1. Using the equation $KE = \frac{1}{2}mv^2$, $W = \Delta KE$ and $W = FD$:

   $FD_{A1} = \frac{1}{2}mv_{A1}^2$

   $FD_{A2} = \frac{1}{2}m(2v_{A1})^2$

   By solving for displacement for each equation:

   $D_{A1} = \frac{mv_{A1}^2}{2F}$

   $D_{A2} = \frac{4mv_{A1}^2}{2F}$

   In other words:

   $D_{A2} = 4D_{A1}$

   The displacement of the new arrow is **4 times greater** compared to the original arrow.
2. Using the equation $KE = \frac{1}{2}mv^2, W = \Delta KE$ and $W = FD$:

   $A \rightarrow B: FD = \frac{1}{2}mv_1^2$

   $B \rightarrow C: FD = \Delta KE = (\frac{1}{2}mv_2^2) - (\frac{1}{2}mv_1^2)$

   Substitute *FD* with $\frac{1}{2}mv_1^2$

   $\frac{1}{2}mv_1^2 = (\frac{1}{2}mv_2^2) - (\frac{1}{2}mv_1^2)$

   $2(\frac{1}{2}mv_1^2) = \frac{1}{2}mv_2^2$

   $2v_1^2 = v_2^2$

   $v_2 = v_1\sqrt{2}$

   It will be **less than 2v** because $\sqrt{2} < 2$
3. Using the equation $F = ma$, $x = x_0t + \frac{1}{2}at^2$ and $W = FD$:

   $D = \frac{1}{2}(2)(7)^2 = 49$

   $F = (5)(2) = 10$

   $W = FD = 490J$

   The net work done on the box is **490 joules**
4. Using the equation $W = \Delta KE$, $W = FD$ and $KE = \frac{1}{2}mv^2$:

   $F = 100N$, $D = 78cm = 0.78m, m = 88g = 0.088kg$

   $110(0.78) = \frac{1}{2}(0.088)v^2$

   $171.6J = 0.088 \times v^2$

   $v^2 = 1950$

   $v = 5\sqrt{78} \approx 44.1588$

   The initial launch speed is ~**44.16 m/s**
5. A. **2200 Joules**

   B. **1600 Joules**

6. B > C = D > A
7. C > B > A = D
8. D > A = B > C
9. A. Greater than 0
   B. Must be 0
   C. Less than 0
   D. Less than 0
   E. Greater than 0
10. The one thrown **vertically upwards** will hit the ground with the largest velocity. When you throw the balloon upwards, the balloon will come pass you with the same velocity you threw it up with (energy is not lost when this happens with no air res, etc.) When you throw the balloon upwards, all of the energy goes towards the vertical axis. When you throw horizontally, the balloon goes down with no initial velocity, thus making it hit the ground with the least velocity.
11. A. We use the equations $W = \Delta KE$, $W = FD$, $PE = mgy$ and $KE = \frac{1}{2}mv^2$

    $\frac{1}{2}mv_2^{\ 2} = \frac{1}{2}mv_1^{\ 2} + mgh_1$

    $\frac{65}{2}v_2^{\ 2} = \frac{65\times5^2}{2} + (65 \times 9.8 \times 3)$

    $v_2 = 9.154\frac{m}{s^2}$

    B. We use the equations $PE = kx^2$, $PE = mgy$ and $KE = \frac{1}{2}mv^2$

    $\frac{1}{2}mv_2^{\ 2} + mgh_2 = \frac{1}{2}kh_2^{\ 2}$

    $\frac{65\times9.154^2}{2} + 65 \times 9.8 \times h_2 = \frac{6.2\times10^4}{2}h_2^{\ 2}$

    $h_2 = 0.306m$
12. We use the equations $KE = \frac{1}{2}mv^2$ and $PE = mgy$

    $v_x = v \times cos(\theta) = 130.815$

    $v_y = v \times sin(\theta) = 130.815$

    $\frac{1}{2}mv_y^{\ 2} + mgh = \frac{1}{2}mv_{2y}^{\ 2}$

    $\frac{1}{2}v_y^{\ 2} + gh = \frac{1}{2}v_{2y}^{\ 2}$

    $v_{2y} = 149.354\frac{m}{s^2}$

    v_x does not change because it is the horizontal component during launch

    $v = \sqrt{v_x^{\ 2} + v_y^{\ 2}} = 198.543\frac{m}{s^2}$
13. The **same**, this is because of the law of conservation of energy. $mgy = \frac{1}{2}mv^2 \rightarrow gh = \frac{1}{2}v^2$ .The only thing that is able to change is height, and height is the same for both people. $g$is also a constant, so only h may determine v
14. A.

    Using the equation $PE = mgy$ and $PE = \frac{1}{2}kx^2$

In this case $x = y$, let's name it h

$mgh = \frac{53}{2}h^2$

$h \approx 0.9245m = 92.4cm$

$107.4cm = 92.4cm + 15cm$ (offset)

104.4 cm

B.

$PE_{elastic} = \frac{1}{2} \times 53 \times 0.9245^2 = 22.6496J$

22.65 J

15. A. U_s

    B. $U_s \& K$

    C. K

    D. U_g

16. We use the equations $KE = \frac{1}{2}mv^2$, $W = \Delta KE$ and $W = FD$:

$F_{fr} = \mu_k F_N$

$F_{fr} = \mu_k mg = 323.4$

$FD = \frac{1}{2}mv_1^2$

$350N \times 15m = \frac{1}{2} \times 110kg \times v_1^2$

$v_1 = 9.77\frac{m}{s}$

$(F - F_{fr})D = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

$v_2 = 10.1345\frac{m}{s}$

17. A.

Using the equations $PE = mgy$ and $KE = \frac{1}{2}mv^2$:

$mgy = \frac{1}{2}mv^2$

$0.145kg \times 9.8 \times 13 = \frac{0.145}{2}v^2$

$v \approx 15.962\frac{m}{s}$

B.

Using the equations $W = FD$, $PE = mgy$ and $W = \Delta KE$

$mgy - \frac{1}{2}mv^2 = FD$

$F = 1.064N$

18. Using the equation $P = \frac{W}{t}$

We will need to find θ, so the equation will be:

$0 = F_C - (F_{fr} + sin(\theta)mg) \rightarrow \theta = sin^{-1}(\frac{F_C - F_{fr}}{mg})$

$mg = 1200 \times 9.8 = 11760N$

$W_C = 120 \times 746 = 89520\frac{J}{s}$

$F_C = \frac{W_C}{D} = \frac{89520\frac{J}{s}}{20.8\frac{m}{s}} = 4303.85N$

$\theta = sin^{-1}(\frac{4303.85N - 650N}{11760N}) \approx 18.1$

19. Use the equations: $KE = \frac{1}{2}mv^2$, $W = \Delta KE$ and $P = \frac{W}{t}$

$P = \frac{\frac{1}{2}mv^2}{t}$

$P = \frac{\frac{1}{2}(7.3kg)(14\frac{m}{s})^2}{1.5s} = 476.933W$