<u>Chapter Questions</u>

1. A block is suspended from a string; does the gravitational force do any work on it?

2. What is the difference between work done by the gravitational force on descending and ascending objects?

3. A woman climbs up stairs; does she do any work? Does she do any work standing in an ascending elevator?

4. What happens to an object's velocity if there is work done by a friction force? Why?

5. An object is suspended from a spring and is at equilibrium; does the elastic force do any work?

6. It is known that water applies some pressure on a container; does water do any work in this case?

7. What kind of energy does a flying bullet have?

8. A stone is thrown vertically up. What kind of energy did the stone have initially? What happens to this energy as the stone ascends?

9. A steel ball and an aluminum ball of equal volume are located at the same altitude. Which ball has greater gravitational potential energy?

10. What happens to the gravitational potential energy of an object when it moves up? When it moves down?

11. Is it possible for a static friction force to do mechanical work? Give an example?

12. Can kinetic energy ever be negative? Explain.

13. Describe the energy transformation that takes place when a small mass oscillates at the end of a light string.

14. Describe the energy transformations that take place when a small mass oscillates at the end of an elastic spring.

15. An elevator is lifted vertically upwards at a constant speed. Is the net work done on the elevator negative, positive, or zero? Explain.

16. Can the net work done on an object during a displacement be negative? Explain.

Chapter Problems

Work:
Examples

1. A car engine applies a force of 65 kN, how much work is done by the engine as it pushed a car a distance of 75 m?

2. A force does 30000 J of work along a distance of 9.5 m. Find the applied force.

3. How high can a 40 N force move a load, when 395 J of work is done?

4. How much work is required to lift a 500 kg block 12 m?

Class Work

5. A 60 N force is applied over distance of 15 m. How much work was done?

6. A railroad car is pulled through the distance of 960 m by a train that did 578 kJ of work during this pull. How much force did the train supply?

7. A boy pulls a sled at a constant speed 0.6 m/s by applying a force of 350 N. How much work will be done during 1800 s?

Homework

8. A light plane travels a distance of 150 m along a runway before takeoff. Find the work done by the plane engine if it is applying a force of 13500 N.

9. A horse pulls a carriage by applying 450 N of force. Find the traveled distance if the horse did 89 kJ of work.

10. A truck travels at a constant speed of 45 m/s. How much work did the truck engine do during a 2 hour period if it supplied a force of 25 kN of force.

11. Airflow lifts a 3.6 kg bird 50 m up. How much work was done by the flow?

Gravitational Potential Energy (GPE):
Examples

12. A 2.4 kg toy falls from 2 m to 1 m. What is the change in GPE?

13. If (on earth) an object falls 18 m and loses 36 J of GPE. What is the object's mass?

14. A 1 Kg object loses 20 J of GPE as it falls. How far does it fall?

15. A small, 3 kg weight is moved from 5 m from the ground to 8 m. What is the change in potential energy?

Class Work

16. An 80 kg person falls 60 m off of a waterfall. What is her change in GPE?

17. A Gravitational Potential Energy (GPE) Sensor attached to a 12 Kg ball changes from 12 J to 22 J, by height change alone. What is the change in height?

18. A man rides up in an elevator 12 m. He gains 6500 J of gravitational potential energy. What is the man's mass?

19. When a 5 kg rock is dropped from a height of 6 m on Planet X, it loses 24 J of GPE. What is the acceleration due to gravity on Planet X?

Homework
20. What is the gravitational potential energy of a 450 Kg car at the top of a 25 m parking garage?

21. What is the change in gravitational potential energy of a 45 kg weight that is moved from 2 m to 18 m on earth? What is it *on the moon* (g = 1.6 m/s²)?

22. A 0.25 kg book falls off a 2 m shelf on to a 0.5 m chair. What was the change in GPE?

23. A 60 kg girl falls off of a waterfall and loses 10 kJ of GPE. What was her height?

24. When a 0.5 kg rock is dropped from a height of 12 m on Planet Z, it loses 45 J of GPE. What is the acceleration due to gravity on Planet Z?

Kinetic Energy (KE)
Examples
25. How much kinetic energy does an 80 kg man have while running at 1.5 m/s?

26. A bird flies at a speed of 2.3 m/s if it has 14 J of kinetic energy, what is its mass?

27. A child does 12 J of work pushing his 3 kg toy truck. With what velocity does the toy move after the child is done pushing?

Class Work
28. A 6 kg object has a speed of 24 m/s. What is its kinetic energy?

29. A rock hits the ground with a speed of 7 m/s and a kinetic energy of 100 J. What is the rock's mass?

30. A bullet is fired into a 12 kg block of wood. After the bullet stops in the block of wood the block has 29 J of kinetic energy. At what speed is the block moving?

Homework
31. How much kinetic energy does a 4 Kg cat have while running at 9 m/s?

32. What is the mass of an object moving with a speed of 4 m/s and a kinetic energy of 2000 J?

33. A 400 Kg car has 1.8×10^5 J of kinetic energy. How fast is it moving?

34. How fast is a 3 Kg toy car with 20 J of kinetic energy moving?

35. A student runs to physics class with a speed of 6 m/s. If the student has 880 J of kinetic energy, what is her mass?

36. What is the speed of a 1200 kg car moving with a kinetic energy of 15 kJ?

Elastic Potential Energy
Examples
37. A spring with a spring constant of 120 N/m stretches by 0.02 m. What is the potential energy of the spring?

38. An elastic spring stores 45 J of potential energy when it is stretched by 2 cm. What is the spring constant?

39. A 50 N force causes a spring to compress 0.09 m. What is the spring constant? What is the potential energy of the spring?

Class Work
40. An 80 N force causes a spring to compress 0.15 m. What is the spring constant? What is the potential energy of the spring?

41. A spring with a spring constant of 200 N/m stretches by 0.03 m. What is the potential energy of the spring?

42. A spring stores 68 J of potential energy when it is stretched by 6 cm. What is the spring constant?

43. A spring with spring constant 60 N/m has 24 J of EPE stored in it. How much is it compressed?

Homework
44. How much energy is stored in a spring with a spring constant of 150 N/m when it is compressed 2 cm?

45. A spring with spring constant 175 N/m has 20 J of EPE stored in it. How much is it compressed?

46. A spring stores 96 J of potential energy when it is stretched by 5 cm. What is the spring constant?

47. A 0.20 kg mass attached to the end of a spring causes it to stretch 3.0 cm. What is the spring constant? What is the potential energy of the spring?

48. A 5 kg mass, hung onto a spring, causes the spring to stretch 7.0 cm. What is the spring constant? What is the potential energy of the spring?

Mixed Problems
Class Work

49. A 5 kg rock is raised 28 m above the ground level. What is the change in its potential energy?

50. A 65 kg cart travels at constant speed of 4.6 m/s. What is its kinetic energy?

51. What is the potential energy of stretched spring, if the spring constant is 40 N/m and the elongation is 5 cm?

52. A 3.5 kg object gains 76 J of potential energy as it is lifted vertically. Find the new height of the object?

53. A spring has a spring constant of 450 N/m. How much must this spring be stretched to store 49 J of potential energy?

54. A 60 kg runner has 1500 J of kinetic energy. How fast is he moving?

Homework

55. A spring with spring constant 270 N/m has 5 J of energy stored in it. How much is it compressed?

56. A 0.02 kg rock strikes the ground with 0.36 J of kinetic energy. What was its velocity?

57. A woman riding a bicycle has a kinetic energy of 3600 J when traveling at a speed of 12 m/s. What is her mass?

58. On Planet X a 0.5 kg space rock falls a distance of 2.5 meters and loses 20 J of energy. What is the gravity on Planet X?

59. A 50 kg skydiver loses 2400 kJ of energy during a jump. What was her change in height?

60. A child compresses his spring gun 1 cm. If 3 mJ of energy are stored in the spring, what is the spring constant?

61. A stone is thrown vertically up with a speed of 14 m/s, and at that moment it had 37 kJ of kinetic energy. What was the mass of the stone?

Conservation of Energy
Examples

62. A spring gun with a spring constant of 250 N/m is compressed 5 cm. How fast will a 0.025 kg dart go when it leaves the gun?

63. A student uses a spring (with a spring constant of 180 N/m) to launch a marble vertically into the air. The mass of the marble is 0.004 kg and the spring is compressed 0.03 m. How high will the marble go?

64. A student uses a spring gun (with a spring constant of 120 N/m) to launch a marble vertically into the air. The mass of the marble is 0.002 kg and the spring is compressed 0.04 m.
    a. How high will the marble go?
    b. How fast will it be going when it leaves the gun?

65. A roller coaster has a velocity of 25 m/s at the bottom of the first hill. How high was the hill?

Class Work

66. How much work is needed to lift a 3 kg mass a distance of 0.75 m?

67. An arrow is fired vertically upwards by a bow and reaches an altitude of 134 m. Find the initial speed of the arrow on the ground level.

68. A student uses a spring to launch a marble vertically in the air. The mass of the marble is 0.002 kg and when the spring is stretched 0.05 m it exerts a force of 10 N. What is the maximum height the marble can reach?

69. A children's roller coaster is released from the top of a track. If its maximum speed at ground level is 8 m/s, find the height it was released from.

70. A student uses a spring with a spring constant of 130 N/m in his projectile apparatus. When 56 J of potential energy is required to launch the projectile to a certain height, what is the compression in the spring?

71. How much work must be done to accelerate an 8.5 x10^5 kg train: a) from 10 m/s to 15 m/s; b) from 15 m/s to 20 m/s; c) to a stop an initial speed of 20 m/s?

Homework

72. How much work is done in accelerating a 2000 kg car from rest to a speed of 30 m/s?

73. A rock is dropped from a height of 2.7 m. How fast is it going when it hits the ground?

74. A roller coaster is released from the top of a track that is 125 m high. Find the roller coaster speed when it reaches ground level.

75. A 1500 kg car, moving at a speed of 20 m/s comes to a halt. How much work was done by the brakes?

76. A projectile is fired vertically upward with an initial velocity of 190 m/s. Find the maximum height of the projectile.

77. A spring gun is used to project a 0.5 kg ball, in order to perform this experiment the spring was initially compressed by 0.005 m. Find the ball's speed when it leaves the gun, if the spring constant is 395 N/m.

78. A student uses a spring loaded launcher to launch a marble vertically in the air. The mass of the marble is 0.003 kg and the spring constant is 220 N/m. What is the maximum height the marble can reach (a) when compressed 2 cm? (b) when compressed 4 cm?

Power
Examples

79. A heat engine does 23 kJ of work during 1800 s. Find the power supplied by the engine.

80. How much work is done by 15 kW engine during 3.5 min?

81. How long must a 400 W electrical engine work in order to produce 300 kJ of work?

82. How much power is required when using a 12 N force to push an object at a velocity of 3 m/s?

Class Work

83. An elevator motor in a high-rise building can do 3500 kJ of work in 5 min. Find the power developed by the motor.

84. It takes 500 W of power to move an object 96 m in 12 s. What force is being applied to the object?

85. A heat turbine can generate a maximum power of 250 MW. How much work can the turbine do in 7.8 min?

86. How much time is required for a car engine to do 278 kJ of work, if its maximum power is 95 kW?

Homework

87. How much time is required for a elevator to lift a 2000 kg load up 28 m from the ground level, if the motor can produce 13 kW of power?

88. A 50 kW pump is used to pump up water from a mine that is 50 m deep. Find the mass of water that can be lifted by the pump in 1.4 min.

89. Some scientists calculated that a whale can develop 150 kW of power when it is swimming under the water surface at a constant speed 7.77 m/s. Find the resistance force of the water exerted on the whale.

90. A tractor travels at constant speed of 6m/s. Find the power supplied by the engine if it can supply a maximum force of 467 kN.

91. A 7.35 kW lathe can move an iron block at a constant speed by applying a force of 5.56 kN. Find the speed of the block.

General Problems

92. A 255 N force is applied to a 46 kg box that is located on a flat horizontal surface. The coefficient of kinetic friction between the box and the surface is 0.3.

    a. Sketch a free-body diagram and show all the applied forces.

    b. Find the acceleration of the box

    c. How far the box will go in 10 s?

    d. What will be the velocity at the end of this distance?

    e. Find the kinetic energy after 10 s of traveling.

    f. How much work is done during the first ten seconds by each of the following; the applied force, friction force, normal force, gravitational force and net force?

    g. Compare the work done by the net force and the final kinetic energy.

93. A worker pushes a 50 kg crate a distance of 7.5 m across a level floor. He pushes it at a constant speed by applying a constant horizontal force. The coefficient of kinetic friction between the crate and the floor is 0.15.

    a. Find the magnitude of the applied force.

    b. How much work did the worker do on the crate?

    c. How much work did the friction force do on the crate?

    d. How much work did the normal force do on the crate?

    e. How much work did the gravitational force do on the crate?

    f. What was the total work done on the crate?

    g. What was the change in the kinetic energy of the crate?
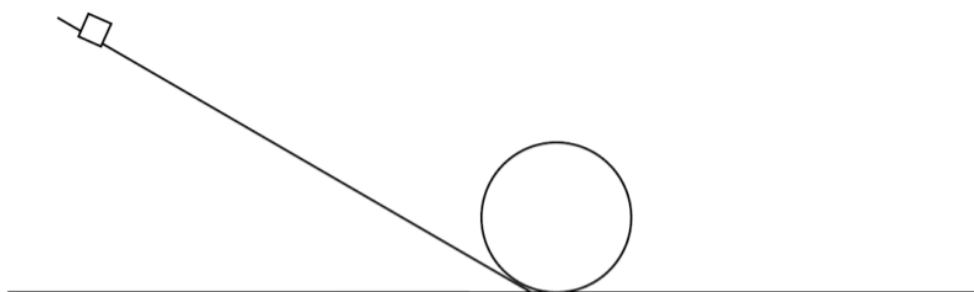
94. A small block, with a mass of 250 g, starts from rest at the top of the apparatus shown above. It then slides without friction down the incline, around the loop and then onto the final level section on the right. The maximum height of the incline is 80 cm, and the radius of the loop is 15 cm.

    a. Find the initial potential energy of the block

    b. Find the velocity the block at the bottom of the loop

    c. Find the velocity of the block at the top of the loop.

    d. What is the normal force on the block at the lowest point of the loop?

    e. What is the normal force on the block at the highest point of the loop?
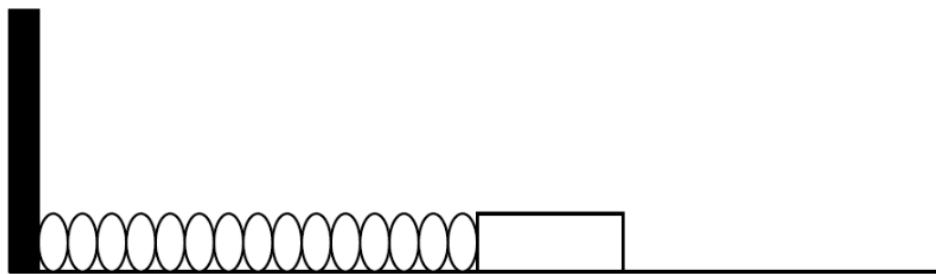
95. A 0.8 kg block is attached to the end of a spring whose spring constant is 85 N/m. The block is placed on a frictionless tabletop, given an initial displacement of 3.5 cm and then released.

    a. What type of energy did the block-spring system initially have?

    b. Find the magnitude of this energy.

    c. How does the total energy of the block-spring system change as the block is pushed across the frictionless surface? Explain.

    d. Find the maximum velocity of the block.
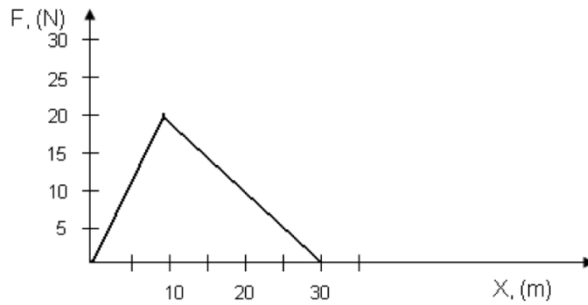
96. An external horizontal force, F, is applied to a 2.5 kg toy car as it moves in a straight line. The force varies with the car's displacement as shown above. Using the graph answer the following questions.

   a. How much work is done by the applied force while the car move the first 10 m?

   b. Determine the kinetic energy of the car when it passes the 10 m point?

   c. What is the velocity of the car when it passes the 10m point?

   d. What is the total work done by the force in the process of displacing the car the first 30 m?

   e. What is the kinetic energy of the car when it is 30 m from the origin?

   f. What is the velocity of the car when it is 30 m from the origin?
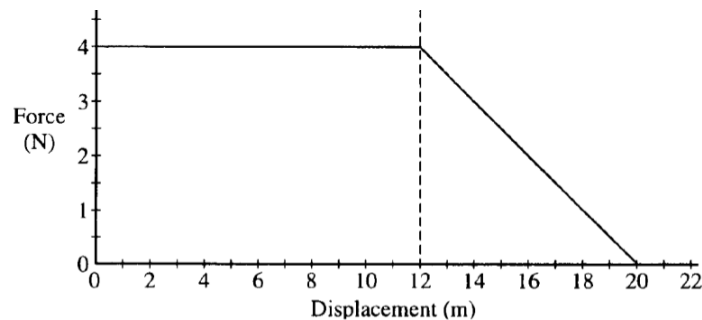
97. A 2 kg object moves along a straight line. The net force acting on the object varies with the object's displacement as shown in the diagram above. The object starts from rest at displacement x = 0 and time t = 0 and is travels a distance 20 m. Find the following.

   a. The acceleration of the object when it has traveled 5 m.

   b. The time taken for the object to be move the first 12 m.

   c. The amount of work done by the net force in displacing the object the first 12 m.

   d. The speed of the object at a displacement of 12 m.

   e. The speed of the object at a displacement 20 m.
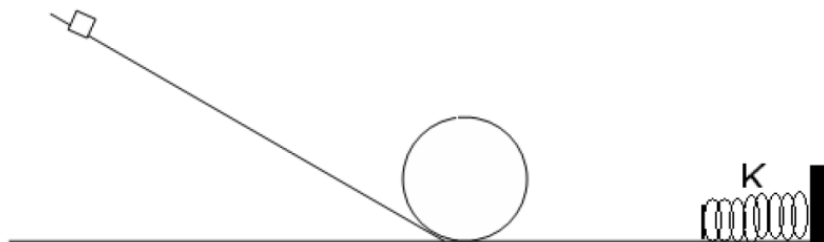
98. A small block, with a mass of 1.5 kg, starts from rest at the top of the apparatus shown above. It then slides without friction down the incline, around the loop and then onto the final level section on the right. It then collides with a spring which momentarily brings the block to a stop. The maximum height of the incline is 2.5 m, the radius of the loop is 0.9 m and the spring constant is 90 N/m.

    a. Find the initial potential energy of the block.

    b. Find the velocity of the block at the top of the loop.

    c. Find the velocity of the block after it goes around the loop, on the flat section of the path.

    d. How much will the block compress the spring before momentarily coming to a stop?
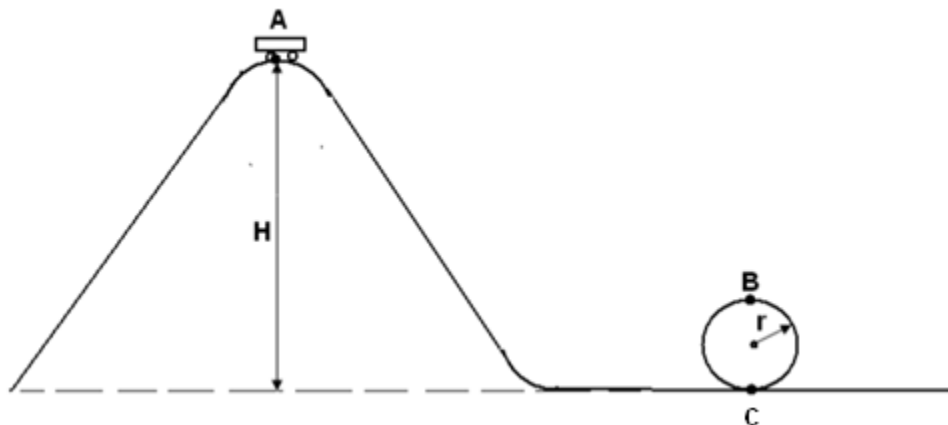
99. A roller coaster of mass 500 kg starts its ride from rest at point A. Point A is located at a height of 70 m above the lowest point on the track. The car rolls down the incline and follows the track around a loop of radius 15 m. Ignore friction force.

a. How much work is required to bring the car to point A?

b. Calculate the speed of the car at point C.

c. On the figure of the car below, draw and label vectors to represent the forces acting on the car it is at point C.

d. Calculate the speed of the car at point B.

e. On the figure of the car below, draw and label vectors to represent the forces acting on the car it is upside down at point B.

f. Now suppose that friction is not negligible. How would friction affect the answers in (a) and (c)?

1) 4875000 J
2) 3158 N
3) 9.875 m
4) 58800 J
5) 900 J
6) 602.08 N
7) 378000 J
8) 2025000 J
9) 198 m
10) 8×10^9 J
11) 1764 J

12) 23.52 J
13) 0.20 kg
14) 2.04 m
15) 88.2 J
16) 47040 J
17) 0.085 m
18) 55.3 kg
19) 0.8 m/s^2
20) 110250 J
21) 7056 J$_{Earth}$
    1152 J$_{Moon}$
22) 3.675 J
23) 17 m
24) 7.5 m/s^2

25) 90 J
26) 5.29 kg
27) 2.83 m/s
28) 1728 J
29) 4.08 kg
30) 2.20 m/s
31) 162 J
32) 250 kg
33) 30.4 m/s
34) 3.65 m/s
35) 48.9 kg
36) 5 m/s

37) 0.024 J
38) 225000 N/m
39) 555.6 N/m
    2.25 J
40) 533.3 N/m
    6 J
41) 0.09 J
42) 37778 N/m
43) 0.89 m
44) 0.03 J
45) 0.48 m
46) 76800 N/m
47) 65.3 N/m
    0.0294 J
48) 700 N/m
    1.715 J

49) 1372 J
50) 687.7 J
51) 0.05 J
52) 2.22 m
53) 0.45 m
54) 7.07 m/s
55) 0.19 m
56) 6 m/s
57) 50 kg
58) 16 m/s^2
59) 4900 m
60) 60 N/m
61) 0.38 kg

62) 5 m/s
63) 2.07 m
64) a) 4.9 m
    b) 9.8 m/s
65) 31.9m
66) 22.05 J
67) 51.2 m/s
68) 12.8 m
69) 3.27 m
70) 0.93 m
71) a) 5.3125×10^7 J
    b) 7.4375×10^7 J
    c) 1.7×10^8 J
72) 900,000 J
73) 7.27 m/s
74) 49.5 m/s
75) 300,000 J
76) 1842 m
77) 0.14 m/s
78) a) 1.5 m
    b) 6.0 m
79) 12.8 W
80) 3.15×10^6 J
81) 750s
82) 36 W
83) 11667 W
84) 62.5N
85) 1.17×10^{11} J
86) 2.9 s
87) 42.2 s
88) 8571.42 kg
89) 1.93×10^5N
90) 2.8×10^6 W
91) 1.32 m/s
92) a) F_N, mg, f, F_A
    b) 2.6 m/s^2
    c) 130 m
    d) 26 m/s
    e) 15548 J
    f) 33150 J
       17581 J
       0 J
       0 J
       15569 J
    g) they are the same

93) a) 73.5 N
    b) 551.25 J
    c) 551.25 J
    d) 0 J
    e) 0 J
    f) 0 J
    g) 0 J

94) a) 1.96 J
    b) 3.96 m/s
    c) 3.13 m/s
    d) 28.586 N
    e) 13.883 N

95) a) EPE
    b) 0.052 J
    c) EPE ↔ KE
    d) 0.36 m/s

96) a) 100 J
    b) 100 J
    c) 8.9 m/s
    d) 300 J
    e) 300 J
    f) 15.5 m/s

97) a) 2 m/s^2
    b) 3.46 s
    c) 48 J
    d) 6.93 m/s
    e) 8 m/s

98) a) 36.75 J
    b) 3.7 m/s
    c) 7 m/s
    d) 0.9 m

99) a) 343000 J
    b) 37.04 m/s
    c) F_N up, mg down
    d) 28 m/s
    e) F_N down, mg down
    f) less velocity at
       B and C

Chapter Problems Work Examples

1. F=65KN   W=FD
   D= 75m   (65x10^3N)(75m)
   W=?   **W=4875000**

2. W=30000J   W=FD
   D= 9.5m   F=W/D
   F=?   (30000J/9.5m)
                 F=3157.9N

3. F=40N   W=FD
   W=395J   D=W/F
   D=?   (395J)/(40N)
                 D=9.875m

4. W=?   F=Mg   W=FD
   M=500kg   (9.8)(500Kg) (4900N)(12m)
   D=12m   F=4900N   **W=58800J**

Class Work

5. F=60N   W=FD
   D=15m   (60N)(15m)
   W=?   **W=900Nm**

6. D=960m   W=FD
   W=578kJ   F=W/D
   F=?   (578kJ)/(960M)
                 F=602.08N

7. V=.6m/s   x=vt   W=FD
   F=350N   (.6m/s)(1800s) (350N)(1080m)
   T=1800s   x=1080m   **W=378kJ**
   W=?

Homework

8. D=150m   W=FD
   F=13,500N   (150m)(13500N)
   W= ?   **W= 2025000J**

9. F=450N   W=FD
   D=?   D=W/F
   W=89kJ   (89kJ)/(450N)
                 D=197.78m

Homework Cont'd

10. V=45m/s   D=vt   W=FD
    W=?   (45m/s)(7200s) (25kN)(324000)
    t=2hr=7200s D= 324,000m **W= 8.1x10^9J**
    F=25kN

100. m=3.6kg   F=mg   W=FD
      D=50m (3.6kg)(9.8)   (35.28N)(50m)
      W=?   F= 35.28N   **W=1764J**

Gravitational Potential Energy

h. m=2.4kg   GPE=Mgh   GPE=Mgh
    xi=2m   (2.4kg)(9.8)(1m)(2.4kg)(9.8)(2m)
    xf=1m   GPE=23.52J   GPE=47.04J
    GPE=?   47.04-23.52=**23.52J**

13. h=18m   GPE=mgh
    w=36J   36J=M(9.8)(18m)
    M-?   M=36J/(9.8)(18)
               M=.204kg

14. h=?   GPE=mgh
    GPE=20J   20J=(1kg)(9.8)h
    M-1kg   H=20J/(9.8)
               H=2.04m

15. m=3kg   GPE=Mgh   GPE=Mgh
    xi=5m   (2.4kg)(9.8)(5m)(2.4kg)(9.8)(8m)
    xf=8m   GPE=147J   GPE=235.2J
    GPE=?   235.2-147=**88.2J**

Classwork
16. m=80kg   GPE=Mgh
    D=60m   (80kg)(9.8)(60)
    GPE=?   **GPE=47,040J**

17. h=?   GPE=mgh
    GPE=10J   10J=(12kg)(9.8)h
    M-12kg   H=10J/(9.8)(12kg)
               H=.085m

18. h=12m   GPE=mgh
    GPE=6500J   6500=M(9.8)(12m)
    M-?   M=6500J/(9.8)(12)

M=55.27kg

Class Work Cont'd

19. M=5kg   GPE=Mgh
   h=6m   24J= (5kg)g(6m)
   GPE=24J   g=24j/(5kg)(6m)
   g=?   **g=.8m/s^s**

Homework

20. m=450kg   GPE=Mgh
   h=25m   (450kg)(9.8)(25m)
   GPE=?   **GPE=110,250J**

               Earth   Moon
21. m=45kg   GPE=Mgh   GPE=Mgh
   h=16m   (45kg)(9.8)(16m)(45kg)(1.6)(16m)
   GPE=?   **GPE=7056J**   **GPE=1152J**

22. m=.25kg   GPE=Mgh
   h=1.5m   (.25kg)(9.8)(1.5)
   GPE=?   **GPE=3.675J**

23. h=?   GPE=mgh
   GPE=10kJ   10kJ=(60kg)(9.8)h
   M=60kg   h=10kJ/(9.8)(60kg)
           h=17.006m

h.   M=.5kg   GPE=Mgh
   h=12m   45J= (.5kg)g(12m)
   GPE=45J   g=45J/(.5kg)(12m)
   g=?   **g=7.5m/s^s**

Kinetic Energy Examples

25. M=80kg   KE=1/2mv^2
   v=1.5m/s   1/2(80kg)(1.5m/s)^2
           KE= 90J

26. V=2.3m/s   KE=1/2mv^2
   KE=14J   14J=1/2m(2.3^2)
   M=?   m=28J/(2.3^2)
           M=5.293J

27. KE=12J   KE=1/2mv^2
   m=3kg   12=1/2(3kg)v^2
   v=?   v= √(24/(3kg))
           v=2.83m/s

Class Work

28. M=6kg   KE=1/2mv^2
   v=24m/s   1/2(6kg)(24m/s)^2
           KE= 1728J

29. V=7m/s   KE=1/2mv^2
   KE=100J   100J=1/2m(7m/s)^2
   M=?   m=200J/(49)
           M=4.08J

30. KE=29J   KE=1/2mv^2
   m=12kg   29J=1/2(12kg)v^2
   v=?   v= √(29/(6kg))
           v=2.198m/s

Homework

31. M=4kg   KE=1/2mv^2
   v=9m/s   1/2(4kg)(9m/s)^2
           KE= 162J

32. V=4m/s   KE=1/2mv^2
   KE=2000J   2000J=1/2m(4m/s)^2
   M=?   m=4000J/16
           M=250kg

33. KE=1.8x10^5J   KE=1/2mv^2
   m=400kg   1.8x10^5J=1/2(400kg)v^2
   v=?   v= √(1.8x10^5J/(200kg))
           v=30.4m/s

34. KE=20J   KE=1/2mv^2
   m=3kg   20J=1/2(3kg)v^2
   v=?   v= √(20J/(3kg))
           v=3.65m/s

35. V=6m/s   KE=1/2mv^2
   KE=880J   880J=1/2m(6m/s)^2
   M=?   m=880J/18
           M=48.89kg

36. KE=15kJ   KE=1/2mv^2
   m=1200kg   15kJ=1/2(1200kg)v^2
   v=?   v= √(30kJ/(1200kg))
           v=5m/s

Elastic Potential Energy Problems

37. K=120N/M   EPE=1/2Kx^2
    x=.02m   1/2(120N/M)(.02)^2
    EPE=?   **EPE=.024J**

38. EPE=45J   EPE=1/2Kx^2
    x=2cm=.02m   45J=1/2k(.02)^2
    v=?   k=90/.0004
                 K=225000N/M

39. F=50N F=Kx   EPE=1/2Kx^2
    x=.09 K=F/x 1/2(555.56)(.09)^2
           50/.09 **EPE=2.25J**
    K=555.56N/M

Class Work

40. F=80N F=Kx   EPE=1/2Kx^2
    x=.15 K=F/x 1/2(533.33)(.15)^2
           80/.15 **EPE=5.99J**
    K=533.33N/M

41. K=200N/M   EPE=1/2Kx^2
    x=.03m   1/2(200N/M)(.03)^2
    EPE=?   **EPE=.09J**

42. EPE=68J   EPE=1/2Kx^2
    x=6cm=.06m   68=1/2k(.06)^2
    k=?   K=136/.0036
                 K=3,777.78N/M

43. K=60N/M   EPE=1/2Kx^2
    EPE=24J   24J=1/2(60)x^2
    x=?   x=√(24/(30)
                 x=.894m

Homework

44. K=150N/M   EPE=1/2Kx^2
    x=.02m   1/2(150N/M)(.02)^2
    EPE=?   **EPE=.03J**

45. K=175N/M   EPE=1/2Kx^2
    EPE=20J   20J=1/2(175)x^2
    x=?   x=√(40/(175)
                 x=.478m

Homework Cont'd

46. EPE=96J   EPE=1/2Kx^2
    x=5cm=.05m   96=1/2k(.05)^2
    k=?   K=192/.0025
                 K=76,800N/M

47. F=?   F=mg   F=Kx
    x=.03m (.2kg)(9.8) K=F/x
    m=.2kg F=1.96N   1.96N/.03,
                         K=65.33N/M

            EPE=1/2Kx^2
            1/2(65.33N/M)(.03)^2
            EPE=.0294J

48. .F=?   F=mg   F=Kx
    x=.07   (5kg)(9.8)   K=F/x
    m=5kg   F=49N   49N/.07,
                         K=700N/M

            EPE=1/2Kx^2
            1/2(7000N/M)(.07)^2
            EPE=1.715J

Mixed Problems
Class Work

49. m=5kg   GPE=Mgh
    h=28   (5kg)(9.8)(28m)
    GPE =?
            GPE=**1372J**

50. M=65kg   KE=1/2mv^2
    v=4.6m/s   1/2(65kg)(4.6m/s)^2
                   KE= 687.7J

51. K=40N/M   EPE=1/2Kx^2
    x=.05m   1/2(40N/M)(.05)^2
    EPE=?   **EPE=.05J**

52. h=?   GPE=mgh
    GPE=76J   76J=(3.5kg)(9.8)h
    M=3.5kg   H=76J/(9.8) (3.5)
                H=2.22m

Class Work Cont'd
53. K=450N/M   EPE=1/2Kx^2

EPE=46J   46J=1/2(450)x^2
x=?   x=√(2)(46)/(450)
x=.45m

54. KE=1500J   KE=1/2mv^2
   m=60kg   1500J=1/2(60kg)v^2
   v=?   v= √(2)(1500)/(60kg))
           v=7.07m/s

Homework

55. K=270N/M EPE=1/2Kx^2
  EPE=5J   5J=1/2(270)x^2
  x=?   x=√(2)(5)/(270)
         x=.19m

56. KE=.36J   KE=1/2mv^2
  m=.02kg   .36J=1/2(.02kg)v^2
  v=?   v= √(2)(.36)/(.02kg))
        v=6m/s

57. V=12m/s   KE=1/2mv^2
  KE=3600J   3600J=1/2m(12m/s)^2
  M=?   m=(2)3600J/(12m/s^2)
        M=50kg

58. M=.5kg   GPE=Mgh
  h=2.5m   20J= (.5kg)g(2.5m)
 GPE=20J g=20J/(.5kg)(2.5m)
  g=?   **g=16m/s^s**

59. h=?   GPE=mgh
  GPE=2400J 2400J=(50kg)(9.8)h
  M=50kg   H=2400J/(9.8) (50kg)
       H=4900m

60. EPE=(3*10^-3)J EPE=1/2Kx^2
  x=.01   3*10^-3 J=1/2k(.01)^2
           k= 3*10^-3/(9.8*10^-4)
      K=60 N/M

61. V=14m/s   KE=1/2mv^2

KE=37J   37J=1/2m(14m/s)^2
M=?   m=(2)37J/(14m/s^2)
      M=.377kg

Conservation of Energy
Examples

62.
KE = EPE   1/2mv^2=1/2Kx^2
  k = 250N/M   √k(x^2)/m = v
  x=.05   v=? √250(.05^2)/.025 = v
  m=.025
      v=5m/s

63.
e. EPE = GPE   1/2Kx^2 = mgh
  k=180N/M   k(x^2)/2gm = h
  m=.004kg h=?   180(.03^2)/2(9.8).004 = h
  x=.03   **H=2.06m**

64. A) GPE=EPE   1/2Kx^2 = mgh
    mgh = 1/2Kx^2   k(x^2)/2gm=h
    m=.002kg   120(.04^2)/2(9.8).002=h
    k=120N/M
    x=.04   H=?   **H=4.89m**

  B) KE = EPE 1/2mv^2= 1/2Kx^2
     v=?   √k(x^2)/m = v
            √120(.04^2)/.002= v
    v=9.8m/s

65.
b) KE=GPE   1/2mv^2=mgh
  v=25m/s   (v^2)/2g = H
  g=9.8 m/ss   (25^2)/2(9.8) = H
     H=31.9m

66. Class Work

f. W =Fd   F=mg
  m=3kg   F= 3(9.8)= 29.4N
  d=.75m   W= (29.4) (.75)
     W=22.05J

Class Work Cont'd
67.
e. GPE=KE   mgh=1/2mv^2

H=134m $\sqrt{2gh}$ = v   H=125m $\sqrt{2gh}$ = v
g=9.8 m/ss $\sqrt{2(9.8)134}$ = v   g=9.8 m/ss $\sqrt{2(9.8)125}$ = v
           v=51.24m/s   **v=49.49m/s**

68.
2) F=kx   EPE=GPE $1/2Kx^2$ = mgh   KE=$1/2mv^2$ KE=W   m= 1500kg
    F= 10N $k(x^2)/2gm$=h   KE=$(1/2)(1500)(20^2)$ v=20m/s
    x= .05 $200(.05^2)/2(9.8).002$=h   **W=300,000J**
  F/x =k
  10/.05= 200N/M   **H=12.8m**   76. KE=GPE $1/2mv^2$=mgh
69.   v=190m/s $(190^2)/2g$ = H
1) GPE=KE $1/2mv^2$=mgh   g=9.8 m/ss $(190^2)/2(9.8)$ = H
    v=8m/s $(v^2)/2g$ = H   **H=1841.83m**
    g=9.8m/ss $(8^2)/2(9.8)$ = H
           H=3.27m   77. EPE = KE $1/2mv^2$=$1/2Kx^2$
70.   k = 395N/m $\sqrt{k(x^2)/m}$ = v
1) GPE = EPE   GPE = $1/2Kx^2$ x=.005   v=? $\sqrt{395(.005^2)/.5}$ = v
    GPE = 56J $\sqrt{2(56)/130}$=x   m=.5kg
    k = 130 N/M   **x=.93**   **v=.14m/s**
71.
1) A) Eo+W=Ef   W= Ef-Eo   A) EPE =KE $1/2Kx^2$ = mgh
    m=8.5*10^5 vf=15 vi=10   k=220 $k(x^2)/2gm$=h
        W= $8.5*10^5(.5)((15^2)-(10^2))$ x=.02 $220(.02^2)/2(9.8)(.003)$=h
     W=5.3125*10^7 J   m= .003kg   **H=1.5m**

    B) Eo+W=Ef   W= Ef-Eo   B) EPE =KE $1/2Kx^2$ = mgh
    m=8.5*10^5   vf=20m/s   vi=15m/s   x=.04 $k(x^2)/2gm$=h
        W= $8.5*10^5(.5)((20^2)-(15^2))$ $220(.04^2)/2(9.8)(.003)$=h
     W=7.4375*10^7 J   **H=6m**

    C) KE = KE=$1/2mv^2$
       v = 20m/s   <u>Power</u>
              KE= $1/2(8.5*10^5)(20^2)$ <u>Examples</u>
     KE=1.7*10^8 J
                                               P = W/t   t=1800s   W= 23*10^3J
                                               P=$(23*10^3)/1800$
<u>Homework</u>
                                                      P=12.77W
1) KE= W   KE = $1/2mv^2$
    m=2000kg   KE =$(1/2)(2000)(30^2)$ <u>Power</u>
    v= 30m/s   **W=900,000J**   <u>Examples Cont'd</u>

73. KE =GPE   mgh=$1/2mv^2$ P = W/t   W= Pt
    H=2.7m $\sqrt{2gh}$ = v   t=3.5(60)= 210s
    g=9.8 m/ss $\sqrt{2(9.8)2.7}$ = v   P=15*10^3W
              v=7.27m/s   W=$15*10^3(210)$
                                               W=3.15*10^6J
74. KE = GPE   mgh=$1/2mv^2$

$P = W/t$ $t = W/P$
$t = (300*10^3)/(400)$

t=750s

$P=Fv$ $P = (12)(3)$
$F = 12N$
$v=3m/s$ **P=36W**

Class Work

$P = W/t$
$W=3500*10^3$ $P = (3500*10^3)/300$
$t=5(60)=300s$ **P=11,666.7W**

$P=W/t$ $W=Fd$
$P=500W$ $Pt/d =F$
$t=12s$ $(500)(12)/96 =$
$d= 96m$ **F=62.5N**

$P =W/t$
$Pt =W$ $(250*10^6w) (468) = W$
$P=250*10^6 MW$
$t =468s$ **W=1.17*10^11 J**

$P = W/t$
$t = W/P$ $(278*10^3)/(95*10^3) =t$
$P = 95*10^3 KW$ **t=2.9s**
$W=278*10^3 KJ$

m=8571.42kg

$P=Fv$
$P=150*10^3 kW$ $P/v =F$
$v=28*10^3Km/s$
    $(150*10^3W)/(7.77m/s)= F$
F =1.93X10^5N

$P=Fv$
$F=467*10^3 kN$
$v = 6m/s$
    $P= (467*10^3) (6m/s)$
P= 2.8X10^6W

$P=Fv$
$F = 7.35*10^3 kW$ $P/F=v$
$P= 5.56*10^3 kN$
    $v=(7.35*10^3)/(5.56*10^3)$
v=1.32m/s

Homework

87. $P = Fd/t$
   $t = Fd/P$ $m = 2000kg$
   $F=mg = (2000)(9.8)=19600N$
   $t = (19600)(28)/(13*10^3)$
   t=42.2s

   $P=mgd/t$ $P= 50*10^3$ $t = (1.4)(60)= 84$
    $pt/dg=m$ $d = 84m$ $g = 9.8m/ss$
   $(50*10^3)(84)/(50)(9.8) = m$

General Problems

92.a.

Fn (up), Ffr (left), Fa (right), Mg (down)
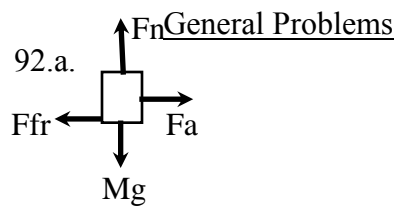
17. $\Sigma F=ma$
Fa-μmg=ma
225-(.3)(46)(10)/46
a=2.54m/s^2

101. $x=x_o+v_ot+1/2at^2$
$x=1/2at^2$
$1/2(2.54)(10)^2$
x=127m

d. $v=v_o+at$
(2.54)(10)
V=25.4m/s

i. $KE=1/2mv^2$
$1/2(46)(25.4)^2$
KE=14838.68J

i. A) W=FD
(255)(127)
W=32835J
b) W=umgD   F=umg=138
(138)(127)=
W=17526J
f. **W=0J**
c) **W=0J**
g. W=Fd
F= 255-138=117
(117)(138)= **14859J**

g. they are about the same

3) a. $\Sigma F=ma$
$F=\mu mg$
F=(.15)(50)(9.8)
F=73.5N

2)   W=FD
(73.5)(7.5)
W=551.25J

2) Same as part b (551.25J)
2) 0
2) 0
3) 0
4) 0

94a.   GPE= MGH
(.25)(10)(8)
GPE=2 J

GPE=KE
$GPE=1/2mv^2$
$V=\sqrt{(2GPE/m)}$
$\sqrt{(4/.25)}$
V= 4m/s

$GPE_1=KE+GPE_2$
$\sqrt{(2GPE_1-2GPE_2)/m}$
$\sqrt{(4-1.5)/.25}$
v=3.16m/s

N-mg=Mv^2/r

N= 29N

N+mg=mv^2/r
N=13.8N

General Problems (Cont'd)

95.

a. EPE

$1/2Kx^2 = EPE$
$1/2(65)(.035^2) = $ **EPE =.05J**

It alternates between EPE and KE.

$EPE = KE$
$.05 = 1/2mv^2$
$√(2)(.05)/.8 = $ **.35m/s = KE v max**

96.

a. W=Fd   W = area triangle
$.5(10)(20)= $ **100J = W**

$KE = W$ **W=100J**

$KE = 1/2mv^2$
$√(2)(100)/2.5 = $ **8.94 m/s = v**

300J=W = 100 + 200
$100 = (.5)(10)(20)$
$200 = (.5)(20)(20)$

$KE = W$ **300J =KE**

$KE= 1/2mv^2$
$√(2)(300)/2.5 = $ **15.49 m/s = v**

97.

$F=ma$ $F/m = a$ $4/2 = $ **2m/ss=a**

$KE = 1/2mv^2$
$√(2)(48)/2 = 6.92/2 = $ **3.46s =t**

c. w = Fd   W= area   W= (12)(4)= **48J= W**

d. KE= $1/2mv^2$ $√(2)(48)/2 = $ **6.92m/s=v**

e. KE $=1/2mv^2=(1/2)(2)v^2 =√64 =$**8m/s =v**
   a. GPE=mgh
      $(1.5)(9.8)(2.5) =$**36.75J = GPE**
b. GPEi=KE top+GPE top
  GPEi-GPE top =KE top (solve for v in KE top)
 $√(2)(36.75-((10)(1.8)(1.5)))/1.5=$**3.7m/s=v**

c. KE= $1/2mv^2$
  $√(2)(36.75)/1.5=$**7m/s=v**

d. EPE =KE   KE= 36.75
   $1/2Kx^2= 36.75$
    $√(2)$ 36.75/90=**.9m=x**

   a. GPE = mgh
      $(500)(9.8)(70)= $ **343,000J=W**
                 b. GPE=KE

F

$√(2)(343000)/500=$**37.04 m/s=v**

c.   m

d. GPEi-GPE top =KE top (solve for v in KE top)

Fn
& $√(2)(343000-$
mg

f.   The speeds at A and C would be less.

$((9.8)(30)(500)))/500=$**28m/s=v**

e.