Temperature, internal energy and heat

1. Complete the following sentences using the terms *heat* and *temperature*.

a) Whether or not it is advisable to touch a hot stovetop is a matter of .....

b) The unit of ..... is Kelvin.

c) Keeping a large house warm during winter requires a lot of …… .

d) If you place a pot of cold water onto a hot stovetop, ... flows from the stovetop to the pot of water.

e) When mixing water of 20 °C with water of 40 °C, after a while, the ..... of the water equalizes.

f) An object can warm up by absorbing ..... .

g) If two objects of different temperatures touch, ... flows from one to the other.

2. Complete the following sentences using the terms *internal energy*, *heat* and *temperature*.

a) Two hot bricks joined together have more ..... than just one of them.

b) Two hot bricks joined together have the same ..... as each one of them.

c) An extremely hot brick contains a lot of .....

d) If ……..... flows to a brick it warms up.

3. Pam fills an empty jam jar with water, closes is and shakes it vigorously for one minute. The work done on the water by shaking it is $W = 230$ J. Afterwards Pam puts the jar on a table and the water loses $Q = 170$ J, this being transferred to the surroundings.

a) In what way does the temperature change while Pam is shaking the jar?
b) How does the temperature change while the jar is left on the table?
c) Is the water's final temperature higher or lower than in the beginning?
d) What is the water's change in internal energy ΔU?

4. A little brick ($m = 0.500$ kg) falls from a height of 130.0 m onto the ground and remains there at rest.

a) What happens to the brick's molecules just at that moment when it hits the ground?
b) What happens to the temperature of the brick shortly after it hits the ground?
c) By what amount does the internal energy of the brick change?
d) How does the temperature of the brick change while lying on the ground right after the impact?
e) What does the brick release right after the impact while lying on the ground?

Specific heat capacity

Assumption: An exchange of energy with the surroundings does not occur in all of the following problems.

5. Go to

   https://phet.colorado.edu/sims/html/energy-forms-and-changes/latest/energy-forms-and-changes_en.html

   and choose “Intro”. Grab the containers filled with water and olive oil and place them on top of the little stoves. Then grab the thermometer and stick one of them into the water and the other one into the olive oil (make sure they are well immersed). Tick the box “Link Heaters”.

a) Look up the specific heat capacities of water and of olive oil:

   c_{water} = $c_{olive\ oil}$ =

b) Grab one of the levers and push it upwards, onto “Heat”. Watch the thermometers in both liquids. Where does the temperature rise more? Why?
   Use the terms *heat gain, increase in internal energy* , *specific heat capacity*, *increase in temperature*.

6. How much heat is needed for rising the temperature of 200.0 ℓ of water in a bath tub from 20.0 °C to 35.0 °C? (1.0 ℓ of water has a mass of 1.0 kg)

7. How many ℓ of water can be heated from 7.00 °C to 94.0 °C with 1.00 MJ of energy?
   (1.0 ℓ of water has a mass of 1.0 kg)

8. A pot of water (5.30 ℓ) of temperature ϑ_0 = 22.0 °C sits on a stove and is heated for cooking spaghetti.
   Calculate the water’s temperature after 88.0 kJ of heat was supplied.

9. The temperature of a cylinder made of aluminium (V = 37.4 cm^3) increases from 18 °C to 32 °C.
   What is the amount of heat needed?

10. The internal energy of a silver ball of diameter 3.48 cm and initial temperature ϑ = 22.0 °C increases by ΔU = 651 J.
    What is the final temperature?

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solutions:
3. d) 60 J
4. c) 638 J
6. 12.5 MJ
7. 2.75 ℓ
8. 26 °C
9. 1.3 kJ
10. 33.9 °C