Next Gen PET

IE Unit EM Extension D

Scientific Explanations – Quiz KEY

Quiz Question 1

Which of the following provides evidence that the thermal energy of an object is decreasing?

A) Its speed is increasing.

B) Its speed is decreasing.

C) Its temperature is increasing.

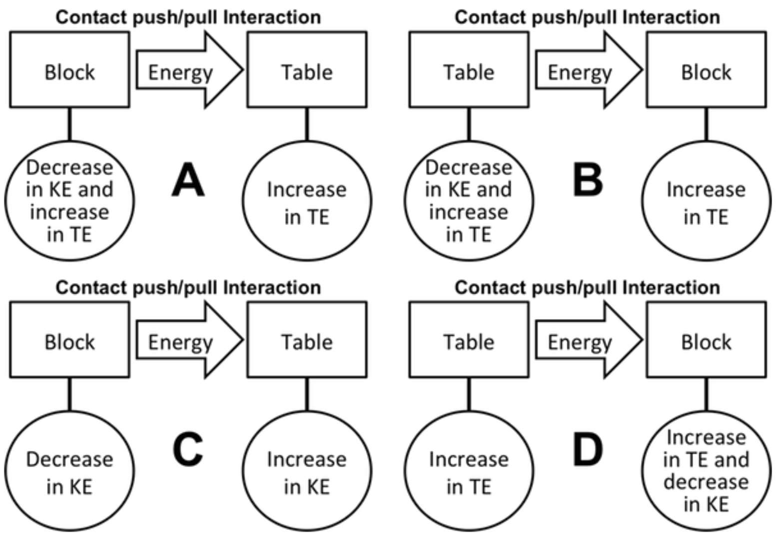
D) Its temperature is decreasing.

Feedback: Choice D is correct.

IE Unit EM Extension D

Quiz Question 2

A block is observed to slide across the table, slowing down to a stop. Which one of the following G/R energy diagrams might plausibly describe the interaction between the block and table? (TE = thermal energy; KE = kinetic energy)



Feedback: Energy diagram A is the best choice.

Quiz Question 3

A chair is pushed across the floor, and then let go. The chair comes to a very quick stop. A previous student wrote an explanation narrative for why the chair slows down after being let go. Read her evaluation, and then evaluate it for accuracy.

(1) There is a contact push/pull interaction between the chair and floor. (2) During the interaction, energy is transferred from the chair to the floor. (3) The kinetic energy of the chair decreases while its thermal energy increases, as well as the thermal energy of the floor. (4) Because the thermal energy of the chair increases, it slows down.

This explanation is

A) Accurate as written.
B) Not accurate because sentence #1 is not correct.
C) Not accurate because sentence #2 is not correct.
D) Not accurate because sentence #3 is not correct.
E) Not accurate because sentence #4 is not correct.
F) Not accurate because more than one sentence is not correct.

Feedback: The explanation is not accurate because sentence #4 is wrong (choice E). The chair does not slow down because its thermal energy increases; it shows down because its kinetic energy decreases.

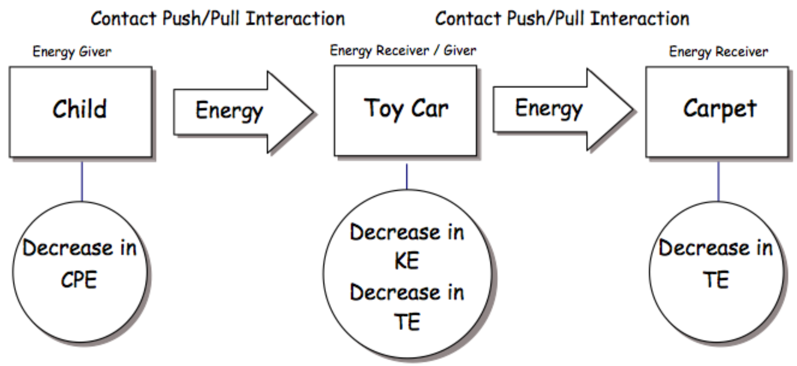
Simultaneous Interactions – Quiz **KEY**

For these questions consider a third situation associated with the child pushing the toy car across the carpet. Toward the end of the scenario, while still in contact with both the hand and the carpet, the toy car decreased in speed and stopped. Note that during this period the car and the carpet continued to get warmer because friction was still affecting them.

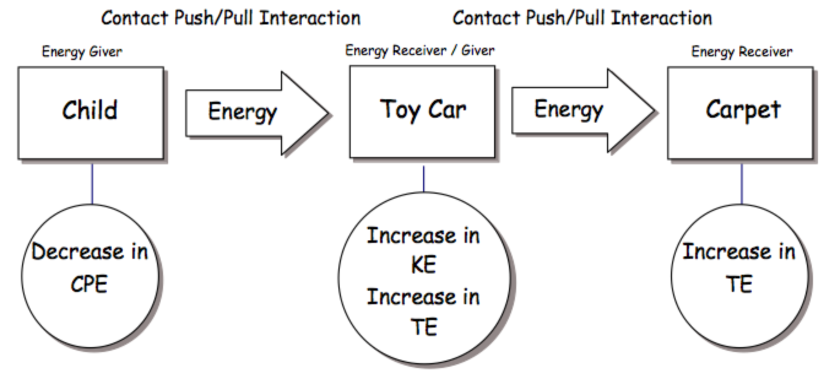
Quiz Question 1

Which of these G/R energy diagrams would be most appropriate for this situation?

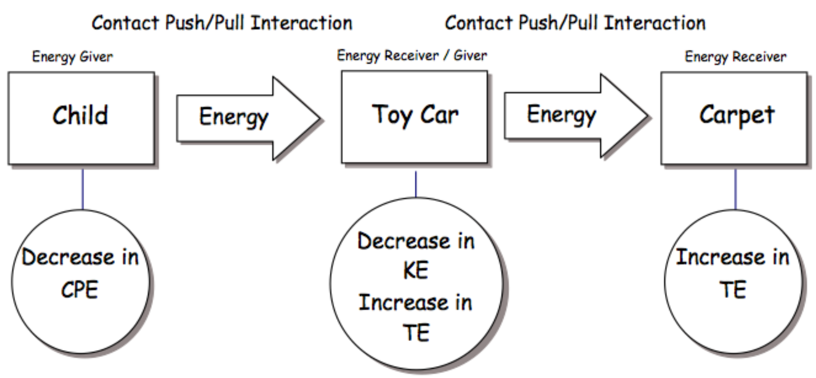
A



B



C



Feedback: Energy diagram C is correct.

Quiz Question 2

While the speed of the toy car was decreasing, what can you say about the tendency of the two interactions involved?

While the speed of the toy car was decreasing, what can you say about the tendency of the two interactions involved?

A. The tendency of interaction with the hand to increase the speed ~~kinetic energy~~ of the cart was **stronger** than the tendency of the interaction with the carpet to decrease its speed ~~kinetic energy~~.

A. The tendency of interaction with the hand to increase the speed ~~kinetic energy~~ of the cart was **equal to** the tendency of the interaction with the carpet to decrease its speed ~~kinetic energy~~

A. The tendency of interaction with the hand to increase the speed ~~kinetic energy~~ of the cart was **weaker** than the tendency of the interaction with the carpet to decrease its speed ~~kinetic energy~~ .

Feedback: Statement C is correct.

Quiz Question 3

Which of the following would be an appropriate statement of conservation of energy for this situation? (CPE = chemical potential energy, EPE = elastic potential energy, KE = kinetic energy)

A *Decrease in CPE of child* = *Increase in TE of toy car* + *Increase in TE of carpet*

B *Decrease in CPE of child* = *Decrease in KE of toy car* + *Increase in TE of toy car* + *Increase in TE of carpet*

C *Decrease in CPE of child* + *Decrease in KE of toy car* = *Increase in TE of toy car* + *Increase in TE of carpet*

Feedback: Statement C is correct.

Next Gen **PET**

IE Unit EM Extension G

Mechanisms for Heat Interactions – Quiz **KEY**

Quiz Question 1

As you saw in the first part of this homework, at the microscopic level heat conduction is a chain of collisions by particles of different kinetic energies. Suppose a heat interaction occurs between a hot object of 80 °C and a cool object of 10 °C, and the primary energy transfer mechanism is heat conduction. If the interaction continues long enough, how will the average kinetic energy of the particles in the (initially) hot object compare to the average kinetic energy of the particles in the (initially) cool object?

A) The average KE of the hot object particles will be greater than the average KE of the cool object particles.
B) The average KE of the hot object particles will be smaller than the average KE of the cool object particles.
C) The average KE of the hot object particles will be the same as the average KE of the cool object particles.
D) There is no way to determine the correct answer.

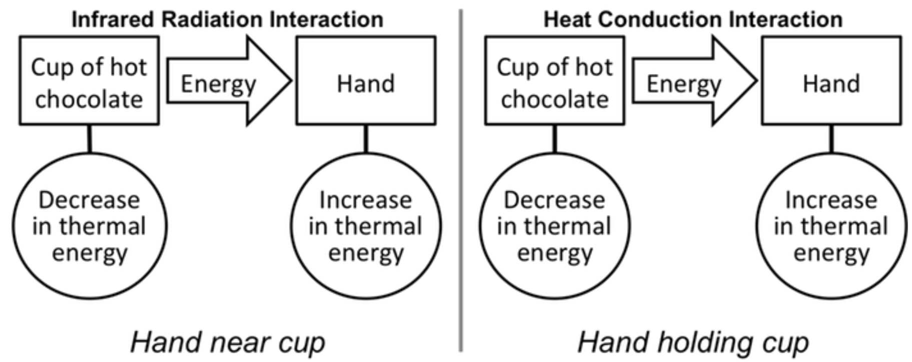
Feedback: Choice C is correct. If the interaction continues long enough, the temperatures of the two objects will be equal, so the average KE of all the particles will be the same.

IE Unit EM Extension G

Quiz Question 2

Suppose a cup of hot chocolate is sitting a table. A woman puts her hand close to the cup on its right side, but not touching (as in the image). Nonetheless, her hand begins feeling a bit warmer. When she grasps the cups, she feels her hand warming up even more rapidly. The energy diagrams below right demonstrate the mechanisms involved in making her hand warmer.

(Note that these diagrams are incomplete, because both the cup and hand also transfer energy to the surroundings through heat interactions. These interactions are not shown because they are not needed for answering this question.)



Now consider the **primary mechanism(s)** behind the first interaction and energy transfer (left diagram). Which of the following **best** explains why her hand begins to feel warmer before she touched the cup?

A) Charged particles in the hot chocolate and the cup vibrate more rapidly than the charged particles in her hand, emitting higher-intensity infrared radiation than her hand does, so that the hand absorbs more IR radiation than it emits.
B) Vibrating molecules in the hot chocolate move faster than the vibrating molecules in her hand, producing a wave of energy that travels through the air and is absorbed by her hand.
C) Collisions between high-speed, vibrating molecules in the hot chocolate and the cup generate more infrared radiation than collisions between the (relatively) low-speed molecules in her hand, so that the hand absorbs more IR radiation than it emits.
D) Collisions between particles in the hot chocolate and the cup with air particles transfer energy to the air particles, causing the air near the cup to warm up. Interacting with the cool air around it, the warm air rises upward through the cool air until it touches the hand. Collisions between air and hand particles then cause the hand to warm up.

Feedback: Choice A is the best explanation. Choice C mixes up the mechanisms for heat conduction and IR. Choice D brings in the mechanism for convection. Although the explanation is plausible, the hand is never located above the cup.

Quiz Question 3

If you were designing a room in a house, where would be the better place to put a heater, near the floor or near the ceiling? Why? Consider your answer in the context of convection.

A) Near the ceiling, because the air warmed by the heater would quickly spread down and across the room, replacing the cold air.

B) Near the floor, because the heater would warm the air close to it. After being heated, the now-warm air would rise, and be replaced by cool air, which the heater would warm. The cycle would continue until the room is heated.

C) Near the ceiling, because the heater would warm the air close to it. After being heated, the now-warm air would descend, and be replaced by cool air, which the heater would warm. The cycle would continue until the room is heated.

D) Near the floor, because the air warmed by the heater would quickly spread up and across the room, replacing the cold air.

Feedback: Choice B is correct.

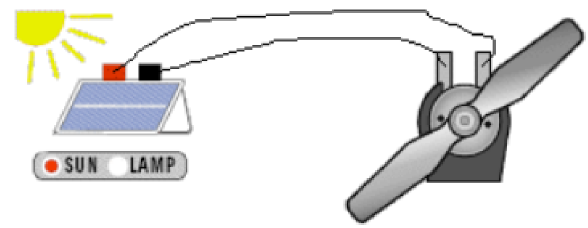
Next Gen **PET**

IE Unit EM Extension I

More on Efficiency & Conservation of Energy – Quiz **KEY**

Quiz Question 1

Consider a solar battery connected to a motor/fan. A simulation of this setup is run for 10 seconds and produces the display of energy values (in units of J) shown here. One value has been deliberately blacked out.



Solar battery 1		
ENERGY INPUT		
Energy (Light IA)		60.0
ENERGY OUTPUT		
Energy (Elec. Circ. IA)	[redacted]	
Energy (Heat IAs)		0.19
Energy (Light IA)		52.45
ENERGY CHANGES IN SYSTEM		
Thermal		0.17

What is the value of the energy transferred out from the solar battery due to the electric circuit interaction (the blacked out value)?

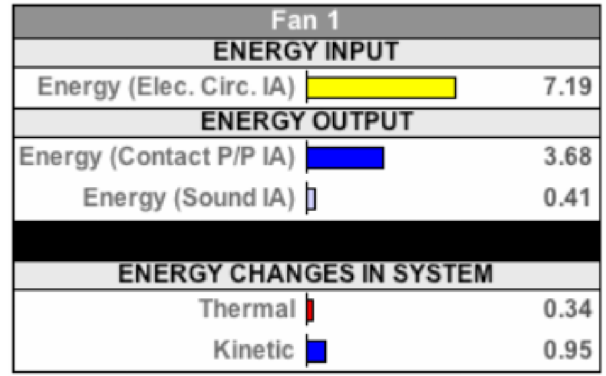
A. 7.19 J
B. 7.57 J
C. 7.91 J
D. 131.62 J

Feedback: Choice A is correct. Using the Law of Conservation of Energy:

Total energy input = Total energy output + Total energy change in system
60.00 J = (x + 0.19 J + 52.45 J) + 0.17 J = (x + 52.64 J) + 0.17 J = x + 52.81 J
x = 60.00 J - 52.81 J = **7.19 J**

Quiz Question 2

This simulator display shows the energy values associated with the motor/fan in the same circuit over the same period as in the previous question. In this case one of the energy outputs has been completely blacked out.



What type of interaction is associated with the blacked-out energy output and what value should it have?

A. 1.81 J associated with an Electric Circuit Interaction
B. 4.39 J associated with Heat Interactions
C. 4.39 J associated with Light Interactions
D. 1.81 J associated with Heat Interactions
E. 3.51 J associated with Heat Interactions

Feedback: Choice D is correct. Because the motor/fan warms up (its thermal energy increases), there are heat interactions between the motor/fan and the surroundings. So the blacked-out output is due to heat interactions.

For the value of the missing energy output, we use the Law of Conservation of Energy:

Total energy input = Total energy output + Total energy change in system

7.19 J = (3.68 J + 0.41 J + x) + (0.34 J + 0.95 J) = (4.09 J + x) + 1.29 J = x + 5.38 J
x = 7.19 J – 5.38 J = **1.81 J**

Quiz Question 3

In all the systems (both electrical and non-electrical) you have examined, what type of interaction is **always** responsible for at least some energy output from every device/object involved?

A. Electric Circuit Interactions
B. Contact Push/Pull Interactions
C. Heat Interactions
D. Light Interactions
E. Sound Interactions

Feedback: Choice C is correct.

Next Gen **PET**

IE Unit EM Extension J *(optional review extension)*

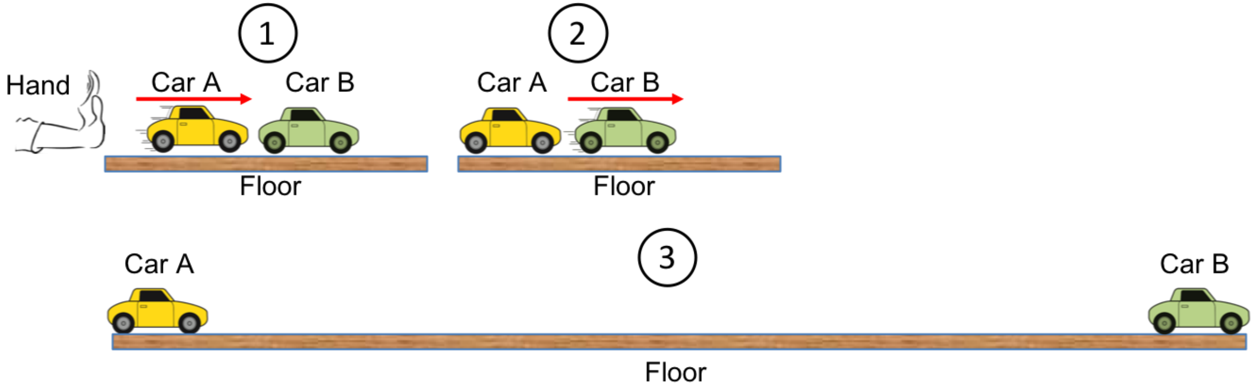
Reviewing Energy and Interactions–Quiz **KEY**

Quiz questions are on the three following slides.

IE Unit EM Extension J

Question 1

In the situation illustrated below, (1) Car A is given a push. Almost immediately **after** the push, Car A collides with Car B, which is stationary. This results in (2) Car A stopping, and Car B moving away from the collision with approximately the same speed Car A had right before the collision. Then Car B gradually slows down, and sometime later, (3) it comes to a stop. Which explanation below best describes the changes in the motion of **Car B** in terms of energy? (Note: KE=kinetic energy, TE=thermal energy.)



A. When Car A collides with Car B, there is a contact push/pull interaction between Car A and Car B. During the interaction, energy is transferred from Car A to Car B, so Car B increases in KE and speeds up to about Car A's speed just before the collision. After the collision, there is a friction-type contact push/pull interaction between Car B and the floor. During the interaction, energy is transferred from Car B to the floor, so Car B decreases in KE until it stops, while the floor increases in TE.

B. The energy of the push is transferred to Car B when Car A collides with Car B in a contact push/pull interaction. During the interaction, Car B increases in KE, so it starts moving, while Car A loses the energy of the push, so it stop moving. After the collision, there is a friction-type contact push/pull interaction between Car B and the floor, during which energy is transferred from Car B to the floor. Car B decreases in KE and both Car B and the floor increase in TE. Because of the decrease in KE, Car B slows down until it stops.

C. When Car A collides with Car B, there is a contact push/pull interaction between Car A and Car B, during which energy is transferred from Car A to Car B. Car A decreases in KE (to zero), while Car B increases in KE. Because of the increase in KE, Car B speeds up to about Car A's speed just before the collision. After the collision, there is a friction-type contact push/pull interaction between Car B and the floor, during which energy is transferred from Car B to the floor. Car B decreases in KE and both Car B and the floor increase in TE. Because of the decrease in KE, Car B slows down until it stops.

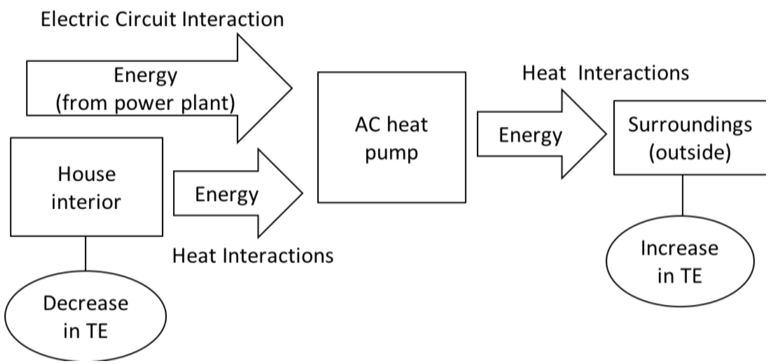
Feedback: Explanation C is the best and most complete answer.

IE Unit EM Extension J

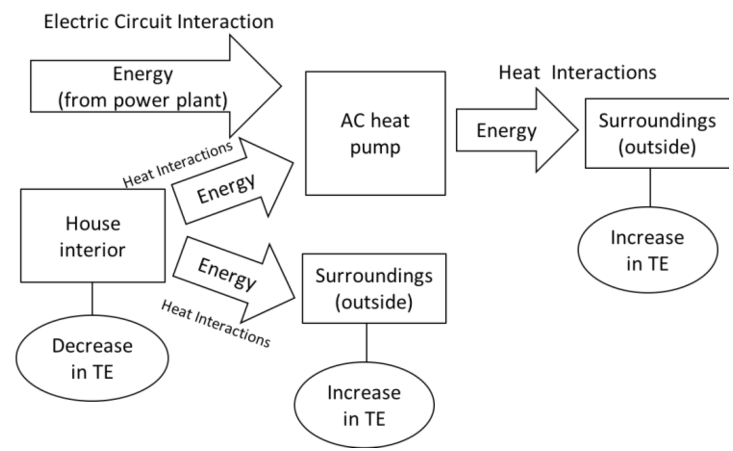
Question 2

Air conditioners are another device that rely upon heat pumps. Like refrigerator heat pumps, the heat pumps in AC units cool the environment inside a “box” (in this case, a(n) house, apartment, office, etc.) that is separated by a physical barrier (walls, ceilings) from the warmer outside environment. Which of following energy diagrams represents air conditioning in a house that has essentially **NO** thermal insulation— so that, even with the AC on, it’s just as hot inside as outside? (Assume that the AC heat pump is in dynamic equilibrium.)

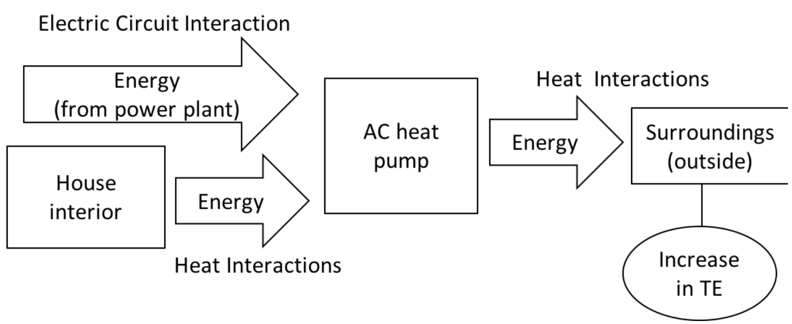
A



B



C



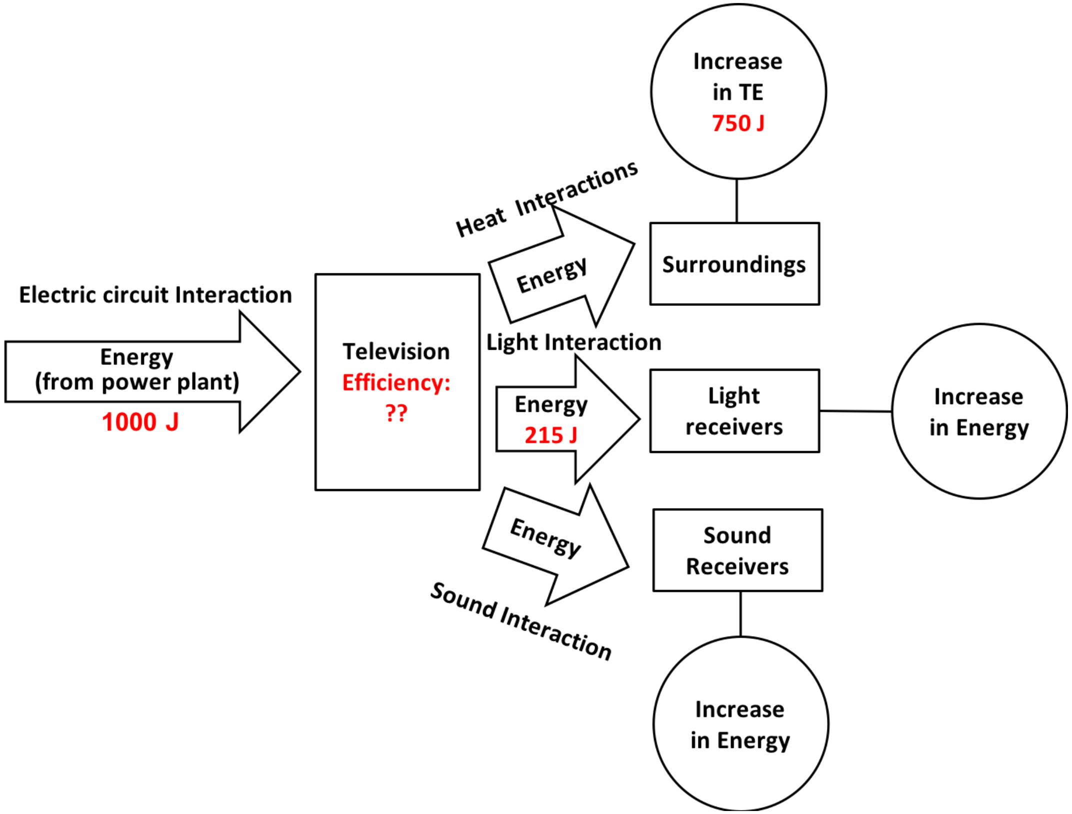
Feedback: Energy diagram C is the only one that shows that the house’s thermal energy is not changing, so its temperature remains constant. It has no interaction with the outside environment because it is the same temperature as it is outside. The thermal energy outside can increase without affecting the temperature (much), because it is so much larger than the inside of the house. Note that energy diagram A is appropriate for a well-insulated house, one that has essentially no energy transfers via heat interactions with the outside environment.

IE Unit EM Extension J Question 3

Examine the energy diagram to the right. For every 1000 J of energy input to a particular television set, on average there are 215 J of energy output through the light interaction, and heat interactions to the surroundings cause their thermal energy to increase 750 J.

What is the efficiency of the TV set? Hint: What are the useful energy outputs?

A) 3.5%
B) 18.0%
C) 21.5%
D) 25.0%
E) 35.0%



Feedback: From the law of conservation of energy, the energy in the output arrow from the TV set due to heat interactions must be equal to the increase in thermal energy of the surroundings, or 750 J. By conservation of energy the sum of the three energy outputs from the TV must equal the energy input (1000 J). From this, the energy output from the TV due to the sound interaction is 1000 J – 750 J– 215 J = 35 J.

As television is both a visual and audio medium, the useful energy output of a TV set is the sum of its energy outputs due to the light and sound interactions, which is 215 J +35 J = 250 J here. Thus the efficiency of the TV set is **25%** (D).