# WORK and POWER Name _____

**Part D: Quantitative Work-Energy Theorem (quantitative)**

| **Work-Energy Theorem (quantitative)**<br><br>Work = change in energy<br><br>This formula changes based on what type of work you do! |
|---|

| **Work you Did** | **New Type of energy you got** | **How Much Energy you got** |
|---|---|---|
| Lifted Something Up | Gravitational Potential Energy | $W = \Delta GPE = mg\Delta h$ |
| Pushed or pulled a spring | Elastic Potential Energy | $W = \Delta EPE = \frac{1}{2}k\left(x_f^2 - x_i^2\right)$ |
| Pushed something and made it move faster | Kinetic Energy | $W = \Delta KE = \frac{1}{2}m\left(v_f^2 - v_i^2\right)$ |
| Pushed something, but it did not move faster because of friction | Thermal Energy | $W = Q = mC\Delta T$ |

| If you did no work, the change in energy is zero. |
|---|

**D.1** A toy car is moving at an initial speed of 2 m/s. It has a mass of 20 kg. The car experiences a force of 40 Newtons and moves a distance of 4 meters
**i.** What is the work done on the car?

**ii.** What is the change of kinetic energy of the car? [hint: This question is very easy! Use the *work-energy* theorem.]

**iii.** What is the final velocity of the car? [hint: pick one of the four formulas from the table.]

| Looking For | Formula |
|---|---|
| Already Know | |
| Answer as equation *with unit*: | |

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**D.2** A toy car is moving at an initial speed of 6 m/s. It has a mass of 3 kg. The car experiences a force of 24 Newtons and moves a distance of 4 meters
**i.** What is the work done on the car?

**ii.** What is the change of kinetic energy of the car? [hint: This question is very easy! Use the *work-energy* theorem.]

**iii.** What is the final velocity of the car? [hint: pick one of the four formulas from the table.]

| Looking For | Formula |
|---|---|
| Already Know | |
| Answer as equation *with unit*: | |

**D.3** Someone is lifting a heavy box. The box has a mass of 12 kilograms. While lifting, she does 1235 Joules of work.

**i.** What was the change in *Gravitational Potential Energy* of the box? [hint: This question is very easy! Use the *work-energy* theorem.]

**ii.** What is the change in height of the box? [hint: pick one of the four formulas from the table.]

| Looking For | Formula |
|---|---|
| Already Know | |
| Answer as equation *with unit*: | |

**D.5** Someone does 400 Joules of work lifting a box to a height of 2 meters. What was the mass of the box?

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**D.6** Jane pushes a box 2 meters along the floor using a force of 150 Newtons.
The box does not change in speed while she is pushing it, and the floor has a rug with lots of little bumps.

What new type of *energy* is Jane getting? How much does she get?

**D.7** Diana pulls back a bow and arrow. While pulling, she exerts an average force of 50 Newtons. The bow and arrow moves backward by 0.45 meters. The arrow has a mass of 0.30 kg.

What type of energy does the arrow now have? How much?

When Diana releases the bow and arrow, it converts into what new type of energy?

What is the speed of the arrow after it is released from the bow?

**D.8** Joey pulls a bow and arrow backwards a distance of 0.38 meters with an average force of 48 Newtons. He then points the bow straight into the air and fires. The arrow fires straight up into the air. The arrow has a mass of 0.30 kg.

Explain the enter transfer, beginning with the energy storied inside of Joey's muscles to the energy of the arrow as it is high up in the air:

_____ converts to _____ converts to _____ converts to _____.

Using the formulas and methods from the problems above, figure out how high the arrow flies into the air.

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**Answers**

1 5 Watts
2 160 Joules
3a 250 Joules
3b 2.5 Watts
4 600 Joules
5a. 6 Amps
5b. 72 Watts
5c. 4320 Joules
6. Your work and power are both 0.

7a.

| | Weight (N) | Work Done (J) | Time (s) | Power (W) |
|---|---|---|---|---|
| John | 500 | 15,000 | 12 | 1250 |
| Paul | 550 | 16,500 | 13 | 1269 |
| George | 588 | 17,640 | 15 | 1,176 |
| Ringo | 650 | 19,500 | 15 | 1,300 |

7b. John

7c. Paul

7d. Because Paul weighs more, he does more work.

8a

| **Appliance** | **Power (W)** | **Time used (s)** | **Energy Used (J)** | |
|---|---|---|---|---|
| Light #1 | 80 | 43,000 | 3,440,000 | $3.4 \times 10^6$ |
| Light #2 | 140 | 43,000 | 6,020,000 | $6.0 \times 10^6$ |
| Refrigerator | 2000 | 86,400 | 172,800,000 | $1.7 \times 10^8$ |
| Stereo system | 4000 | 2000 | 8,000,000 | $8.0 \times 10^6$ |

8b. The stereo system.

8c. The refrigerator