Heat Energy PROBLEMS:

name: SOLUTIONS

ENERGY EFFICIENCY.

1) A water tank contains 200 kg of water. The water is heated by a 4500-W heating element

How much energy is required to raise the temperature of the water from 15°C to 60°C?

$Q = mC\Delta T$

$Q = 200\,000\,(4.19)(45)$

$Q = 37\,710\,000\,J$

$=$

$37\,710\,KJ$

A) 37 710 kJ **C)** 62850 kJ

B) 50 280 kJ **D)** 202 500 kJ

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2) Which of the following procedures requires the most energy?

A) Raising the temperature of 10 grams of water from 10°C to 22°C.

B) Raising the temperature of 10 grams of water from 43°C to 55°C.

C) Raising the temperature of 20 grams of water from 72°C to 78°C.

D) Raising the temperature of 20 grams of water from 30°C to 42°C ← Biggest Temp difference & Biggest mass.

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3) The table below gives information about the antifreeze in a car's cooling system.

Mass: 5 000 g
Initial temperature: 5°C
Specific heat capacity: 2.2 J/(g•°C)

$Q = mC\Delta T$

$935000 = 5000\,(2.2)\Delta T$

$85°C = \Delta T$

$\Delta T = T_f - T_i$

$85 = T_f - 5$

$90°C = T_f$

When the car is running, this mass of antifreeze absorbs 935 000 J.

What will be the final temperature of the antifreeze? **(recall: $\Delta T = T_f - T_i$)**

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4) When a 3500-g block of lead was heated, its temperature increased from 20°C to 200°C.

How much heat energy was absorbed by this block of lead?

$Q = mC\Delta T$

$Q = 3500\,(0.13)(200-20)$

$Q = 81900\,J$

A) 81.9 J **C)** 81900 J

B) 9 100 J **D)** 91000 J

5) You pour some water that has a temperature of 22°C into a calorimeter. You plug in the calorimeter and let the water heat for 10 minutes. You then note that the temperature of the water has risen to 42°C. The quantity of electrical energy consumed by the calorimeter is 87 000 J. (assume 100% efficiency)

What is the mass of the water in the calorimeter?

$Q = mC\Delta T$

$87000 = m(4.19)(42-22)$

$1038.2\,g = m$

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6) An electric water heater has a 40% efficiency in converting electricity to heat. The heater contains 2 liters of water inside of it and it consumes 215 000 J of electricity. By how much did the water increase in temperature.

① $E.E = \frac{E\ used}{E\ consumed} \times 100$

$40\% = \frac{E\ used}{215000\,J} \times 100$

$E\ used\ as\ Heat = 86000\,J$

② $Q = mC\Delta T$

$86000 = 2000(4.19)\Delta T$

$10.26\,°C = \Delta T$

2000 mL → 2000 g

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7) ~~A kettle consumes 15 500 J of energy. It is 85 % effieient. How mueh energy was~~ used by the kettle?

a) 18 235 J
b) 1 317 500 J
c) 182 J
d) 13 175 J

$E.E = \frac{E\ used}{E\ consumed} \times 100$

$85 = \frac{E\ used}{15500} \times 100$

$\frac{85(15500)}{100} = E\ used$

$13\,175\,J = E\ used$

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8) Some homes are still heated by hot water boiler furnaces which use domestic heating oil as their source of combustion. The components of the system are an oil tank a furnace, water pipes and radiators. The furnace burns the oil from the storage tank, the heat from the combustions is used to heat water which is then pumped to radiators throughout the house. These radiators are designed to dissipate the heat evenly within the room.

If all the heat from the combustion was used to heat the water, the system would be 100% efficient, however some heat is lost in the furnace exhaust and some is lost from the pipes delivering the water to the radiators.

One litre of oil delivers 38 000 kJ (consumed) of energy, assuming 7 600 kJ are lost to the exhaust, and 1 900 kJ are lost (lost) in transporting the hot water to the radiators; calculate the efficiency of this heating system.

$E.E = \frac{E\ used}{E\ consumed} \times 100$

$E.E = \frac{28500}{38000} \times 100$

$E.E = 75\%$

$38000\,KJ - (7600\,KJ + 1900\,KJ)$ (LOSSES)

$38000 - 9500$

$= 28500\,KJ$ (used)

Solutions	1) a	2) d	3) 90°C	4) c	5) 1038g	6) ~ 10.3°C	7) 13175J	8) 75%