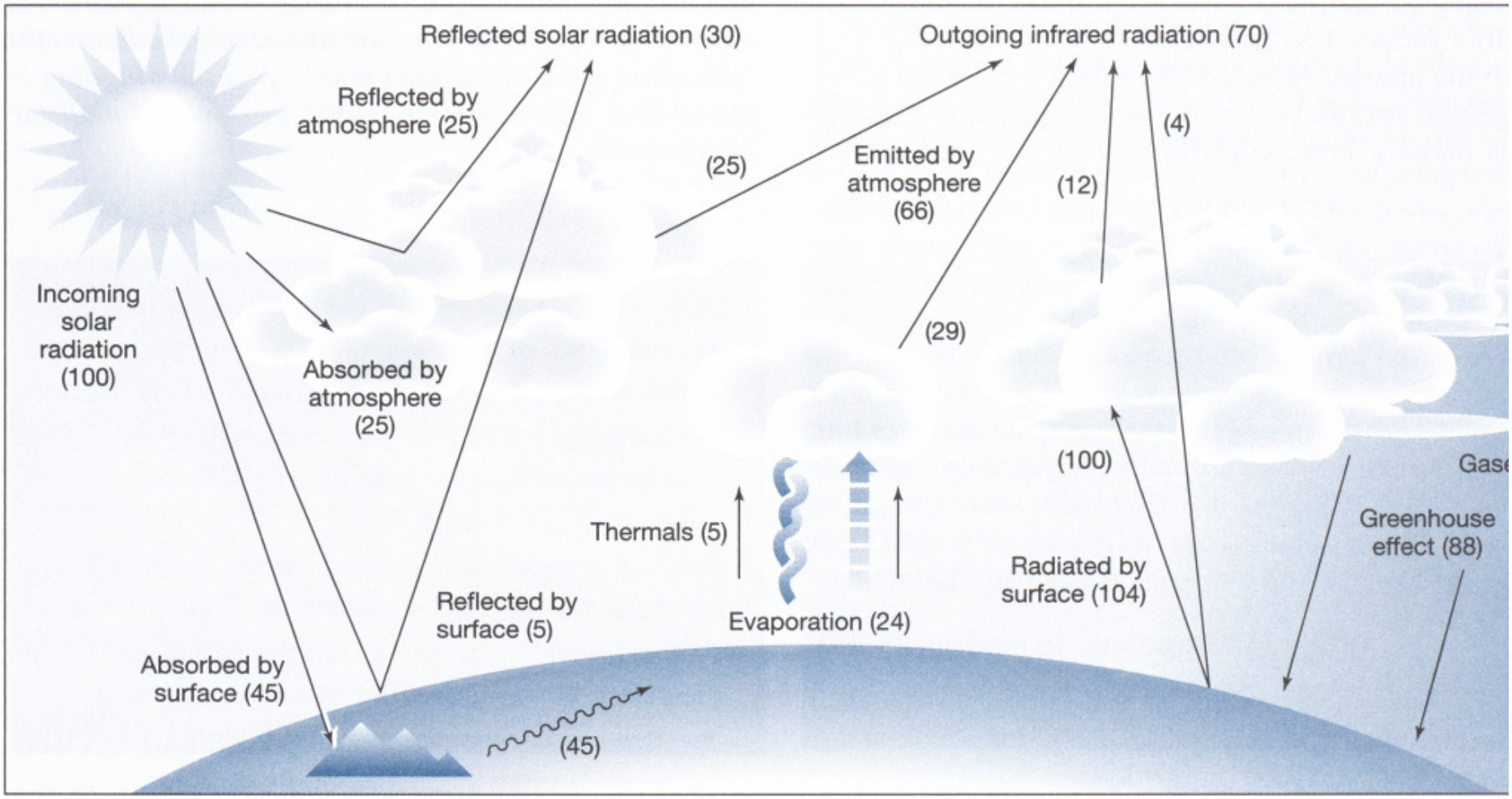
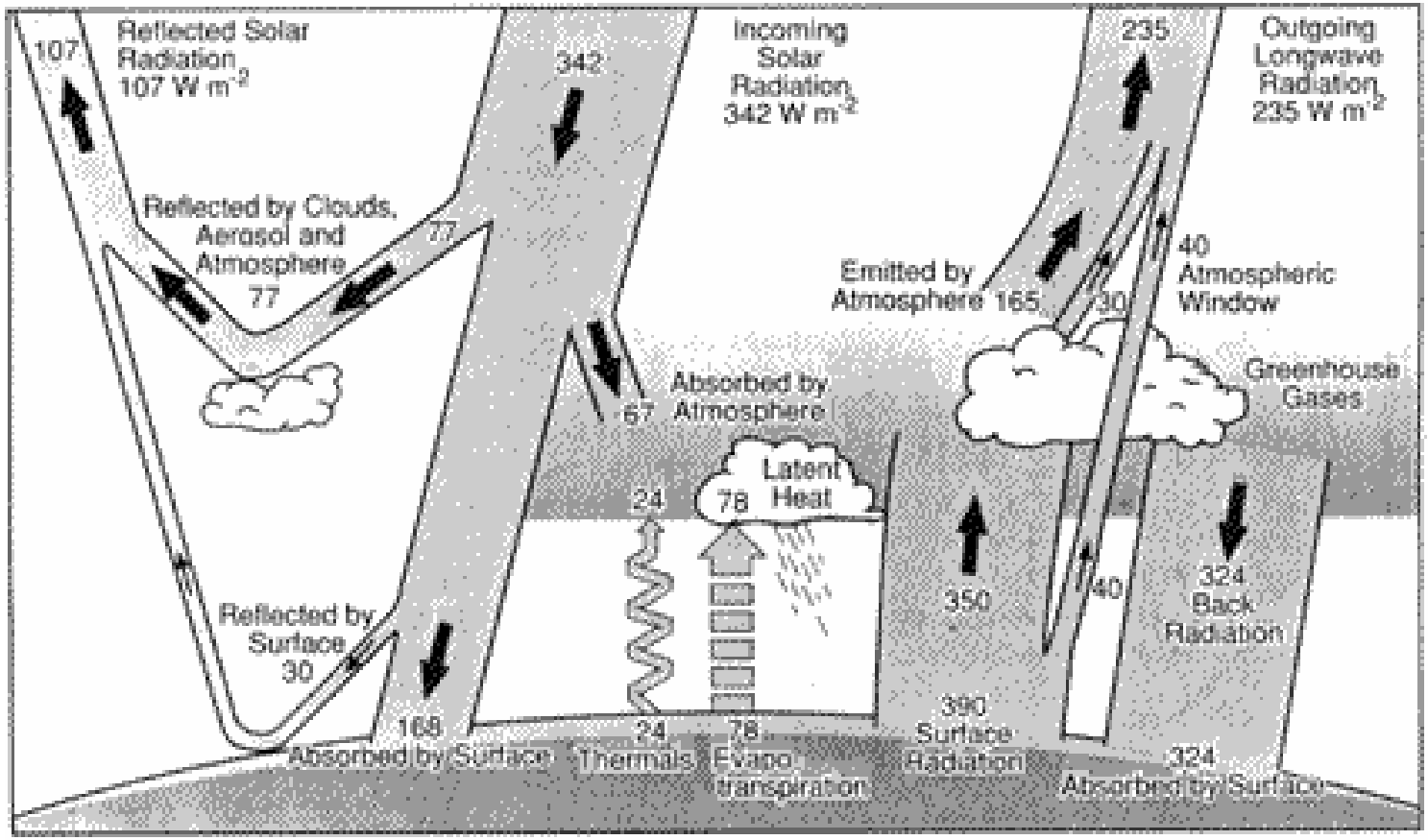


FIGURE 3-19

Earth's globally averaged atmospheric energy budget. All fluxes are normalized relative to 100 arbitrary units of incident radiation. (From Schneider, *Climate Modeling*, Scientific American, 256:5, 72–80, 1987.)

Atmospheric Absorption



- From: http://www.everythingweather.com/atmospheric-radiation/absorption.shtml

Green house effect

1) **Model one: Glass layer effects on the earth temperature;**

2) **Atmospheric model with Green house effect (with Green house gases).**