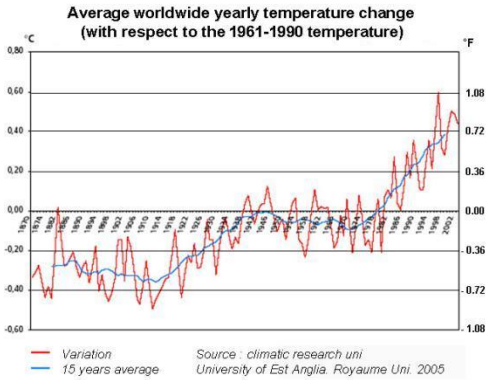
Nom: **Date:**

HVAC Learning.com

Exercise Booklet

Print this exercise booklet before studying the lesson on-line. It will enable you to write your answers to the HVAC learning exercises. You will thus be able to switch between reading or listening to the file on-line and writing in the booklet.



GLOBAL WARMING PART 2

English lesson
https://hvac-learning.com/renewable-energy/global-warming-training/global-warming-part-2/

French version:
https://formation.xpair.com/cours/rechauffement-climatique-partie-2.htm

For each exercise, you will write your answer, then you will study its correction on-line before going to the next exercise.
*If you cannot do an exercise, you will be able to study its correction directly, but **force yourself to write your answer** as often as possible.*

Note that between 2 exercises, you will find it necessary to study the course. As a warning, in the booklet, you will sometimes find the following indication:

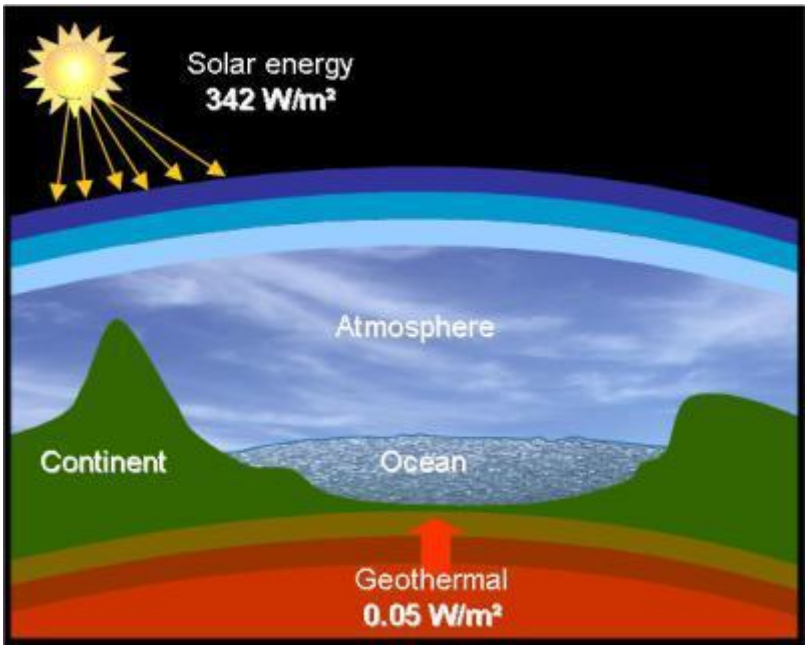
- *" **Study the course on-line before doing the next exercise**" or*
- *" **Study the course on-line before going to the next paragraph**"*

Only study the paragraphs or the exercises which have an equal or a lower level than the one your training requires.
NVQ Level = Vocational Certificate
A Level = High school Diploma
HND Level = Associate's Degree
MSC Level = Engineering Schools

Then, when you have completed a file, you will be able to assess your level on-line through a Multiple Choice Questionnaire in which you will only answer the questions related to the themes you have studied.
So now off you go and work well!
Good luck!
The Authors.

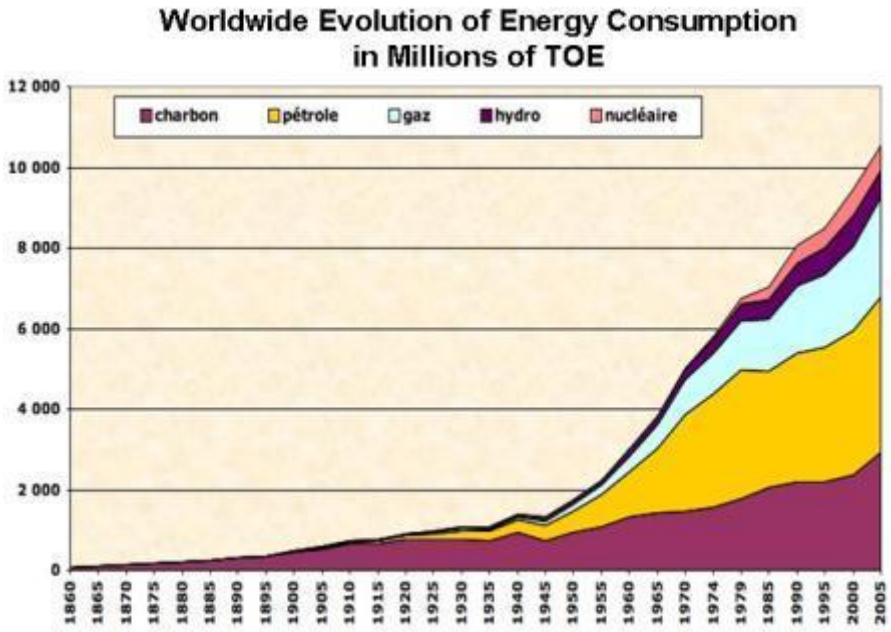
N°1 – Solar energy training – HND to MSC level

Study the course on-line before treating the next exercise.



N°2 – Power of human origin- HND to MSC level

Study the course on-line before treating the next exercise.



Source : International Energy Agency

Question 1

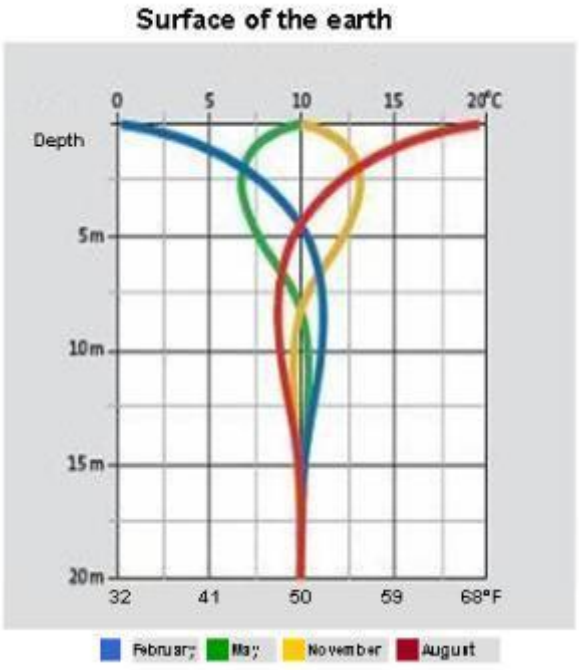
Given the indications above, and given that one [kWh] corresponds to 3,600 [kJ], compute in [W] the worldwide energetic power produced in 2005.

ANSWER

Considering the worldwide energy consumption, the power produced in 2005 was of 1.4 x E^{13} [W], the estimation of 1.5 x E^{13} [W] in 2008 is therefore coherent.

N°3 – Is human activity powerful enough to explain training – HND to MSC level

Study the course on-line before treating the next exercise.



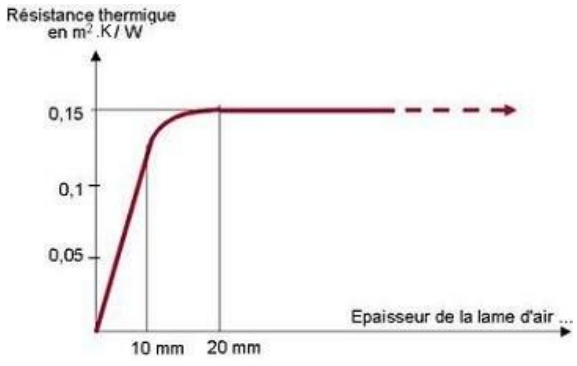
Question 1

Compute in Joule the quantity of heat corresponding to a homogeneous increase of 0.5 [°C] (0.5 K) on the entire atmosphere and of 0.25 [°C] (0.25 K) on the first 15 meters of rocks and water below the surface.
Without accounting for the concomitant increase of energy losses towards space, compute the thermal power that corresponds to this warm up recorded over the last 30 years. Data:

- Mass of the atmosphere: 5.13 x E^{18} [kg]
- Specific heat capacity of air: 1,000 [J/kg.K]
- Surface of the earth : 5.10 x E^{14} [m^2]
- Average density at the surface of the oceans and of the crust: 1,580 [kg/m^3]
- Average specific heat capacity at the surface of the oceans and of the crust: 3,315 [J/kg.K]

N°4 – Accounting for greenhouse effect when establishing the new thermal equilibrium – HND to MSC level

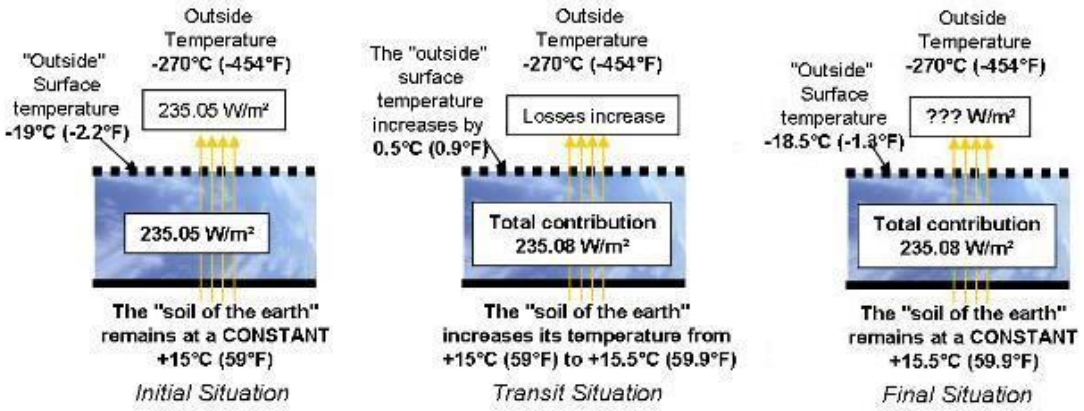
Study the course on-line.



Résistance thermique des lames d'air horizontales en fonction de leur épaisseur (flux ascendant)

N°5 – Let's assume global warming is "observed" from space

Study the course on-line before treating the next exercise.



Question 1

• Given that the flux exchanged between the planet and space was 235.05 [W/m²] prior to Global Warming, under a temperature of the planet's "exterior surface" of -19 [°C] (-2.2°F) and a temperature of the universe of -270 [°C] (-454°F).

• Given that the flux exchanged by radiation is of the following type: Flux = k x ($T1^4 - T2^4$)

With:

– Flux: power exchanged by radiation in [W]

– T1 : temperature of the warmer element in [K]

– T2 : temperature of the colder element in [K]

– k : constant ratio in [W/K^4]

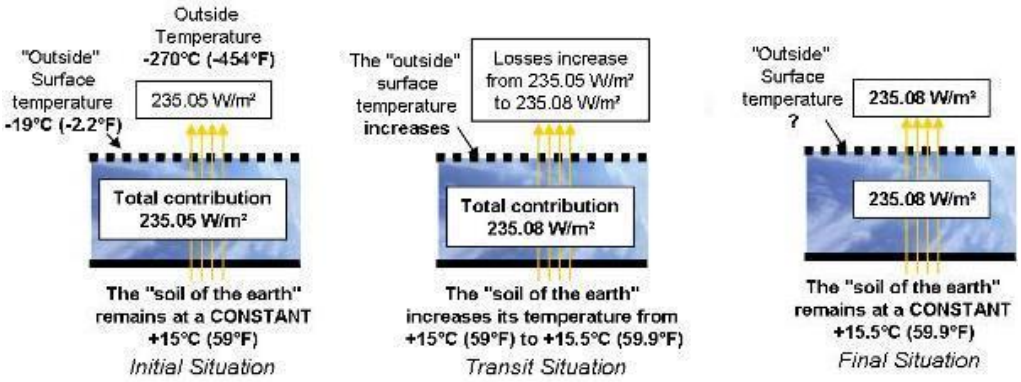
• Given that the surface of the earth amounts to 5.1 x E^{14} [m²]

Determine the additional thermal power that would be evacuated from the planet if its "exterior surface" temperature changed from -19 to -18.5 [°C] (from -2.2°F to -1.3°F).

Study the course on-line before treating the next paragraph.

N°6 – Let's assume global warming is not "observed" from space

Study the course on-line before treating the next exercise.



Question 1

• Given that the flux exchanged by the planet with space prior to Global Warming amounts to 235.05 [W/m²] under an "exterior surface" temperature of -19 [°C] (-2.2°F) and space at -270 [°C] (-454°F).

• Given that the flux exchanged by radiation is of the following type:

Flux = k x ($T1^4 – T2^4$)

With:

– Flux: power exchanged by radiation in [W]

– T1 : temperature of the warmer element in [K]

– T2 : temperature of the colder element in [K]

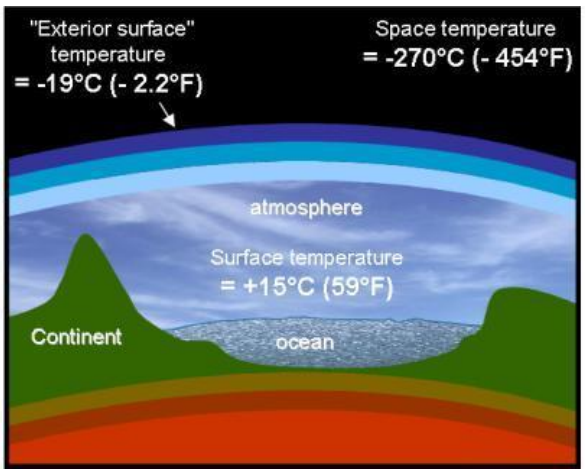
– k : constant ratio in [W/K^4]

Determine the "exterior surface" temperature the earth must reach in order to be able to evacuate 235.08 [W/m²].

Study the course on-line before treating the next paragraph.

N°7 – Did the thermal resistance of the atmosphere increase? – HND to MSC level

Study the course on-line before treating the next exercise.

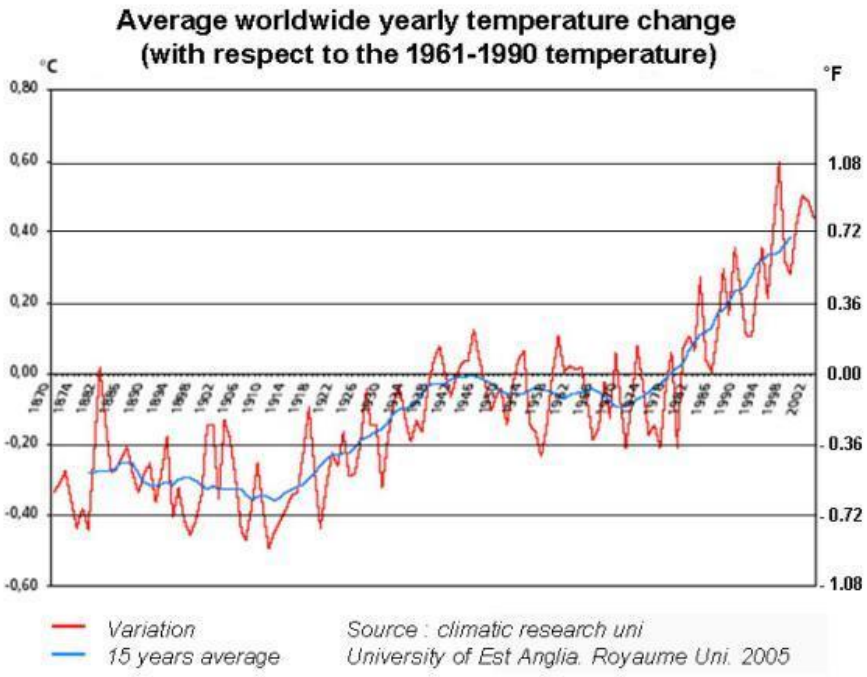


Question 1

If we compare the temperatures measured at 1,000 [m] and 4,400 [m], does the thermal resistance of the atmosphere seem to have increased between 1999 and 2008?

N°8 – Summary

Study the course on-line.



N°9 – Resources – Part 2

Websites and resources used to prepare this file:

- *CNRS website: dossier Climat, systèmes et facteurs climatiques, effet de serre. Mme Marie-Antoinette Mélières*
- *BRGM website: Empreintes paléothermiques du sous-sol site du BRGM, MrLaurent Guillou-Frottier*
- *IFEN website: Les indices du réchauffement climatique, Mr Moamedou Ba*
- *CERMA website: Centre de recherche méthodologique d'architecture, dossier Théorie solaire*
- *Planet-terre.ens-lyon.fr website*
- *International Energy Agency website*
- *Site AMSU-A Températures*
- *National Climatic Data Center website*
- *University Corporation for Atmospheric Research website*

Physics data used in the calculations:

Physical data used in the calculations	
Surface of the earth	5.10 x E ^{14} [m²]
Solar power	3.826 x E ^{26} [W]
Solar power received by the planet	1.744 x E ^{17} [W]
Solar power absorbed and rejected by the planet	1.2 x E ^{17} [W]
Geothermal power	2.55 x E ^{13} [W]
Human worldwide production and consumption of energy in 2008	1.5 x E ^{13} [W]
Air mass in the atmosphere	5.13 x E ^{18} [kg]
Specific heat capacity of air	1,000 [J/kg K]
Mass of the vapour contained in the atmosphere	1.8 x E ^{16} [kg]
Latent heat of vapour	2,500,000 [J/kg]
Proportion of water at the surface of the earth	71 %
Volume mass of rocks	3,000 [kg/m³]
Specific heat capacity of rocks	1,200 [J/kg K]
Average volume mass at the surface of the earth (continents and oceans)	1,580 [kg/m³]
Average specific heat capacity at the surface of the earth (continents and oceans)	3,315 [J/kg K]

English lesson
https://hvac-learning.com/renewable-energy/global-warming-training/global-warming-part-2/

French version:
https://formation.xpair.com/cours/rechauffement-climatique-partie-2.htm