Energy worksheet

1. A dog pulls a 40 kg wagon with a force of 300 N over distance of 50 m. How much work was done by the dog?

$$W = Fs \qquad W = 300 \times 50 = 15000\ J$$

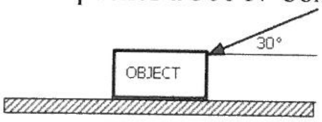
2. In order to insert a nerf dart into a toy gun, 50 J of energy needed to be used. If the dart was inserted 6 cm, then how much force was required to install the nerf dart?

$$F = \frac{W}{s} \qquad F = \frac{50}{0.06} = 833.3\ N$$

3. A bicyclist did 30,000 J of work while traveling with a force of 10,000 N. How much distance was covered by the bicyclist?

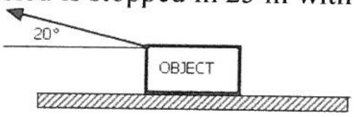
$$s = \frac{W}{F} \qquad s = \frac{30000}{10000} = 3\ m$$

4. A box is pushed by a 600 N force that acts at a 30° angle with the ground. The force pushes a 500 N box 10 meters from rest. How much work is done?



$$W = Fs\cos\theta \qquad W = 600 \times 10 \cos 30^\circ = 5196\ J$$

5. A 175 kg bob-sled is stopped by a force applied at a 20° angle with the ground. The sled is stopped in 25 m with 800 J of work. What is the magnitude of the force?



$$W = Fs\cos\theta \qquad F = \frac{W}{s\cos\theta} \qquad F = \frac{800}{25\cos 20^\circ} = 34\ N$$

6. What is the kinetic energy of a 80 kg football player running at 8 m/s?

$$E_K = \frac{mv^2}{2} \qquad E_K = \frac{80 \times 8^2}{2} = 2560\ J$$

7. How fast must a 0.0050 kg bullet travel if it is to have the same kinetic energy as a 20,000 kg locomotive traveling at 2 m/s?

$$E_K = \frac{20000 \times 2^2}{2} = 40000\ J \qquad v = \sqrt{\frac{2E_K}{m}}$$

$$v = \sqrt{\frac{2 \times 40000}{0.005}} = 4000\ ms^{-1}$$

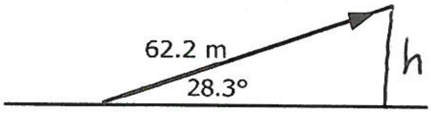
8. A 7.3 kg gallon paint can is lifted 1.78 meters vertically to a shelf. What is the change in potential energy of the paint can?

$$E = mgh$$

$$E = 7.3 \times 9.8 \times 1.78$$

$$= 127.3\ J$$

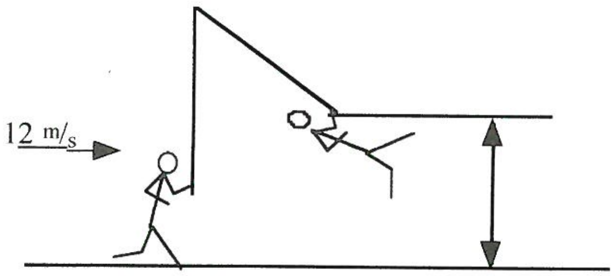
9. A car coasts 62.2 meters along a hill that makes a 28.3° angle with the ground. If the car's mass is 1234 kg, then what is the change in potential energy?



$h = 62.2 \sin(28.3°) = 29.5$

$W = mgh = 1234 \times 9.8 \times 29.5 = 356.75\,J$

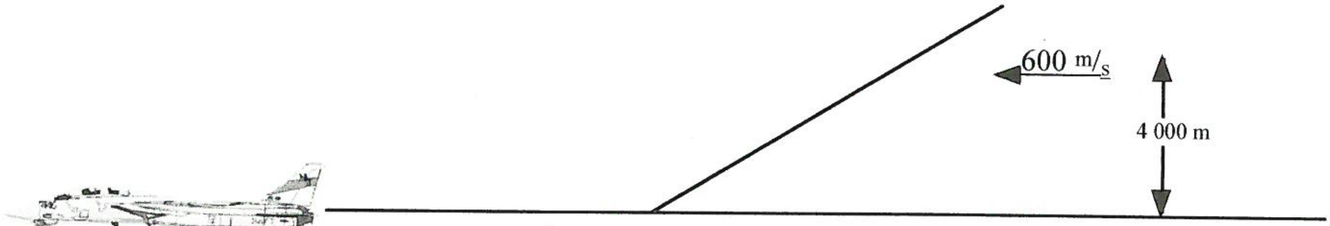
10. What is the highest height Tarzan can travel to given the information below?



$\frac{mv^2}{2} = mgh$

$h = \frac{v^2}{2g}$ $h = \frac{12^2}{2 \times 9.8} = 7.86\,m$

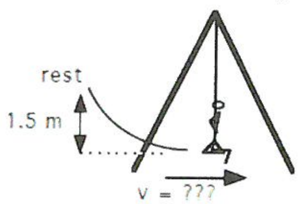
11. What is the jet's new velocity if it coasts to its new, lower, altitude?



$\frac{mu^2}{2} + mgh = \frac{mv^2}{2}$ $v^2 = 600^2 + 2 \times 9.8 \times 4000 = 438400$

$v = 662.1\,ms^{-1}$

12. What is the velocity of the rider at the bottom of the swing?

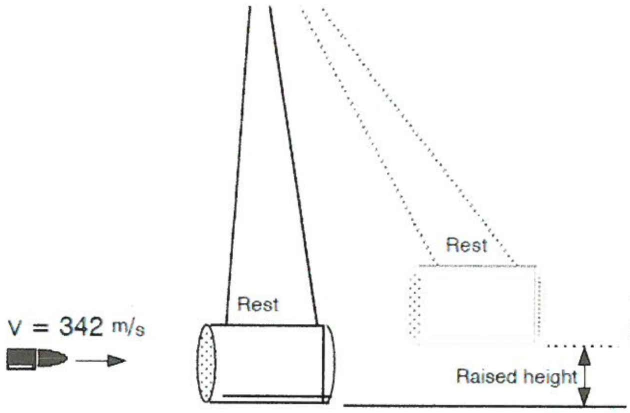


$mgh = \frac{mv^2}{2}$

$v = \sqrt{2gh}$

$v = \sqrt{2 \times 9.8 \times 1.5} = 5.4\,ms^{-1}$

13. A bullet is shot into a can filled with 19.88 kg of clay. The filled can is tied to the end of a string so that it can act like a pendulum. The bullet (mass = 0.012 kg) is traveling 342 m/s before it impacts the clay filled can. The bullet passes through the can. The bullet exits the back of the can at 325 m/s.
What is the maximum height of the can?

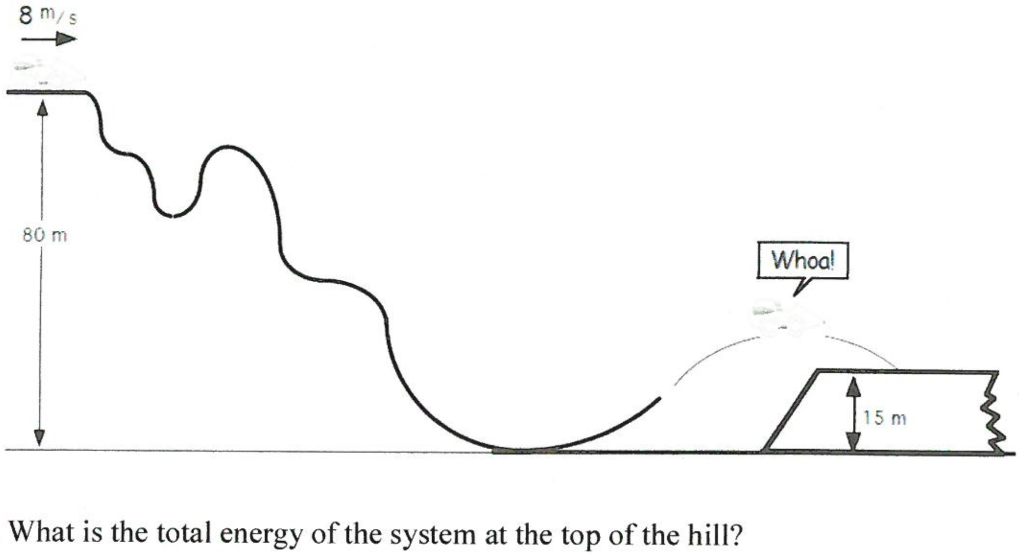


$$\frac{mu^2}{2} = \frac{mv^2}{2} + Mgh$$

$$\frac{0.012 \times 342^2}{2} = \frac{0.012 \times 325^2}{2} + 19.88 \times 9.8\,h$$

$$68 = 19.88 \times 9.8\,h \qquad h = 0.35\ m$$

This information is related to questions 14 - 17
A roller coaster car, 500 kg, is to travel from 8 m/s down a wavy hill. It will coast without friction. Near the end of the ride it will make a death defying jump.



14. What is the total energy of the system at the top of the hill?

$$E_{tot} = \frac{mu^2}{2} + mgh$$

$$E = \frac{500 \times 8^2}{2} + 500 \times 9.8 \times 80 = 408000\ J$$

15. What is the total energy of the system at the bottom of the hill?

408000 J

16. What is the speed of the cat at the bottom of the hill?

$\frac{mv^2}{2} = 408000 \quad v = \sqrt{\frac{2 \times 408000}{500}} = 40.4\ ms^{-1}$

17. What is the speed of the car after landing on the 15 m hill?

$\frac{mv^2}{2} + mgh = 408000 \quad \frac{500v^2}{2} + 500 \times 9.8 \times 15 = 408000$

$v^2 = 1602.6 \quad v = 40\ ms^{-1}$

18. A 1500 kg does 20,000 J of work when it accelerates across 200 m. The car starts from 20 m/s before traveling the 200 m. What is the final velocity of the car?

$W = FS$

$F = \frac{W}{S}$

$F = \frac{20000}{200} = 100\ N$

$a = \frac{F}{m}$

$a = \frac{100}{1500} = 0.07\ ms^{-2}$

$v^2 = u^2 + 2as$

$v^2 = 20^2 + 2 \times 0.07 \times 200$

$v^2 = 428$

$v = 20.7\ ms^{-1}$

19. A bullet, 10 g, is shot through a piece of wood. The bullet enter the wood at 600 m/s. The wood is 5 cm thick. The wood exerts 10,000 N of force to slow the bullet down. How fast is the bullet traveling when it leaves the piece of wood on the opposite side?

$\frac{mu^2}{2} = \frac{mv^2}{2} + W$

$W = FS$

$W = 10\,000 \times 0.05 = 500\ J$

$\frac{0.01 \times 600^2}{2} = \frac{0.01 v^2}{2} + 500$

$1800 = \frac{0.01 v^2}{2} + 500$

$1300 = \frac{0.01 v^2}{2}$

$v^2 = 260000$

$v = 509.9\ ms^{-1}$

20. What is the potential energy of a spring that is compressed 0.53 meters from equilibrium if the spring constant is 219 N/m?

$W = \frac{kx^2}{2} \quad W = \frac{219 \times 0.53^2}{2} = 30.76\ J$

21. What is the spring constant of a spring that is stretched 34.2 centimeters if 1298 J of energy is used to stretch the spring?

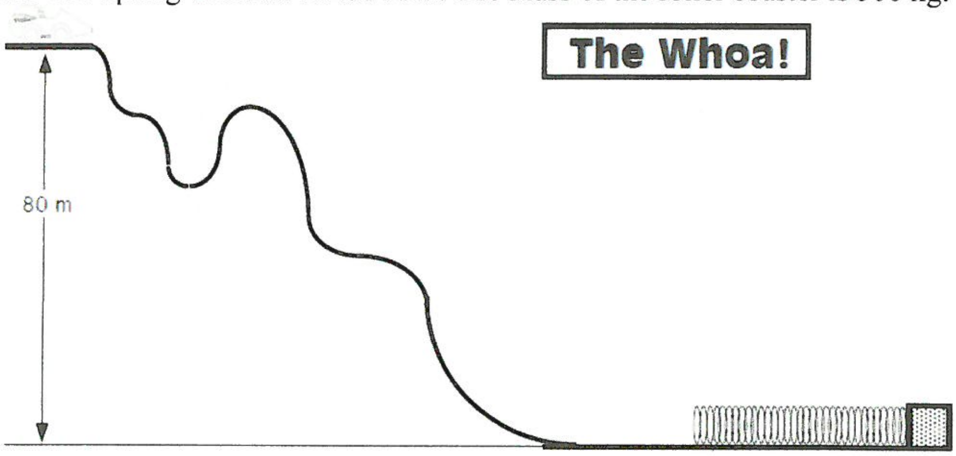
$k = \frac{2W}{x^2} \quad k = \frac{2 \times 1298}{0.342^2} = 22195\ Nm^{-1}$

22. What is the stretched distance of spring with a spring constant of 12.5 N/m if the spring uses 127 J?

$W = \frac{Kx^2}{2}$ $\quad x = \sqrt{\frac{2 \times 127}{12.5}} = 4.51\ m$

$x = \sqrt{\frac{2W}{K}}$

This information is related to questions 23 - 29
A roller coaster car is to travel from rest down a wavy hill. Then it will coast without friction into the spring. The roller coaster will compress the spring until it comes to rest. The spring constant is 200 N/m. The mass of the roller coaster is 500 kg.



23. What is the total energy of the system at the top of the hill?

$W = mgh \quad W = 500 \times 9.8 \times 80 = 392000\ J$

24. What is the total energy of the system at the bottom of the hill?

392 000 J

25. What is the total energy of the system before it hits the spring?

392 000 J

26. What Is the total energy of the system when the spring is completely compressed?

392 000 J

27. What is the speed of the car at the bottom of the hill?

$\frac{mv^2}{2} = mgh \quad v = \sqrt{2gh} \quad v = \sqrt{2 \times 9.8 \times 80} = 39.6\ ms^{-1}$

28. What is the speed of the car before it hits the spring?

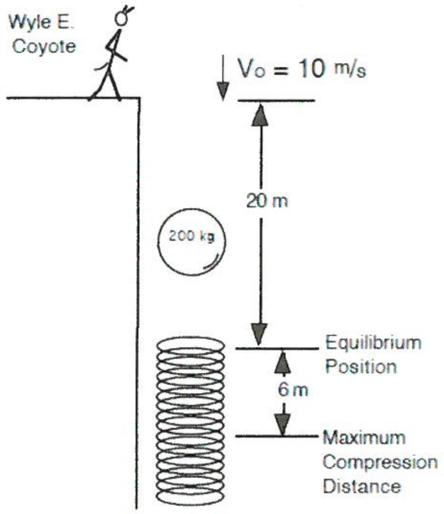
$39.6\ ms^{-1}$

29. What is the maximum distance the spring is compressed?

$\frac{Kx^2}{2} = 392000$

$x = \sqrt{\frac{2 \times 392000}{200}} = 62.6\ m$

This information is related to questions 30 – 32
Wyle E. Coyote is still trying to catch that road runner -when will he learn? As part of this new ACME trap he throws a ball down on a spring as shown.



30. What is the velocity of the ball the instant it makes contact with the spring?

$$\frac{mv^2}{2} = \frac{mu^2}{2} + mgh \qquad v = \sqrt{u^2 + 2gh}$$

$$v = \sqrt{10^2 + 2 \times 9.8 \times 20} = 22.2\ ms^{-1}$$

31. What is the spring's spring constant?

$$\frac{mu^2}{2} + mgh = \frac{kx^2}{2} \qquad \frac{200 \times 10^2}{2} + 200 \times 9.8 \times 26 = \frac{k \times 6^2}{2}$$

$$18k = 60960$$

$$k = 3387\ Nm^{-1}$$

32. How fast is the ball traveling when the spring is compressed 2 meters from the equilibrium position of the spring?

$$\frac{mu^2}{2} + mgh = \frac{kx^2}{2} + \frac{mv^2}{2}$$

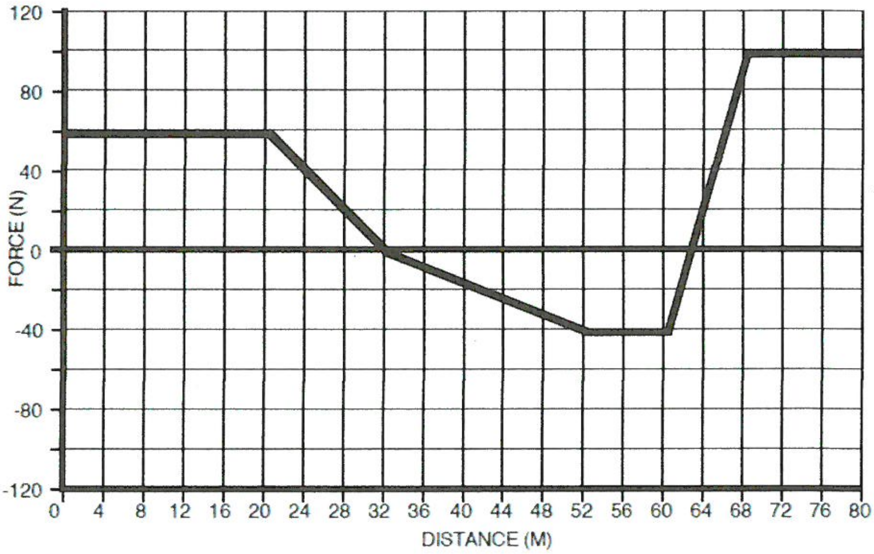
$$\frac{200 \times 10^2}{2} + 200 \times 9.8 \times 22 = \frac{3387 \times 2^2}{2} + \frac{200 v^2}{2}$$

$$100 v^2 + 6774 = 53120$$

$$v^2 = 463.5$$

$$v = 21.5\ ms^{-1}$$

This information is related to questions 33 – 35



33. What is the work done over the first 12 meters?

$W = 60 \times 12 = 720\ J$

34. What is the work done over the first 32 meters?

$W = \frac{20 + 32}{2} \times 60 = 1560\ J$

35. What is the work done over the first 52 meters?

$1560 - \frac{1}{2} 16 \times 40 = 1240\ J$

36. A student lifts a bucket with a 98 N force in 30 seconds out of a well. If the bucket is lifted 30 m then;

(a) How much work is done on the bucket by the student?

$W = FS \quad W = 98 \times 30 = 2940\ J$

(b) How much power is exerted by the student?

$P = \frac{W}{t} \quad P = \frac{2940}{30} = 98\ W$