Name: ________________________
Hour: ____ Date: ___________

Physics: *Work, Energy, Power, and Simple Machines HW*

Set 1: Work

1. A mover lifts a crate a vertical distance of 1.45 m. If he exerts an upward force of 390 N on the crate, what work does he do on the crate?

G:

U: S:

E: S:

2. A train engine pulls a damaged coal car with a constant horizontal force of 1.50×10^3 N, causing the car to move through a distance of 1.32 km. How much work does the engine do on the car?

G:

U: S:

E: S:

3. Brianna does 1.7 J of work in raising a 195 g orange against the force of gravity. How far is the orange lifted?

G:

U: S:

E(2): S:

4. A worker in a warehouse pushes a cart with 55 N directed at an angle of 31^o below the horizontal. Find the work done by the worker on the cart as he moves the cart along a 42.5 m length of warehouse floor.

5. A box of mass m is dragged a distance d across a horizontal floor via a rope having a tension T that is tilted at an angle Θ above the horizontal. The coefficient of kinetic friction is μ_k. In terms of m, d, T, Θ, μ_k, and g, find the magnitude of the net work done on the box.

ANSWERS: 1. 570 J 2. 1.98×10^6 J 3. 0.89 m 4. 2.0×10^3 J

Set 2: Kinetic Energy

6. Cars A and B have the same speed, but B has twice the mass of A. Find the ratio of their kinetic energies.

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8. A loaded canoe has a kinetic energy of 950 J when it goes 3.2 m/s. What is the mass?

G:

U: S:

E: S:

9. What is the speed of a 168 g softball if its kinetic energy is 65 J?

G:

U: S:

E: S:

10. Calculate the speed of an 8.3×10^4 kg passenger airplane that has a kinetic energy of 2.2×10^9 J.

G:

U: S:

E: S:

11. A block has weight F_w and has kinetic energy KE. In terms of F_w, KE, and g, find the speed of the block.

G: E(2):

U: S:

ANSWERS: 8. 190 kg 9. 28 m/s 10. 230 m/s

Set 3: Potential Energy

12. The spring in a stapler has a relaxed length of 10.2 cm. If the spring constant is 43.2 N/m, how much elastic potential energy is stored in the spring when its length is 15.6 cm?

G:

U: S:

E: S:

13. A 32.6 kg child swings in a tire swing having a length of 2.70 m. Find the gravitational potential energy of the child relative to the child's lowest position under the following conditions:

a. at the bottom of the circular arc

b. when the ropes are horizontal

c. when the ropes make a 35.0º angle with the vertical

14. A block has weight F_w and possesses the gravitational potential energy PE_g with respect to a reference line. In terms of F_w and PE_g, find the height h of the block above the reference line.

G: E(2):

U: S:

15. A block has weight F_w and is at rest at some unknown height h above a reference line. The block also rests against a horizontal spring that is compressed a distance Δx and has a spring constant k. It has been determined that the total potential energy of the block-spring system is PE_{tot}. In terms of F_w, Δx, k, and PE_{tot}, find the height h of the block above the reference line.

ANSWERS: 12. 0.063 J 13a. 0 J 13b. 863 J 13c. 156 J

Set 4: Conservation of Mechanical Energy

16. A pendulum bob of mass m is pulled back and released from rest. It has speed v_f at the bottom of its arc. In terms of v_f and g, from what height h above the bottom of the arc was it released?

Sketch of snapshots “A” and “B”:

	A	B
KE		
PE_g		
PE_{elas}		
ME		

Variables-only answer:

17. Based on your answer to Q16, calculate h if the bob’s speed at the bottom of the arc is 0.873 m/s.

18. A mass m is dropped from rest and falls a total distance h, compressing a vertical spring of force constant k. The spring compresses a distance Δx. In terms of h, k, Δx, and g, what is the mass?

Sketch of snapshots “A” and “B”:

	A	B
KE		
PE_g		
PE_{elas}		
ME		

Variables-only answer:

19. Based on your answer to Q18, calculate m if h = 1.750 m, k = 673 N/m, and Δx = 0.380 m.

20. A tennis player tosses a ball straight up with a speed of 5.01 m/s. How high will the ball travel?

ANSWERS: 17. 0.0388 m 19. 2.83 kg 20. 1.28 m

21. A bird carrying a fish of mass m flies with speed v_i at a height h above the water. If the bird drops the fish, with what speed will the fish hit the water?

Sketch of snapshots “A” and “B”: Variables-only work and answer:

22. Based on your answer to Q21, calculate the speed with which the fish hits the water if its mass is 1.53 kg, the initial distance above the water is 4.32 m, and the bird was flying at 5.22 m/s.

23. A 52.0 kg Olympic diver dives off the 10.0 m platform. Assuming the diver starts from rest, find the diver’s speed halfway down.

24. If the diver in Q23 leaves the platform with an initial upward speed of 2.80 m/s, find the diver’s speed when she strikes the water.

25. A mass m rests on a spring that has a compressed length Δx. When the spring is released, the mass is launched vertically. At some instant later, it is determined that the mass is moving upward with a speed v and is a height h above its initial elevation. In terms of m, Δx, v, g, and h, find the magnitude of the spring constant k.

ANSWERS: 22. 10.6 m/s 23. 9.90 m/s 24. 14.3 m/s

Set 5: Work-Kinetic Energy Theorem

26. An 88.4 kg hockey player pushes back on the ice with a net force of 156 N. For what distance must the player apply this constant force, starting from rest, so that his final speed is 5.8 m/s?

G:

U: S:

E: S:

27. A 78 kg bobsled is pushed from rest along a horizontal surface at the Winter Olympics. After the bobsled is pushed a distance of 4.3 m, its speed is 6.6 m/s. Find the magnitude of the net force on the bobsled.

G:

U: S:

E: S:

28. A 2700 kg car accelerates from rest. The weight and normal forces cancel, but a forward force of 1630 N acts on the car, provided by traction between the wheels and the road. Also, a 940 N resistive force acts, due to various frictional forces. How far must the car travel for its speed to reach 2.5 m/s?

29. A 2300 kg car starts from rest at the top of a ramp sloped at an angle of 16^o downward. A friction force of 4200 N acts opposite the car's motion. If the car's speed at the bottom of the ramp is 4.1 m/s, what is the length of the ramp?

30. A mass m moves with initial speed v_i. The mass experiences the force F_{net} in the direction of its motion over a distance of d meters. In terms of m, F_{net}, v_i, and d, find the mass's speed at the end of that distance.

G: E:

U: S:

ANSWERS: 26. 9.5 m 27. 4.0×10^2 N 28. 12 m 29. 9.6 m

Set 6: Power

31. How long does it take a 24 kW engine to do 51 MJ of work?

G:

U: S:

E: S:

32. A 1350 kg elevator carries a load of 850 kg. A 4100 N frictional force acts opposite the elevator's motion upward. What minimum power must the motor deliver to lift the elevator at a constant speed of 4.25 m/s?

33. A 42 m-high water tower holds 6.8×10^5 kg of water. How many hours would it take for a 5.0 kW pump to fill the tower?

34. If a speedboat engine delivers a power of 110.0 hp (horsepower), how long will it take for the engine to do 3.7×10^6 J of work? (1 hp = 746 W)

ANSWERS: 31. 2100 s 32. 1.1×10^5 W 33. 16 h 34. 45 s

Set 7: Simple Machines

35. A lever requires that a 34 N force be applied to the handle to lift the lid of a paint can 0.60 cm. The lever has an ideal mechanical advantage of 9.4 and an efficiency of 77%. Find the:

    a. lever's actual mechanical advantage   b. force that is applied to the lid

36. A pulley is used to raise a 44.1 kg crate. Moving the crate vertically upwards 1.85 m requires that a 275 N force to travel 3.61 m. Find the pulley's efficiency.

37. A resistance of 485 N is displaced 0.671 m by an effort force of 173 N. Find the displacement of the effort force if the machine's efficiency is 68.5%.

38. The efficiency of a ramp is 71.7%. Find the input work required to raise a 209 kg mass 3.16 m.

39. A worker exerts a force of 2360 N on the end of a lever to raise a 288 kg boulder 1.68 m. The lever's efficiency is 53.4%. How far does the effort force move?

40. A force of 148 N is used to roll a barrel up a ramp 7.21 m long. The barrel has a weight of 617 N and is displaced to a height of 1.37 m. Find the:

    a. work needed to overcome friction   b. the efficiency of the ramp

ANSWERS:				
	35a. 7.2	36. 80.6%	38. 9040 J	40a. 222 J
	35b. 240 N	37. 2.75 m	39. 3.77 m	40b. 79.2%

Set 8: Review Problems

41. A toy gun has a spring with a force constant of 46.7 N/m. The foam-tipped dart has a mass of 11.5 g. When the dart is loaded into the gun, the spring compresses 4.82 cm before it locks into place. When the trigger is pulled, the spring is released. With what speed does the dart emerge from the gun?

42. When catching a 162 g baseball that was initially moving at 38.2 m/s, a catcher's glove moves backwards 14.8 cm. What average force does the glove apply to the ball to bring it to rest?

43. A machine exerts a force of 3700 N in moving a mass 18.5 m over a time interval of 1 minute 32 seconds. In kW, what is the power rating of the machine?

44. A child on a sled slides down a snowy hillside towards a small, 21^{o} ramp at the bottom. The combined mass of the child and the sled is 29.5 kg and the sled starts up the ramp at the initial speed of 5.7 m/s. If the coefficient of kinetic friction is 0.21, how far up the ramp does the sled move before stopping?

45. A 231 N effort force moves 7.44 m in raising a 1330 N weight 0.967 m. Find the machine's efficiency.

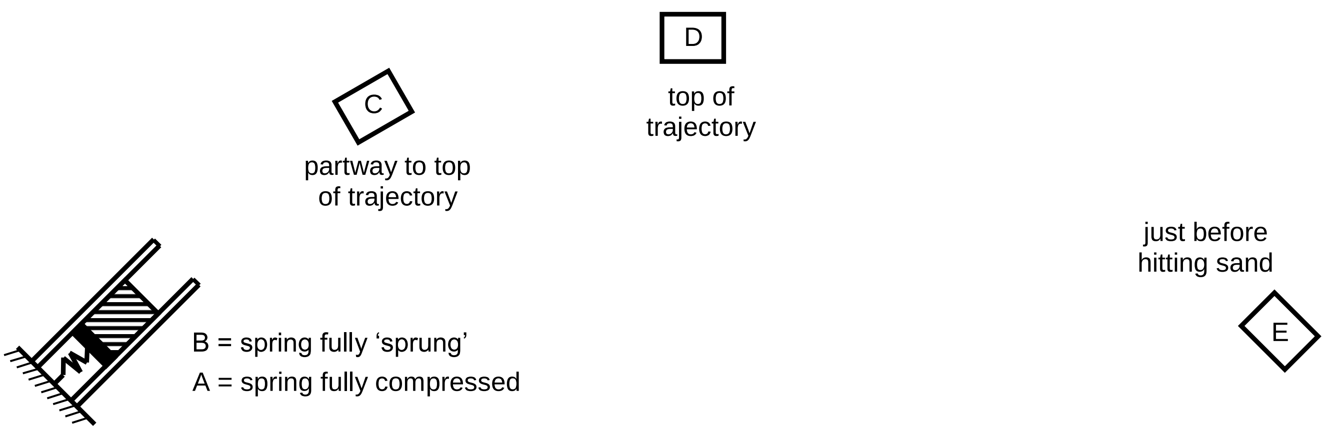
ANSWERS: 41. 3.07 m/s 42. 800. N 43. 0.74 kW 44. 3.0 m 45. 74.8%

Energy Transformations

Mass with compressed spring (shown with cross-section of launching tube)

1. Ignoring the slight changes in the altitude of the mass as the spring is released and assuming no energy is "lost" before or during the mass's flight, find the mass's speed when the mass is 5.8 m above the ground.

2. Assuming mechanical energy is conserved, state the form(s) of energy at points A-E in the diagram below. Where applicable, state the locations where the various energies are either zero or at a maximum value.



3. Describe how some useful mechanical energy is converted into useless heat energy as the mass is…

   a. …moving through the launching tube

   b. …moving through the air

4. a. What happens, in terms of energy, at the instant the mass hits the sand?

b. What happens, in terms of energy, AFTER what you stated in Q4a?

c. What is the end result of all of the ME that was originally stored in the spring, before the mass was fired?

d. Is energy conserved in the above scenario?

5. Draw line segments on the graph below to show how the amount of ME changes in the system (i.e., the spring and mass) over time. Describe each part of the curve with a phrase of explanation.