

# Energy Concept Inventory

Version 05.04.26

Wait until you are told to begin, then turn to the next page and start. There are 35 items in this Inventory. Choose the best available choice for each item. There is only one best choice for each item. Use a #2 pencil to mark your answers on the answer sheet. **Please do not write on this test.** You will have about 30 minutes to complete this Inventory. Your teacher will tell you when to stop working.

# Energy Concept Inventory

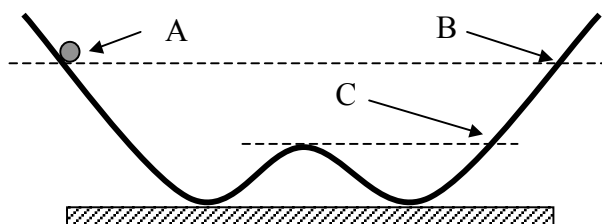
1. Workers from the electric company regularly read the meters on houses. These meters measure the amount of

- i.* energy that we use.
- ii.* power that we use.
- iii.* force that we use.



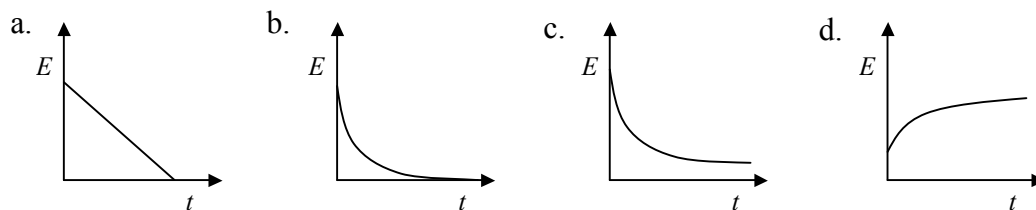
- a. *i* only
- b. *ii* only
- c. *iii* only
- d. *i* and *ii*
- e. *i, ii, and iii*

2. A steel ball is placed at position A on the curved, hard surface shown below. The surface is fixed to the table on which it sits so that it does not move. The ball is held at rest at position A and then is released. It rolls smoothly along the surface. Which choice below most nearly describes the greatest height attained by the ball on the other side of the curve?

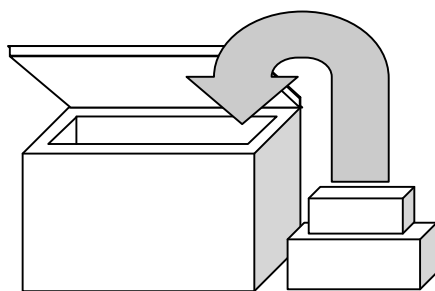


- a. It will not get over the hill in the middle.
- b. Significantly below position C
- c. Almost to position C
- d. Almost to position B
- e. Slightly higher than position B

3. A book slides across a table and comes to rest. Which of the following graphs best describes the total energy of the book, table, and surroundings during this process?

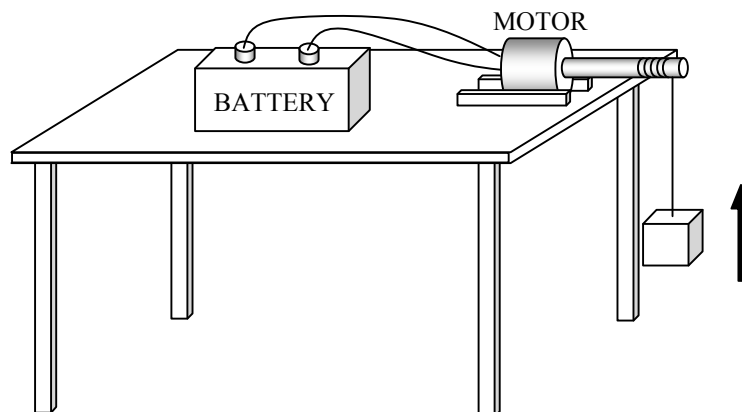


- e. None of these



4. A hot 8-kg copper bar is placed in contact with a 5-kg copper bar at room temperature inside a good Styrofoam cooler. The hot bar does not melt the cooler. The cooler is tightly closed. Which statement below best describes the temperatures of the bars after an hour?
- The temperatures of the bars are nearly the same, about half way between the original temperatures.
  - The temperatures of the bars are nearly the same, closer to the original temperature of the cold bar.
  - The temperatures of the bars are nearly the same, closer to the original temperature of the hot bar.
  - The 5-kg bar has warmed up and the 8-kg bar has cooled off, but they will never be at the same temperature.
  - Both bars will be at room temperature.
5. You have a can of soda that you would like to keep cold and a sandwich to keep warm. You have woolen blankets and some aluminum foil. What combination of materials would work best?
- Aluminum foil wrapped around the soda and a woolen blanket wrapped around the sandwich.
  - A woolen blanket wrapped around the soda and aluminum foil wrapped around the sandwich
  - Aluminum foil wrapped around each individually.
  - A woolen blanket wrapped around each individually.
  - Wrapping each separately with either material would work equally well.

For questions 6 and 7, consider a system that consists of only the **earth and box**. A battery-powered motor not considered part of the system lifts the box from the ground to a certain height above the earth's surface.



6. Which statement below is most accurate after the box has been lifted?
- The energy in the box has increased.
  - The energy in the box has decreased.
  - The energy in the system remains the same, because the box is not moving.
  - The energy in the system has decreased.
  - The energy in the system has increased.

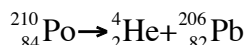
7. What has happened to the battery's energy as a result of lifting the box?
- The battery's energy has increased.
  - The battery's energy remains the same.
  - The battery's energy has decreased.
  - The battery's energy decreases at first until it recovers as it rests.
  - There is not enough information to answer the question.

8. During soccer practice one of your teammates sprains her ankle. Because it is starting to swell, the coach gets an "instant cold pack" from the first aid box and asks you to use it on her ankle. It is not at all cold when he gives it to you. The instructions on the cold pack tell you to punch the pack so that you break open a sack of chemicals inside it. When you do that you notice that the cold pack rapidly becomes quite cold. Therefore you conclude that



- some of the energy from the cold pack is used up and no longer exists when the chemicals react.
- the cold pack gives energy to its surroundings as a result of the chemical reaction.
- by punching the pack you gave the chemicals inside the energy they needed to permit the cooling down.
- the cold pack gains energy from its surroundings as a result of the chemical reaction.
- the chemical reaction in the cold pack produces the energy needed to cool it down.

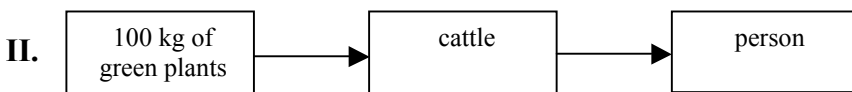
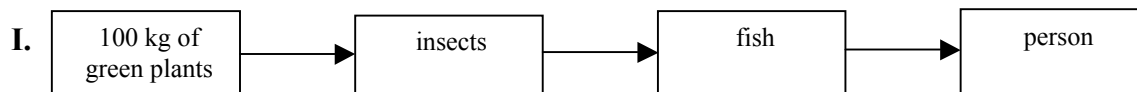
9. A tropical rainforest is an example of an ecosystem. Which of the following statements about matter and energy in a tropical rainforest is the most accurate?
- Energy in a tropical rainforest is recycled again and again within the rainforest, but matter in a tropical rainforest is not recycled. Therefore, the matter must continually be replenished.
  - Matter in a tropical rainforest is recycled again and again within the rainforest, but energy in a tropical rainforest is not recycled. Therefore, the energy must continually be replenished.
  - Both matter and energy in a tropical rainforest are recycled again and again within the rainforest until one or the other is used up.
  - Neither matter nor energy in a tropical rainforest is recycled within the rainforest. Therefore, both matter and energy must continually be replenished.
  - Neither matter nor energy in a tropical rainforest needs to be replenished, because both are conserved.
10. When a polonium nucleus undergoes radioactive decay an alpha particle (which is a helium nucleus,  ${}^4_2\text{He}$ ) shoots out from it at high speed leaving a lead nucleus ( ${}^{206}_{82}\text{Pb}$ ) behind. This decay process is represented as follows:



When we measure the masses of the helium and lead nuclei ( ${}^4_2\text{He}$  and  ${}^{206}_{82}\text{Pb}$ ) we find that their total mass is less than the original mass of the parent polonium nucleus. Why is there less mass?

- Some of the protons or neutrons lose matter in alpha decay.
- Some protons or neutrons are lost in alpha decay.
- Some matter is converted to energy in alpha decay.
- The lead and helium daughter nuclei at rest possess less total energy than the parent polonium nucleus.
- A mistake was made; the mass of the helium and lead must add up to the original mass of the polonium nucleus from which they came.

For questions 11 and 12, consider the three diagrams below. They represent three situations in which 100 kg of green plants serve as the original source of food for each of the food chains. In situation II, for example, cattle eat 100 kg of green plants and then people eat the beef that is produced by the cattle as a result of having eaten the plants.



11. In which of the three situations is the most energy available to the person?

- I.
- II.
- III.
- Situations I and II will roughly tie for the most energy.
- The same amount of energy will be available to the person in all three situations.

12. In which of the three situations is the most energy lost to the environment?

- I.
- II.
- III.
- Situations II and III will roughly tie for the most heat.
- There will be the same amount of heat transferred to the environment in all three situations.

13. As a small sample of water freezes,

- it absorbs energy from its surroundings.
- it absorbs the coldness from its surroundings.
- it absorbs coldness from and releases energy to its surroundings.
- its surroundings absorb energy from it.
- it neither absorbs nor releases energy, because its temperature stays constant.

For questions 14 and 15, consider a smooth piece of wood and a smooth piece of steel that both have a temperature of  $0^{\circ}\text{C}$ .


14. What would you feel if you grab one item in each hand?
- Wood cannot be cooled to  $0^{\circ}\text{C}$ ; therefore the steel would feel colder.
  - The wood would feel colder than the steel.
  - The steel would feel colder than the wood, even though they have the same temperature.
  - Sometimes the wood would feel colder, but other times the steel would.
  - Both objects would feel equally cold.

15. The best explanation for your answer to the previous question is.
- Your perception of coldness depends only on the temperature of the material.
  - Steel absorbs cold better than wood does.
  - Wood stores cold better than steel does.
  - Metals are cold by nature.
  - Heat goes more quickly from your hand to the steel than it does to the wood.

16. You drop a ball of soft clay onto a concrete floor. The ball is shown below in its initial position from which it is dropped and in its final position after it hits the floor. It does not bounce. Which of the following statements best describes what has happened to the kinetic energy that the ball had just before it hit the floor?

initial position 

- The energy no longer exists anywhere after the ball stops.
- Most of the energy is in the floor just after the ball hits it.
- The energy is evenly divided between the clay and the floor.
- The kinetic energy of the ball has become potential energy.
- Most of the energy is in the clay just after hitting the floor.

final position 

17. You put fresh batteries into a flashlight. Then you turn it on and leave it on until the bulb gradually dims and finally goes out. Which statement best describes the involvement of energy in this process?
- The energy has been used up by the bulb and no longer exists anywhere.
  - All the energy that the batteries originally had when new still exists somewhere or other.
  - The energy of the batteries was converted to heat by the bulb, so it no longer exists.
  - The amount of energy in the flashlight, batteries, and bulb remain the same, because energy is conserved.
  - The energy has moved from one end of the batteries to the other.

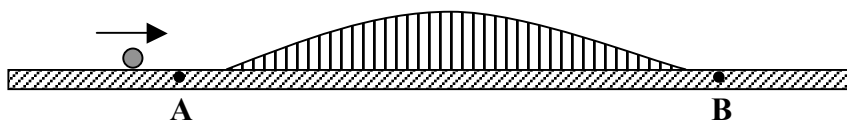
For questions 18 and 19 consider a situation in which twenty 100-g aluminum plates and twenty 100-g wooden plates have been stored overnight in a freezer. These plates were designed to be the same size and shape.

18. How do the temperatures of the aluminum and wooden plates compare when first removed from the freezer?
- The aluminum plates will be at a lower temperature.
  - The wooden plates will be at a lower temperature.
  - Both will be at the same temperature.
  - Usually the aluminum plates will be at a lower temperature.
  - Usually the wood plates will be at a lower temperature.
19. One minute after they have been removed from the freezer and placed on a table in the same environment, how will the temperatures of the wooden and aluminum plates compare?
- The aluminum plates will always be at a lower temperature.
  - The wooden plates will always be at a lower temperature.
  - All the wooden and aluminum plates would be at the same temperature.
  - Usually the aluminum plates will be at a lower temperature.
  - Usually the wood plates will be at a lower temperature.
20. What happens to the energy used to operate a toaster after the toaster is finished toasting?
- It still exists in the toast and toaster, around the toaster, and in the air.
  - It returns to the electric company.
  - It is consumed by the toast.
  - It gradually disappears until none of it remains anywhere.
  - It becomes potential energy.
21. Just after warm leftover chili is placed in the refrigerator,
- the refrigerator gradually destroys all the heat in the chili until it has only coldness.
  - the chili gives up energy to the refrigerator and its contents.
  - the refrigerator gradually destroys some heat in the chili until it has more coldness than energy.
  - the chili absorbs coldness from the refrigerator and its contents.
  - Both choices (b) and (d) are true.



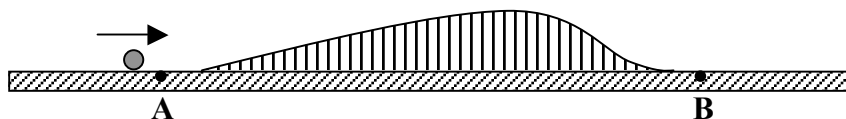


22. A small ice cube is placed in a refrigerator that maintains a temperature of  $5^{\circ}\text{C}$ . At that moment the ice cube is observed to have a temperature of  $0^{\circ}\text{C}$ . What will happen to the temperature of the ice?
- It will decrease until the ice is completely melted.
  - It will fluctuate between  $0^{\circ}\text{C}$  and  $5^{\circ}\text{C}$  as ice is melting.
  - It gradually increases to as much as  $5^{\circ}\text{C}$  as it melts.
  - It increases to  $5^{\circ}\text{C}$ , and then the ice begins to melt.
  - It will remain  $0^{\circ}\text{C}$  until the ice is completely melted.
23. What is the primary source of energy for plants?
- light
  - nutrients in the soil
  - water
  - air
  - They make their own energy.
24. A living tree in its environment
- does not possess energy.
  - possesses energy that it has received from the sun.
  - possesses energy that it has made as well as energy that it has received from the sun.
  - possesses only energy that it has made.
  - possesses energy from the sun and the energy of its life force.
25. A dead tree in its environment
- does not possess energy.
  - possesses energy that it has received from the sun.
  - possesses energy that it has made as well as energy that it has received from the sun.
  - possesses energy that it has made.
  - possesses energy from the sun and still a little energy from its life force.
26. A steel ball rolls along a smooth, hard, level surface with a certain speed. It then smoothly rolls up and over the hill shown below. How does its speed at point **B** after it rolls over the hill compare to its speed at point **A** before it rolls over the hill?



- Its speed is significantly less at point **B** than at point **A**.
- Its speed is very nearly the same at point **B** as at point **A**.
- Its speed is slightly greater at point **B** than at point **A**.
- Its speed is much greater at point **B** than at point **A**.
- The information is insufficient to answer the question.

27. A steel ball rolls along a smooth, hard, level surface with a certain speed. It then smoothly rolls up and over the hill shown below. How does its speed at point **B** after it rolls over the hill compare to its speed at point **A** before it rolls over the hill?



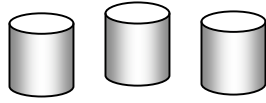
- Its speed is significantly less at point **B** than at point **A**.
  - Its speed is very nearly the same at point **B** as at point **A**.
  - Its speed is slightly greater at point **B** than at point **A**.
  - Its speed is much greater at point **B** than at point **A**.
  - The information is insufficient to answer the question.
28. Liquid water is boiling in a pan on a stove. The burner on the stove is set on “LOW.” While the water is boiling the burner is turned to the “HIGH” setting. What happens to the temperature of the liquid water?
- It decreases slightly due to the extra boiling.
  - It decreases very much due to the extra boiling.
  - It increases, and it does so at a faster rate than when the burner was on “LOW.”
  - It increases, and it does so at the same rate as when the burner was on “LOW.”
  - It remains the same

29. When a candle burns the energy released

- comes mainly from the wax and air.
- comes mainly from the burning wick.
- is produced mainly by the fire.
- comes from the match that lighted the candle.
- comes mainly from the wax.

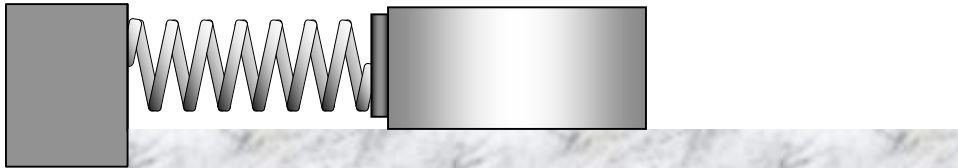


30. Which of the following statements describe(s) the difference between a strong chemical bond and a weak chemical bond between two atoms?
- The strong chemical bond stores more energy than the weak chemical bond.
  - More energy is needed to separate strongly bonded atoms than weakly bonded atoms.
  - More energy is released to the environment when two atoms become strongly bonded than when two atoms become weakly bonded.
- i* only
  - ii* only
  - iii* only
  - ii* and *iii* only
  - i*, *ii*, and *iii*



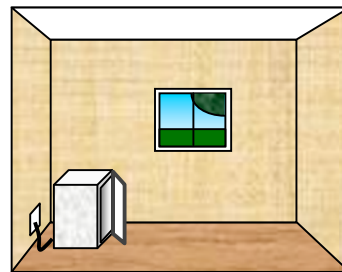
Uranium dioxide pellets are placed in fuel rods. These rods are placed inside nuclear reactors of some electric power plants.

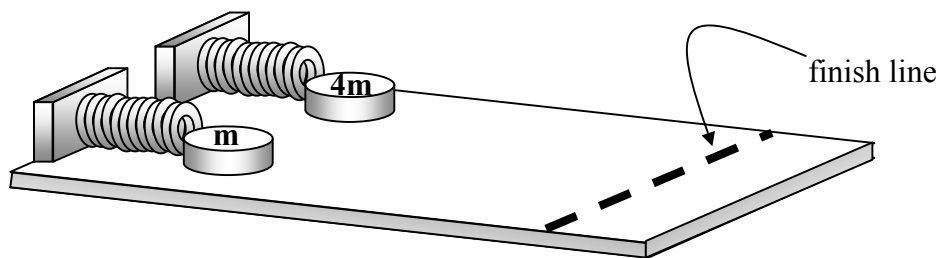
31. Uranium dioxide is formed into pellets (pictured above) that are used as fuel in nuclear power plants. These pellets
- contain energy that is transferred from the power plant to the customers.
  - do not contain energy, but they start nuclear reactions that do produce energy.
  - do not contain energy until brought close together.
  - are important energy sources since they produce more energy than they contain.
  - do not actually make energy; the electric generators in the power plant do that.
32. A puck sitting on level ice is pushed back against a spring that is attached to a wall. This partially compresses the spring. The puck is released, and the spring propels it.



If you have only this spring, but a variety of different pucks, how could another puck be given more energy?

- Use a puck with less mass.
  - Use a puck with more mass.
  - Compress the spring more.
- i* only
  - ii* only
  - iii* only
  - i* and *iii*
  - ii* and *iii*
33. The air conditioning breaks down in your dorm room. In an attempt to keep the room cool for the rest of the afternoon you open the door of a refrigerator that you have in your room. Over the rest of the afternoon what effect will the open refrigerator have on the temperature of your room?





34. Two pucks on level ice are shown above, pressed back by equal amounts against identical springs. The pucks are the same size and shape, but one has four times the mass of the other. The pucks are released and the springs propel them to the finish line. At the finish line how does the speed of the less massive puck compare to the speed of the more massive puck?
- It is the same as the speed of the more massive puck.
  - It is four times the speed of the more massive puck.
  - It is twice the speed of the more massive puck.
  - It is half the speed of the more massive puck.
  - It is one-fourth the speed of the more massive puck.
35. A balloon is inflated with a mixture of natural gas and air. A burning match is touched to the balloon, and the mixture explodes. The energy released by the explosion
- was originally in the natural gas and air.
  - came from the match.
  - was not originally in the natural gas and air but was produced in the reaction between the natural gas and air.
  - was originally in only the natural gas.
  - was originally in only the air.

**END OF TEST**