Physics 11 **Name: _____ Block: ___**

Work, Energy and Power: Prodigious Practice Problems

Work

1. Calculate the work done by a 47 N force pushing a pencil 0.26 m.

2. Calculate the work done by a 47 N force pushing a 0.025 kg pencil 0.25 m against a force of 23 N.

3. Calculate the work done by a 2.4 N force pushing a 400 g sandwich across a table 0.75 m wide.

4. How far can a mother push a 20.0 kg baby carriage, using a force of 62.0 N if she can do 2.0 kJ of work?

5. How much work is it to lift a 20.0 kg sack of potatoes vertically 6.50 m?

6. If a small motor does 520 J of work to move a toy car 260 m, what force does it exert?

7. A girl pushes her little brother on his sled with a force of 300 N for 750 m. How much net work is done on the sled if the force of friction acting on the sled is (a) 200 N, (b) 300 N?

8. A 75.0 kg man pushes on a 5.0×10^5 **ton** wall for 250 s but it does not move. How much work does he do on the wall? (2000 lb = 1 ton; 0.454 kg = 1 lb)

9. A boy on a bicycle drags a wagon full of newspapers at 0.800 m/s for 30.0 min using a force of 40.0 N. How much work has the boy done?

10. You carry a 25 N object 5.0 meters horizontally at a constant velocity. How much work was done on the object?

11. You carry a 20.0 N bag of dog food up a 6.00 m flight of stairs. How much work was done?

12. You push down on a 3.0 N box for 10.0 minutes. How much work was done?

13. You use 35 J of energy to lift a 7.0 N object. How far did you lift it?

14. When a 50.0 kg person hangs from a 20.0 m bungee cord it stretches to a length of 32.0 m.
    (a) Find the spring constant of the bungee cord, assuming it obeys Hooke's law.
    (b) How much work is required to stretch the cord by this much?

Kinetic Energy

15. Calculate the kinetic energy of a 45 **gram** golf ball travelling at: (a) 20. m/s, (b) 40. m/s, (c) 60. m/s.

16. How fast must a 1000. kg car be moving to have a kinetic energy of:
    (a) 2.0×10^3 J, (b) 2.0×10^5 J, (c) 3.6 MJ

17. A 50.0 kg bicyclist on a 10.0 kg bicycle speeds up from 5.00 m/s to 10.0 m/s.
    (a) What was the total kinetic energy before accelerating?
    (b) What was the total kinetic energy after accelerating?
    (c) How much work was done to increase the kinetic energy of the bicyclist?
    (d) Is it more work to speed up from 0 to 5.00 m/s than from 5.00 to 10.0 m/s?

18. A 4.00 kg rock is rolling 10.0 m/s. Find its kinetic energy.

19. An 8.0 kg cat is running 4.0 m/s. How much kinetic energy does it have?

20. A rolling ball has 18 J of kinetic energy and is rolling 3.0 m/s. Find its mass.

21 A 4.0 kg bird has 8.0 J of kinetic energy. How fast is it flying?

22. A 6.0 kg metal ball moving at 4.0 m/s hits a 6.0 kg ball of putty at rest and sticks to it. The two go on at 2.0 m/s.
    (a) What is the kinetic energy of the metal ball before it hits?
    (b) What is the kinetic energy of the metal ball after it hits?
    (c) What is the kinetic energy of the putty ball after being hit?
    (d) How much energy does the metal ball lose in the collision?
    (e) How much kinetic energy does the putty ball gain in the collision?
    (f) What happened to the rest of the energy?

23. A 3.0 kg metal ball, at rest, is hit by a 1.0 kg metal ball moving at 4.0 m/s. The 3.0 kg ball moves forward at 2.0 m/s and the 1.0 kg ball bounces back at 2.0 m/s.
    (a) What is the total kinetic energy before the collision?
    (b) What is the total kinetic energy after the collision?
    (c) How much energy is transferred from the small ball to the large ball?

Gravitational Potential Energy

24. What is the gravitational potential energy of a 61.2 kg person standing on the roof of a 10-story building relative to (a) the tenth floor, (b) the sixth floor, (c) the first floor? (Each story is 2.50 m high.)

25. A 1.00×10^4 kg airplane lands, descending a vertical distance of 1.00 **km** while travelling 100.0 km measured along the ground. What is the plane's loss of potential energy?

26. A coconut falls out of a tree 12.0 m above the ground and hits a bystander 3.00 m tall (the circus is in town!) on the top of the head. It bounces back up 1.50 m before falling to the ground. If the mass of the coconut is 2.00 kg, calculate the potential energy of the coconut relative to the ground at each of the following sites:
    (a) while it is still in the tree, (b) when it hits the bystander on the head,
    (c) when it bounces up to its maximum height, (d) when it lands on the ground,
    (e) when it rolls into a groundhog hole, and falls 2.50 m to the bottom of the hole.

27. How high would you have to lift a 1000.0 kg car to increase its potential energy by:
    (a) 2.0×10^3 J, (b) 2.00×10^5 J, (c) 1.00 kWh (see this later, it's 3.60×10^6 J)

28. Calculate the potential energy (relative to the ground) of a 5.00 kg object sitting on a 3.00-meter-high ledge.

29. A 10.0 kg rock is at the top of a 20.0 m tall hill. How much potential energy does it have, relative to the bottom of the hill?

30. A 25 N object is 3.0 meters up. How much potential energy does it have?

31. How high up is a 3.00 kg object that has 300.0 J of energy?

Springs and Elastic Energy (not on formula sheet (or on test) but $E_e = \frac{1}{2} kx^2$)

32. A spring with a force constant of 5.20 N/m has a relaxed vertical length of 2.45 m. When a mass is attached to the end of the spring and allowed to come to rest, the vertical length of the spring is then 3.57 m. Calculate the elastic potential energy stored in the spring.

33. The staples inside a stapler are kept in place by a spring with a relaxed length of 0.115 m. If the spring constant is 51.0 N/m, how much elastic potential energy is stored in the spring when its length is 0.150 m?

Conservation of Energy

34. A 10.0 kg ball is thrown into the air. It is going 3.0 m/s when thrown. How much potential energy will it gain as it rises to the highest point?

35. A 4.00 kg ball is on a 5.00 m ledge. If it is pushed off the ledge, how much kinetic energy will it have just before hitting the ground?

36. A 25 kg ball is thrown straight up into the air. When thrown it is going 10.0 m/s. Calculate how high it travels.

37. A 3.0 kg rock sits on a 0.80 meter ledge. If it is pushed off, how fast will it be going at the bottom?

38. A catcher's mitt recoils a distance of 12.9 cm in bringing a 142 gram baseball to a stop. If the average applied force is 588 N, then what was the speed of the baseball at the moment of contact with the mitt?

39. At the moment when a shotputter releases a 5.00 kg shot, the shot is 3.00 m above the ground and travelling at 15.0 m/s. It reaches a maximum height of 14.5 m above the ground and then falls to the ground. If air resistance is negligible,
    (a) What was the potential energy of the shot as it left the hand relative to the ground?
    (b) What was the kinetic energy of the shot as it left the hand?
    (c) What was the total energy of the shot as it left the hand?
    (d) What was the total energy of the shot as it reached its maximum height?
    (e) What was the potential energy of the shot at its maximum height?
    (f) What was the kinetic energy of the shot at its maximum height?
    (g) What was the kinetic energy of the shot just as it struck the ground?

40. A physics teacher exerts a force upon a 3.29 kg pile of snow to both lift it and set it into motion. The snow leaves the shovel with a speed of 2.94 m/s at a height of 0.562 m. Determine the work done upon the pile of snow.

41. A 250 gram cart starts from rest and rolls down an inclined plane from a height of 0.541 m. Determine its speed at a height of 0.127 m above the bottom of the incline.

42. A 4357 kg roller coaster car starts from rest at the top of a 36.5 m high track. Determine the speed of the car at the top of a loop that is 10.8 m high.

43. While on the moon, the Apollo astronauts enjoyed the effects of a small gravitation strength. If Neil Armstrong jumped up on the moon with an initial speed of 1.51 m/s to a maximum height of 0.700 m, what amount of gravitational acceleration did he experience? (use energy, then check with kinematics)

44. In a wild shot, Bo flings a pool ball of mass *m* off a 0.68 m high pool table, and the ball hits the floor with a speed of 6.0 m/s. How fast was the ball moving when it left the table?

45. A 500.0 kg pig is standing at the top of a muddy hill on a rainy day. The hill is 100.0 m long with a vertical drop of 30.0 m. The pig slips and begins to slide down the hill. What is the pig's speed at the bottom of the hill?

46. A 50.0 kg gorilla is sitting on the limb of a tree 4.00 meters above the ground. The gorilla jumps down from the tree limb to the ground. Use the conservation of energy to find the velocity of the gorilla just before hitting the ground.

47. A 2.00 kg ball is dropped from the top of a 10.0 m high building. Calculate the potential AND kinetic energies at: (a) 10.0 m (b) 8.00 m (c) 5.00 m (d) 0.00 m.

48. A 10.0 g pebble is placed in a sling shot with a spring constant of 200.0 N/m and is stretched back 0.500 m. What is the maximum velocity the pebble will acquire?

49. A 0.0340 kg bullet traveling at 120 m/s embeds itself in a 1.24 kg wooden block which is at rest on a smooth surface. The block then slides toward a spring and collides with it. The block compresses the spring (k = 99.0 N/m). Calculate how far the block-bullet compresses the spring.

Power

50. How much power does it take to lift 30.0 N 10.0 m high in 5.00 s?

51. How much power does it take to lift 30.0 kg 10.0 m high in 5.00 s?

52. You do 45 J of work in 3.0 seconds. How much power do you use?

53. A car uses 2,500 joules in 25 seconds. Find power.

54. A 60.0 watt light bulb runs for 5.00 seconds. How much energy does it use?

55. How much work can a 22 kW car engine do in 60.0 s if it is 100% efficient?

56. A force of 5.0 N moves a 6.0 kg object along a rough floor at a constant speed of 2.5 m/s.
    (a) How much work is done in 25 s?
    (b) What power is being used?
    (c) What force of friction is acting on the object?

57. How much electrical energy (in **kilowatt-hours**) would a 60.0 W light bulb use in 60.0 **days** if left on steadily?

58. A power mower does 9.00×10^5 J of work in 0.500 h. What power does it develop?

59. How long would it take a 500.0 W electric motor to do 1.50×10^5 J of work?

60. A 12 V car battery is found to be capable of storing 2.00 kWh of electrical energy. For a certain electric car, it is necessary to develop 1.00×10^4 W of power to drive at 5.56 m/s.
    (a) Suppose that the car has 10 such batteries which results in 10 times the energy. How long (in hours) could it run if all 10 of them released all of their energy?
    (b) How far (in kilometers) can the car go on its 10 batteries if they are fully charged?

Thermal Energy

61. A 15.75 g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25 °C to 175 °C. Calculate the specific heat capacity of iron.

62. How many joules of heat are needed to raise the temperature of 10.0 g of aluminum from 22 °C to 55 °C, if the specific heat of aluminum is 897 J/kg°C?

63. Calculate the specific heat capacity of a piece of wood if 1.50 kg of the wood absorbs 67 500 joules of heat, and its temperature changes from 32 °C to 57 °C.

64. 100.0 g of 4.0 °C water is heated until its temperature is 37 °C. If the specific heat of water is 4180 J/kg°C, calculate the amount of heat energy needed to cause this rise in temperature.

65. 0.250 kg of mercury is heated from 25 °C to 155 °C, and absorbs 4550 joules of heat in the process. Calculate the specific heat capacity of mercury.

66. What is the specific heat capacity of silver metal if 55.00 g of the metal absorbs 47.3 J of heat and the temperature rises 3.64 °C?

67. What mass of water will change its temperature by 3.00 °C when 525 J of heat is added to it? The specific heat of water is 4180 J/kg°C

68. A 0.300 kg piece of copper is heated and fashioned into a bracelet. The amount of energy transferred by heat to the copper is 66,300 J. If the specific heat of copper is 390 J/kg°C, what Is the change of the copper's temperature?

69. A 120 g piece of metal at 95.0 °C is placed inside a well-insulated container with 155 g of pure water at 10.0 °C. If the equilibrium temperature reached is 14.5 °C, what is the specific heat capacity of the metal? (The specific heat of water is 4180 J/kg°C)

70. The standard gold bar held as gold reserves by central banks and traded among bullion dealers is the 400-troy-ounce (**12.4 kg** or **438.9** ounces) bar. If one of these bars was heated to 450 °C and placed into an insulated bucket of 6.00 L of water 20.0 °C, what would the equilibrium temperature be? (The specific heat capacities of water is 4180 J/kg°C and gold is 129 J/kg°C).

Bring The Whole Room Together, Like a Good Carpet

71. A motor uses 1500 W to lift a 250 kg mass a vertical distance of 24 m. This takes 52 s. What is the efficiency of the motor?

72. 526 N is used to push a 20.0 kg box 15.0 m along a floor, starting at rest. The force of friction opposing the push is 40.3 N. What speed will the box reach at the end of the push?

73. A roller coaster car of mass 180 kg is traveling at 3.60 m/s when it plummets through a vertical drop of 15.2 m. If 2350 J of heat energy is produced by friction and drag, what speed will the car be traveling at the bottom of the drop?

74. A 900 W ski-hill tow-rope motor is 80% efficient, and accelerates an 82 kg skier from 1.5 m/s to 5.5 m/s in 2.0 s.

    a) Using kinematics, calculate the distance over which the acceleration occurs.

    b) Calculate the useful work done by the motor.

    c) Calculate the net work done on the skier. *(hint: how much work was needed to accelerate?)*

    d) Calculate the work done by friction.

    e) Calculate the average force of friction.