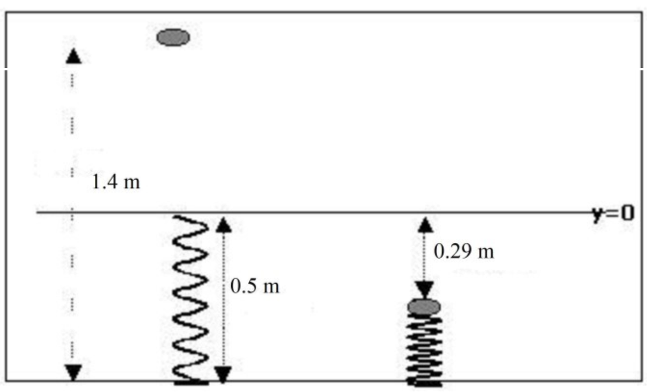
Physics Unit 6: Energy Review

1. Know about work, power, kinetic energy, gravitational potential energy, spring potential energy, Law of Conservation of Energy, simple machines, ideal mechanical advantage, efficiency, which human systems use more energy, where most of our energy comes from
2. Kelly is cutting the grass using a human-powered lawn mower. He pushes the mower with a force of 50 N directed at an angle of 35° below the horizontal direction. Calculate the work that Kelly does on the mower in pushing it 25 m across the yard.
3. A warehouse worker uses a forklift to lift a pallet of veggie dogs on a platform to a height 5 m above the floor. The combined mass of the platform and the pallet is 200 kg. If the power expended by the forklift is 1500 W, how long does it take to lift the pallet?
4. What power is needed to lift a 6000-kg elephant a vertical distance of 2 m in 30 s?
5. A 0.624-kg basketball is 3 m in the air and traveling at 5 m/s. What is the kinetic energy of the ball?
6. A 500-kg car is lifted vertically 3 meters from the surface of the earth. What is the change in the gravitational potential energy of the car?
7. A 0.624-kg basketball is 3 m in the air and traveling at 5 m/s. What is the potential energy of the ball?
8. A spring stores 50 J of energy when compressed 2 cm. What is its spring constant?
9. An engineer is asked to design a playground slide such that the speed a child, starting from rest, reaches at the bottom does not exceed 3 m/s. Determine the maximum height that the slide can be. Ignore friction.
10. A 0.80-kg hockey puck was tipped straight up at 20 m/s. How fast is it going when it accidently hits the scoreboard at 5 m above?
11. A ball of mass 0.5-kg is dropped from a height of 1.4 m (from the ground) onto a massless spring (the spring has an equilibrium length of 0.5 m). The ball compresses the spring by an amount of 0.29 m by the time it comes to a stop. Calculate the spring constant of the spring.



12. Imagine that the stone David used against Goliath has a mass of 0.50 kg and was launched at 20.0 m/s from a height of 1.20 m. How much energy did air resistance absorb if the stone was moving at 18.8 m/s when it hit Goliath's forehead at 2.0 m above the ground?
13. The kinetic energy of a car is 2×10^6 J as it travels along a horizontal road. How much work is required to stop the car in 15 s?
14. What is the ideal mechanical advantage of a pulley supporting the load with 5 ropes?
15. If the ideal mechanical advantage of an inclined plane is 2.25 and the height of the inclined plane is 1.5 m, what is the length of the inclined plane?

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Answers

2. $W = Fd\cos\theta$

   $W = (50\ N)(25\ m)\cos 35°$

   $\boldsymbol{W = 1020\ J}$

3. $P = \frac{W}{t}$

   $W = PE = mgh$

   $1500\ W = \frac{(200\ kg)\left(9.8\frac{m}{s^2}\right)(5\ m)}{t}$

   $t(1500\ W) = 9800\ J$

   $\boldsymbol{t = 6.53\ s}$

4. $P = \frac{W}{t}$

   $W = PE = mgh$

   $P = \frac{(6000\ kg)\left(9.8\frac{m}{s^2}\right)(2\ m)}{30\ s}$

   $\boldsymbol{P = 118{,}000\ W}$

5. $KE = \frac{1}{2}mv^2$

   $KE = \frac{1}{2}(0.624\ kg)\left(5\frac{m}{s}\right)^2$

   $\boldsymbol{KE = 7.8\ J}$

6. $PE = mgh$

   $PE = (500\ kg)\left(9.8\frac{m}{s^2}\right)(3\ m)$

   $\boldsymbol{PE = 14{,}700\ J}$

7. $PE = mgh$

   $PE = (0.624\ kg)\left(9.8\frac{m}{s^2}\right)(3\ m)$

   $\boldsymbol{PE = 18.3\ J}$

8. $PE_{spring} = \frac{1}{2}kx^2$

   $50\ J = \frac{1}{2}k(0.02\ m)^2$

   $\boldsymbol{k = 250{,}000\frac{N}{m}}$

9. $E_0 + W = E_f$

   External work is zero

   $PE_0 = KE_f$

   $mgh_0 = \frac{1}{2}mv_f^2$

   $gh_0 = \frac{1}{2}v_f^2$

   $\left(9.8\frac{m}{s^2}\right)h_0 = \frac{1}{2}\left(3\frac{m}{s}\right)^2$

   $\boldsymbol{h_0 = 0.459\ m}$

10. $E_0 + W = E_f$

    External work is zero

    $KE_0 = PE_f + KE_f$

    $\frac{1}{2}mv_0^2 = mgh_f + \frac{1}{2}mv_f^2$

    $\frac{1}{2}v_0^2 = gh_f + \frac{1}{2}v_f^2$

    $\frac{1}{2}\left(20\frac{m}{s}\right)^2 = \left(9.8\frac{m}{s^2}\right)(5\ m) + \frac{1}{2}v_f^2$

    $200\ J = 49\ J + \frac{1}{2}v_f^2$

    $151\ J = \frac{1}{2}v_f^2$

    $302\ J = v_f^2$

    $\boldsymbol{v_f = 17.4\frac{m}{s}}$

11. $E_0 + W = E_f$

    External work is zero

    $PE_0 = PE_f + PE_{spring}$

    $mgh_0 = mgh_f + \frac{1}{2}kx^2$

    $(0.5\ kg)\left(9.8\frac{m}{s^2}\right)(1.4\ m) = (0.5\ kg)\left(9.8\frac{m}{s^2}\right)(0.5\ m - 0.29\ m) + \frac{1}{2}k(0.29\ m)^2$

    $6.86\ J = 1.029\ J + (0.04205\ m^2)k$

    $5.831\ J = (0.04205\ m^2)k$

    $\boldsymbol{k = 139\frac{N}{m}}$

12. $E_0 + W = E_f$

    External work is from air resistance ≠ 0

    $PE_0 + KE_0 + W_{air} = PE_f + KE_f$

    $mgh_0 + \frac{1}{2}mv_0^2 + W_{air} = mgh_f + \frac{1}{2}mv_f^2$

    $(0.5\ kg)\left(9.8\frac{m}{s^2}\right)(1.20\ m) + \frac{1}{2}(0.5\ kg)\left(20\frac{m}{s}\right)^2 + W_{air} = (0.5\ kg)\left(9.8\frac{m}{s^2}\right)(2\ m) + \frac{1}{2}(0.5\ kg)\left(18.8\frac{m}{s}\right)^2$

    $105.88\ J + W_{air} = 98.16\ J$

    $\boldsymbol{W_{air}} = -7.72\ J$ or $\boldsymbol{7.72\ J}$

13. $E_0 + W = E_f$

    $KE_0 + W = 0$

    $2 \times 10^6\ J + W = 0$

    $\boldsymbol{W = -2 \times 10^6\ J}$

14. $\boldsymbol{IMA} = N = \boldsymbol{5}$

15. $IMA = \frac{L}{h}$

    $2.25 = \frac{L}{1.5\ m}$

    $\boldsymbol{L = 3.38\ m}$