ENERGY TUTORIAL: Introduction to Energy

1) Which ONE of the following statements is TRUE, regarding Hooke's law:

A. It is an expression of conservation of energy
B. It is an expression of conservation of mass
C. It is a constitutive equation for gravitational forces.
D. It is a constitutive equation for the force generated when compressing an elastic material.

2) What are the base SI units of energy?

3) Using base SI units, show that the units for work are dimensionally consistent with the units of (translational) kinetic energy.

4) Determine the base SI units of the spring constant k from the expression for the energy stored in a compressed spring, i.e. $U = \frac{1}{2}k(x - x_0)^2$.

5) What are the base SI units for force?

6) A single piece of Kentucky Fried…Cheese contains 2500 kJ of energy. How high up a ladder could an 79 kg person climb from the energy available from a single piece of fried cheese? Assume muscles work at 25% efficiency converting nutritional energy to mechanical energy.

7) Suppose the person above falls from the top of the ladder and – luckily – lands on a springy mattress (they survive without injury). Explain (in words) what happens to the gravitational potential energy, from the moment they start falling until when they come to rest on the mattress.

8) Briefly explain, using a sketch, why only a small fraction of the sun's energy reaches the earth. How does the *intensity* of the radiant energy depend on the distance from the sun?

9) About 173,000 TW of radiant energy (power) reaches the earth from the sun. About 30% of this is reflected back to space. Meanwhile, geothermal energy supplies about 32 TW of power. By what factor is the power absorbed by the earth greater than the power available from geothermal energy?

10) Of the radiant energy reaching the earth from the sun (see above), suppose 48% is absorbed by the land and sea, 35% is reflected by the clouds/atmosphere and 17% is absorbed by the atmosphere. Calculate the total radiant energy that is absorbed by the atmosphere over one year.

11) Approximately what percentage of the world energy production comes from renewable sources?

A. 20%
B. 40%
C. 60%
D. 80%
E. 200%

12) Approximately what percentage of the world *electricity* production comes from renewable sources?

A. 25%
B. 50%
C. 75%
D. 100%
E. 2000%

13) Total worldwide energy consumption in 2016 was estimated to be 13,000 Mtoe. China consumed about 35,000 TW.h in 2016. Estimate percentage of worldwide energy consumption due to China. (Note: 1 Mtoe = 11.63 TW.h).

14) Use the data from your course book to do the same for the United States.

15) Transport was the main source of energy demand in NZ in 2015. What was the major form of energy supply that was used to meet this energy demand?

16) Suppose the USA consumes about 15,000 PJ in electricity each year (recall peta = 10^{15}). The US population is about 320 million people.

a. First, calculate how many joules are in one kW.h.

b. Next, use your answer from (a), and the other given information, to calculate electricity use of the USA in kW.h per person in one year.

17) NZ uses less than half of the electricity of Norway, who consume 461 PJ in electricity each year. If Norway's population is 5.2 million, what is their electricity use in kWh. per capita.

18) The work required to overcome air resistance (W_{air}), in the form of 'shape drag', plays the biggest role in the total energy budget of a vehicle. The NZ Government are thinking about decreasing the speed limit from 100 km/h to 80 km/h. Estimate the effect this would this have on transport efficiency (and hence fuel consumption etc).

19) Write down an expression for the Reynolds number, define the terms and explain what it represents. Explain its relevance to an engineer designing transport systems at different scales.

20) Explain how the Reynolds number could be used to design an appropriate 'scaled-up' experimental model (e.g. with characteristic length scale of 1 metre) of a microorganism, to be used to experimentally determine efficient swimming strategies.