Work, Energy and Power

Use this key to check answers and read the explanations.

1. A student supports a stack of books for 10 seconds. The stack stays in the same position the entire time. How much mechanical work does the student’s upward force do on the stack?

A. 0 joules
B. 10 joules
C. 20 joules
D. It depends on the weight of the books.

Correct answer: A. 0 joules
The books have no displacement. A supporting force does zero mechanical work on a stationary object, even if the person holding it gets tired.

2. A model elevator moves upward. Gravity pulls downward on its cabin. What is the sign of the work gravity does on the cabin while it rises?

A. Zero
B. Positive
C. Negative
D. It changes from positive to negative if the cabin rises at constant speed.

Correct answer: C. Negative
Gravity points opposite the cabin’s upward displacement. Therefore gravity does negative work during the rise.

3. Two students each transfer the same amount of energy to raise identical classroom props. One transfers it in half the time. How does that student’s average power compare with the other’s?

A. It is half as large.
B. It is twice as large.
C. It is the same.
D. It is four times as large.

Correct answer: B. It is twice as large.
Average power is energy transferred divided by time. The same amount transferred in half the time gives twice the average power.

4. An electric reading lamp runs at a steady temperature. What happens to the electrical energy it receives?

A. It becomes only thermal energy, even though the lamp emits light.
B. It all stays stored in the lamp.
C. It supplies light, and any part that warms the surroundings vanishes.
D. It leaves as light and as thermal energy transferred to the surroundings.

Correct answer: D. It leaves as light and as thermal energy transferred to the surroundings.
The operating lamp sends out light and transfers energy as heat. Its steady temperature means it is not continuously storing the incoming energy.

5. Two gliders move at the same speed along an air track. Glider A has three times the mass of glider B. How does A’s kinetic energy compare with B’s?

A. It is nine times as large.
B. It is three times as large.
C. It is one-third as large.
D. It is the same.

Correct answer: B. It is three times as large.
Kinetic energy is one-half times mass times speed squared. The speed is the same, so three times the mass gives three times the energy.

6. A student pushes a supply crate with a constant 18-newton force in the direction of its 6-meter displacement. How much work does the student’s push do?

A. 108 joules
B. 24 joules
C. 12 joules
D. 3 joules

Correct answer: A. 108 joules
The force and displacement point the same way. Multiply 18 newtons by 6 meters to get 108 joules.

7. A student pulls a teaching model horizontally 4 meters with a 25-newton force at 60 degrees above the horizontal. Use a cosine of 0.50 for that angle. How much work does the pull do?

A. 200 joules
B. 100 joules
C. 25 joules
D. 50 joules

Correct answer: D. 50 joules
The force component along the horizontal motion is 25 times 0.50, or 12.5 newtons. Its work over 4 meters is 50 joules.

8. A tabletop lifting model does 480 joules of useful work in 12 seconds. What is its average useful power?

A. 48 watts
B. 12 watts
C. 40 watts
D. 5,760 watts

Correct answer: C. 40 watts
Divide the work, 480 joules, by 12 seconds. That is 40 joules per second, or 40 watts.

9. A 6-kilogram tray is raised from 0.30 meter above the floor to 1.10 meters. Use 10 meters per second squared for gravitational acceleration. How much does its gravitational potential energy increase?

A. 48 joules
B. 18 joules
C. 66 joules
D. 84 joules

Correct answer: A. 48 joules
The height increases by 0.80 meter. Multiply mass, gravitational acceleration and height change to get 6 times 10 times 0.80, or 48 joules.

10. A small lamp draws a constant 8 watts for 5 minutes. How much electrical energy does it use during that time?

A. 4,800 joules
B. 40 joules
C. 300 joules
D. 2,400 joules

Correct answer: D. 2,400 joules
Five minutes is 300 seconds. Multiply the 8 joules per second by 300 seconds to get 2,400 joules.

11. A 2-kilogram glider initially moves at 3 meters per second on a level air track. The net work done on it is positive 7 joules. What is its final speed?

A. 7 meters per second
B. 2 meters per second
C. 4 meters per second
D. 10 meters per second

Correct answer: C. 4 meters per second
The initial kinetic energy is one-half times 2 times 3 squared, or 9 joules. Net work raises it to 16 joules. With this mass, that gives a final speed of 4 meters per second.

12. A sliding block starts up a ramp with 12 joules of kinetic energy. Over the part of the ramp studied, gravitational potential energy increases by 8 joules, and friction converts 3 joules of mechanical energy into thermal energy. No other energy transfers occur. How much kinetic energy remains?

A. 4 joules
B. 1 joule
C. 7 joules
D. 9 joules

Correct answer: B. 1 joule
Of the initial 12 joules of kinetic energy, 8 become gravitational potential energy and 3 become thermal energy. Subtract both to find the remaining 1 joule.

13. A model pump uses 240 joules of electrical energy and does 180 joules of useful work raising water. What is its efficiency for the raising task?

A. 80%
B. 25%
C. 60%
D. 75%

Correct answer: D. 75%
Efficiency is useful work divided by total input energy. Dividing 180 by 240 gives 0.75, or 75%.

14. Two devices each deliver 360 joules of useful lifting work. Device A averages 100 watts of input for 6 seconds. Device B averages 60 watts of input for 9 seconds. Which device has the higher efficiency?

A. Device B, because it uses less input energy for the same useful work.
B. Device A, because taking less time always means higher efficiency.
C. Device A, because drawing more input power means it wastes less energy.
D. They have the same efficiency because they do the same useful work.

Correct answer: A. Device B, because it uses less input energy for the same useful work.
Device A uses 100 times 6, or 600 joules. Device B uses 60 times 9, or 540 joules. With identical useful outputs, the lower input gives device B the higher efficiency.

15. A tabletop hoist draws 80 watts with 75% efficiency. It lifts a 12-kilogram load at constant speed through a vertical distance of 3 meters. Use 10 meters per second squared for gravitational acceleration. How long does the lift take?

A. 8 seconds
B. 4.5 seconds
C. 6 seconds
D. 18 seconds

Correct answer: C. 6 seconds

The useful work is 12 times 10 times 3, or 360 joules. Useful power is 75% of 80 watts, or 60 watts. Divide 360 joules by 60 joules per second to get 6 seconds.