Name: KEY

Date: _____ Block: ____

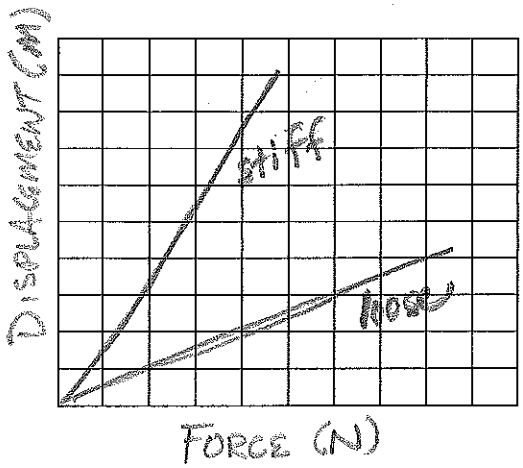
Energy Review Sheet

Elastic (Spring) Potential Energy (E_s)

1. What is the formula for finding elastic potential energy?

$E_S = \frac{1}{2}k(\Delta x)^2$

2. Sketch the graph of force vs. displacement for a stiff (large spring constant) spring and a loose (small spring constant) spring. Label each spring and explain your reasoning.



3. If the force to stretch a spring is given as F = (100 N/m)Δx, What is k? What is the potential energy of the spring if it is stretched 2 meters from rest?

$k = 100$

$E_S = \frac{1}{2}k(\Delta x)^2$

$= \frac{1}{2}(100)(2)^2$

$= 50(4)$

$= 200\ J$

4. A cart with 1000 J of energy crashes into a spring with a spring constant of 100 N/m. How far does the spring compress?

$E_S = 1000\ J$

$k = 100\ N/m$

$\Delta x = ?$

$E_S = \frac{1}{2}k(\Delta x)^2$

$1000 = \frac{1}{2}(100)(\Delta x)^2$

$1000 = 50(\Delta x)^2$

$\sqrt{20} = \sqrt{(\Delta x)^2}$

$\Delta x = 4.47\ m$

Gravitational Potential Energy (E_g)

5. What is the formula for finding gravitational potential energy?

$E_g = mgh$

6. A 70 kg climber with a 30 kg pack climbs 1234 m to the top of Mount Fraser. What is the climber's gravitational potential energy with his pack on?

$m = 70\ kg + 30 = 100\ kg$

$h = 1234\ m$

$E_g = ?$

$g = 9.8$

$E_g = mgh = (100)(1234)(9.8)$

$= 1,209,320\ J$

7. The volcano, Volcán Chimborazo, is 6267m above sea level. If a mountain climber with a mass of 85 kg reaches the mountain's peak, what is the gravitational potential energy associated with the climber with respect to sea level.

$m = 85\,kg$
$g = 9.8\,m/s^2$
$h = 6267m$

$E_g = mgh$
$= (85)(9.8)(6267)$
$= 5,220,411\,J$

8. A 90 kg astronaut is standing on the tallest mountain on the moon; Mons Huygens, 4700m tall. If the astronaut has 685260 J of gravitational potential energy while standing there, what is the acceleration due to gravity on the moon?

$m = 90kg$
$h = 4700m$
$E_g = 685,260\,J$
$g_{moon} = ?$

$E_g = mgh$
$\frac{E_g}{mh} = g = \frac{685,260}{(90)(4700)} = \frac{685,260}{423,000} = 1.62\,m/s^2$

Kinetic Energy (E_k)

9. What is the formula for finding kinetic energy?

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

10. What is the kinetic energy of a 0.2 kg softball thrown at 30 m/s?

$E_k = ?$
$m = .2kg$
$v = 30\,m/s$

$E_k = \frac{1}{2}mv^2$
$= \frac{1}{2}(.2)(30)^2$
$= (.1)(30)^2$
$= (.1)(900)$
$= 90\,J$

11. The kinetic energy of a 1600-kg truck is 5.2×10^5 J. What is the speed of the truck?

$E_k = 5.2 \times 10^5\,J$
$m = 1600kg$
$v = ?$

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

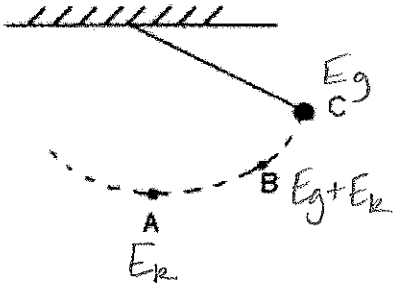
$v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2(5.2 \times 10^5)}{1600}}$
$= \sqrt{650} = 25.50\,m/s$

12. What type of energy does a wound watch spring possess?

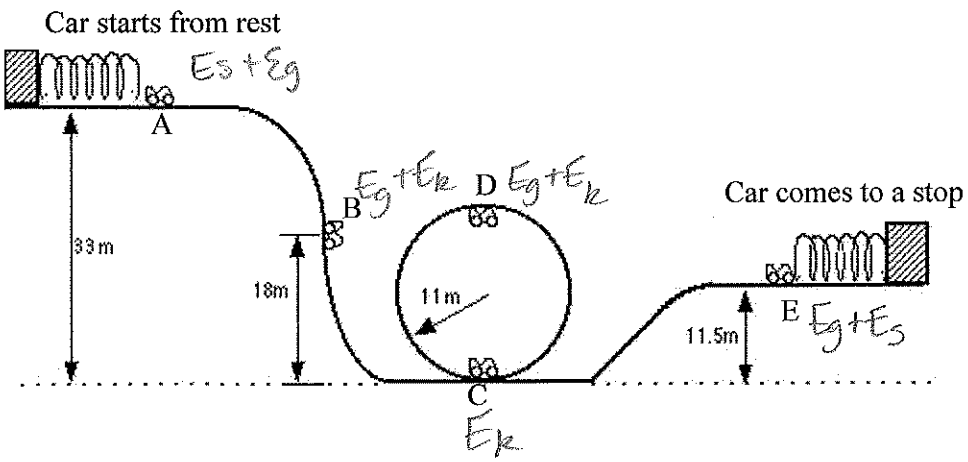
E_s

13. Label the types of energy (K, E_g, E_s) at each point in the following diagrams.

a)

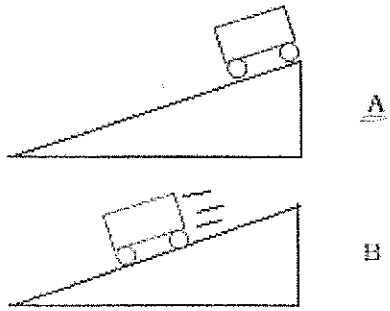


b)



Conservation of Energy ($E_{ki} + E_{gi} + E_{si} + W_{in} = E_{kf} + E_{gf} + E_{sf} + W_{out} + W_f$)

14. A 40 kg cart rolls down a frictionless ramp that is 50 m tall.



a) What is the gravitational potential energy at the top of the hill (at point A)?

$E_g = mgh = (40)(9.8)(50m)$
$= 19{,}600\,J$

b) What is the gravitational potential energy when the cart is 25 m above the ground (as seen at point B)?

$E_T = 19{,}600$
$h = 40$
$g = 9.8$
$h = 25$

$E_g = mgh$
$= (40)(9.8)(25)$
$= 9800\,J$

c) What is the kinetic energy at point B?

$E_{T_B} = E_g + E_k$ $\quad E_T - E_g = E_k = 19{,}600 - 9800 = 9800\,J$

d) What is the gravitational potential energy at the bottom of the hill?

$h = 0$ so $E_g = 0$

e) What is the kinetic energy the cart has at the bottom of the hill?

$E_{T_C} = E_k = 19{,}600\,J$

f) What is the velocity of the cart at the bottom of the hill?

$E_k = \frac{1}{2}mv^2$ $\quad v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2(19{,}600)}{40}} = \sqrt{980} = 31.3\ m/s$

15. The total energy of the system is
    a) increasing
    b) decreasing
    c) remains the same
    d) zero at point A
    e) constantly changing

16. A person of mass 64 kg climbs up a ladder to a height of 5.0 meters.

a.) What work does the person do?

$W = F\Delta x = mg\Delta x$

$= (64)(9.8)(5) = 3,136\ J$

b.) What is the increase in the gravitational potential energy of the person at this height?

3,136 J

c.) Where does the energy come from to cause this increase in potential energy?

increase in height.

17. A 4kg block slides across a frictionless table with a velocity of 5m/s into a spring with a stiffness of 2500N/m. How far does the spring compress to stop the block?

$E_S = \frac{1}{2}k(\Delta x)^2$

$50\ J = \frac{1}{2}(2500)(\Delta x)^2$

$50 = 1250(\Delta x)^2$

$.04 = \Delta x^2$

$.2 = \Delta x$

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

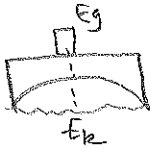
$= \frac{1}{2}(4)(5)^2$

$= 2(25)$

$= 50\ J$

18. A partially filled bag of cement having a mass of 16.0 kg falls 40.0 meters into a river from a bridge.

a.) What is the kinetic energy of the bag as it hits the water?



$E_{g_T} = E_{k_B}$

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

$(16)(9.8)(40) = \frac{1}{2}(16)(v^2)$

$6,272 = 8v^2$

$784 = v^2$

$\sqrt{v^2} = \sqrt{784}$

$= 28\ m/s$ ← b

b.) Using Conservation of Energy only, what vertical speed does it have?

Power

19. Two people of the same mass climb the same flight of stairs. The first person climbs the stairs in 25 seconds. The second person takes 35 seconds. Which person does the most work? Which person expends the most power? Explain your answers.

$W = F\Delta x$ $P = \frac{W}{t}$

Work is Same!

The person who does it in 25 seconds expends more power because he completes the task in less time. As t increases, P decreases.

20. A box that weighs 1000 Newtons is lifted a distance of 20.0 meters straight up by a rope and pulley system. The work is done in 10.0 seconds. What is the power developed in watts *and* kilowatts?

$P = \frac{F\Delta x}{t} = \frac{(1000)(20\text{m})}{10\text{ s}} = 2000\text{ W} \left| \frac{1\text{ kW}}{1000\text{ W}} \right. = 2\text{ kW}$

Work

21. A student walks at constant speed from 15 Mile and Garfield to 15 Mile and Hayes. She applies a constant force of 200 N. The distance traveled is 1 mile West.
How much work did the student do?

$W = F\Delta x$

$= (200)(1600)$

$= 320{,}000\text{ J}$

$1\text{ mi} \left| \frac{1.6\text{ km}}{1\text{ mi}} \right| \frac{1000\text{ m}}{1\text{ km}} = 1600\text{ m}$

22. Ben Travlun carries a 200-N suitcase up three flights of stairs (a height of 10.0 m) and then pushes it with a horizontal force of 50.0 N at a constant speed of 0.5 m/s for a horizontal distance of 35.0 meters. How much work does Ben do on his suitcase during this entire motion?

$W_{up} = F\Delta x$

$= (200\text{N})(10\text{m}) = 2000\text{ J}$

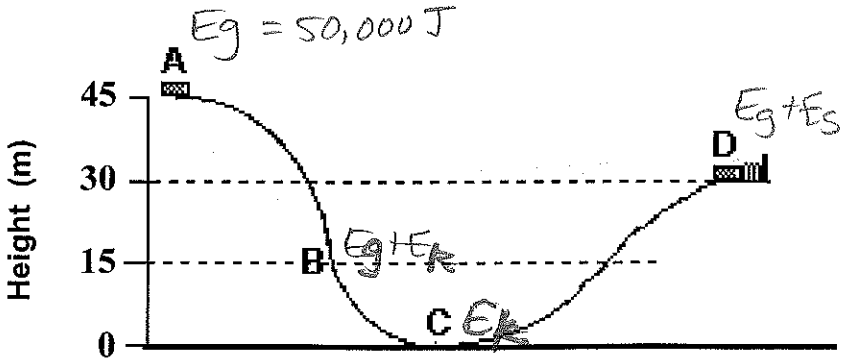
$W_{Horz} = F\Delta x$

$= (50\text{N})(35\text{m})$

$= 1750\text{ J}$

$W_T = 2000 + 1750 = 3750\text{ J}$

A car at rest has **50,000 J** of Potential Energy at point **A**. It moves down a ***frictionless*** track and comes to a stop as it compresses a huge spring at point **D**. The car has a mass of 150 kg. *Consider the car, spring and the earth to be in the system.



23. How fast is the car moving at point **C**? Show work.

$E_T = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2E_T}{m}} = \sqrt{\frac{(2)(50{,}000)}{150}} = \sqrt{666.7} = 25.82\ m/s$

24. What is the gravitational potential energy at point B?

$E_{g_B} = mgh$
$= (150)(9.8)(15)$
$= 22{,}050\ J$

25. What is the kinetic energy at point B?

$E_T = E_g + E_k$
$E_k = E_T - E_g$
$= 50{,}000 - 22{,}050$
$= 27{,}950\ J$

26. What is the gravitational potential energy at point D?

$E_g = mgh$
$= (150)(9.8)(30)$
$= 44{,}100\ J$

27. What is the elastic potential energy at point D?

$E_T = E_g + E_s$
$E_s = E_T - E_g$
$= 50{,}000 - 44{,}100$
$= 5{,}900\ J$

28. What is the kinetic energy at point D?

$E_{k_D} = 0\ J$

29. How far does the spring (k = 7654 N/m) at point D compress?

$E_s = \frac{1}{2}k(\Delta x)^2$
$\Delta x = \sqrt{\frac{2E_s}{k}} = \sqrt{\frac{2(5{,}900)}{7654}}$
$= \sqrt{1.54} = 1.24\ m$