Name: ___________Answer Key___________ Date: ______________________________

Honors Physics Test #7 Review

Energy

1. Read Chapter 5

2. Terms to know: work, power, energy, conservation of energy, work-energy theorem, elastic potential energy, gravitational potential energy, kinetic energy, reference (base) level, spring constant, Hooke's Law, watt, joule, mechanical energy, pendulum, simple harmonic motion.

3. What are the two types of mechanical energy?
   Potential & Kinetic

4. Why does the amount of gravitational potential energy an object has depend on the reference level?
   Because PE is based on how much energy is required to lift the object a certain distance, this depends on the height above a certain object or the reference level.

5. In which situations is a person doing work? Why or why not?
   a) lifting a box b) carrying a box c) holding a box d) dragging a box up a hill e) walking up stairs

6. Which are vector (if any) and which are scalar (if any): work - vector, power - scalar, energy - scalar

7. As the time it takes to lift an object at a constant speed decreases, what happens to:
   a. the work done in lifting the object? Nothing – force x distance
   b. the power exerted by the person lifting it? Increases – W/t

8. What are the units and alternate units for: work, power, energy?
   Work: N-m = Joule (J)
   Power: J/s = Watt (W)
   Energy: Joule (J)

9. Describe the energy transformations and transferals in the following systems:
   a. a planet orbiting the Sun. Nuclear, to electromagnetic to thermal. Sun to planet.
   b. a pendulum swinging back and forth. Potential at the top, kinetic at bottom, potential at top
   c. a ball bouncing off the floor. Potential at the top, kinetic on way down, back to PE on way up
   d. an arrow shot up into the air. Kinetic to potential on way up, back to kinetic on way down
   e. a car bouncing up and down on its shock absorber Kinetic to potential on way up, back to kinetic on way down
   f. a roller coaster ride. Potential to kinetic and back again as it goes up and down hills

Directions: Read each question carefully and record your answers in the space provided. Be sure to show all work! Answers should be in significant figures. You will be graded on proper use of the GUESS method. **These will be the same directions on the test. Practice the GUESS method now.**

10. A 160. N box sits on a 10.0 meter long frictionless plane inclined at an angle of 30.0⁰ to the horizon. Anne A. Bollick uses a rope attached to the box to move it with constant speed up the incline by applying a force (F) parallel to the surface of the incline. Determine the amount of work Anne did in moving the box from the bottom to the top of the incline.

Constant speed – forces balance

$F_{net} = 0N$
$F_A - F_{g\parallel} = 0N$
$F_A = F_{g\parallel}$
$F_A = F_g \sin\theta$
$F_A = (160.N)(\sin 30.0°)$
$F_A = 80.0N$ uphill

$W = F_{app}d$
$= (80.0N)(10.0m)$
$= {}^{+}800.J$

11. A 50.0 kg child running at 6.0 meters per second jumps onto a stationary 10.0 kg sled. The sled is on a level frictionless surface.
    a. Calculate the speed of the sled with the child after she jumps onto the sled.

Before	After
P_{before} =	P_{after}
$p_1 + p_2$ =	$p_{1,2}$
$m_1v_1 + m_2v_2$ =	$(m_1 + m_2)\ v_f$ =
(50.0 kg)(+6.0 m/s) + (10.0 kg)(0) =	(50.0 kg + 10.0 kg)(v_f) =
300 kg•m/s =	(60.0 kg) v_f
5.0 m/s =	v_f

Sticky
Two separate objects before, one combined object after

    b. Calculate the kinetic energy of the sled with the child after she jumps on it.

$$KE = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(60.0kg)(5.0\tfrac{m}{s})^2 = 750J$$

Use the combined mass because they move together

    c. After a short time, the moving sled with the child aboard reaches a rough level surface that exerts a constant frictional force of 54 newtons on the sled. How much work must be done by friction on the sled to bring it to a halt?

$$W = \Delta E_T = KE_f - KE_i = 0J - 750J = -750J$$

KE_f = 0 J because they stop

12. A student drags a physics teacher for 25 m on the end of a rope that makes a 40.0⁰ angle with the ground. The force on the rope is 650 N. How much work is done?

$$W = F_x d = (F\cos\theta)d = (650N\cos 40.0°)(25m) = {}^{+}12{,}000J$$

OR

$$F_x = F\cos\theta = (650N\cos 40.0°) = 5.0\times10^2 N$$
$$W = F_x d = (5.0\times10^2 N)(25m) = {}^{+}13{,}000J$$

Movement is horizontal, so need the horizontal component of the force

13. A 20568 Watt motor applied a constant force of 104 N on a vehicle. What is the vehicle's velocity?

$$v = \frac{P}{F} = \frac{20568W}{104N} = +198\tfrac{m}{s}$$

Velocity needs direction, the question is vague so use a + or forward

14. Claire D. Steers whose mass is 72 kg, decided to try the power lab. She was able to climb the stairs in 3.00 seconds. If the height of the stair case is 3.6 meters, how much power did she develop in climbing the stairs?

$$P = \frac{Fd}{t} = \frac{mgd}{t} = \frac{(72kg)(9.81\tfrac{m}{s^2})(3.6m)}{3.00s} = 850W$$

The applied force is equal in magnitude to her weight

15. A 24.0 kg rock is dropped from a height of 32.0 meters. Just before it lands, it is going 22.2 m/s.

a. How much PE does the rock have before it is dropped?

$$PE = mgh = (24.0kg)(9.81\,\tfrac{m}{s^2})(32.0m) = 7530J$$

b. How much KE does the rock have right before it lands? [Hint: Actually use the speed to calculate]

$$KE = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(24.0kg)(22.2\,\tfrac{m}{s})^2 = 5910J$$

c. What is the difference between the PE at the top and the KE at the bottom? What could have caused this difference?

$$\Delta E_{T\ \text{lost}} = E_f - E_i = KE_{bottom} - PE_{top} = 5910J - 7530J = -1620J$$

- Overcoming air resistance
- The internal energy increased due to friction with the air

d. How much work must be done to the rock to lift it back to the original height?

$$W = Fd = mgd = (24.0kg)(9.81\,\tfrac{m}{s^2})(32.0m) = {}^{+}7530J$$

16. It takes an 84 newton force to hold a spring stretched a distance of 29 centimeters.

a. What is the spring constant of this spring?

$$k = \frac{F}{x} = \frac{84N}{0.29m} = 290\,N/m$$

Convert centimeters to meters

b. What is the elastic potential energy of the spring in this position?

$$PE_{elastic} = \frac{1}{2}kx^2 = \frac{1}{2}290\,N/m\,(0.29m)^2 = 12J$$

17. Find the acceleration due to gravity on Neptune if a simple pendulum, with a length of 1.50 meters has a period of 2.05 seconds.

$$T = 2\pi\sqrt{\frac{L}{g}} \qquad g = \frac{\ell 4\pi^2}{T^2} = \frac{(1.50m)4\pi^2}{(2.05\ s)^2} = 14.1\,\tfrac{m}{s^2}\ down$$

18. Students are collecting data during a pendulum lab. They hold the 32.0 gram pendulum bob 25.0 centimeters above the table. When they release the pendulum, it swings down and at its lowest point is 11.0 centimeters above the table.

a. Calculate the gravitational potential energy of the pendulum at its highest point relative to the lowest point of its swing.

Convert centimeters to meters and grams to kilograms

$$PE = mgh = (0.0320kg)(9.81\,\tfrac{m}{s^2})(0.140m) = 0.0439J$$

You need to use the difference between the two heights

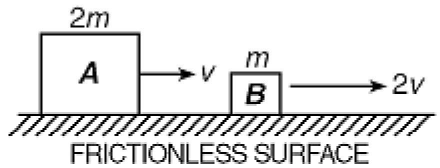
b. Determine the kinetic energy of the pendulum at its lowest point in the swing.

$$E_i = E_f = PE_{top} = KE_{bottom} = 0.0439J$$

c. Calculate the speed of the pendulum bob as it first swings through its lowest point.

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(0.0439J)}{0.0320kg}} = 1.66\,\tfrac{m}{s}$$

19. The diagram below shows blocks A, having mass 2m and speed v, and B, having mass m and speed 2v.

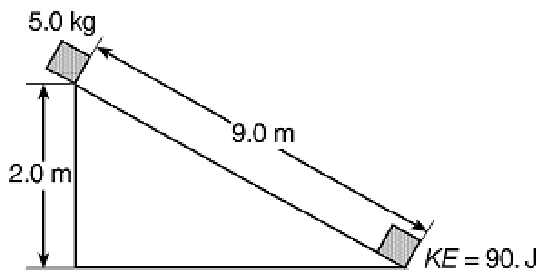


$A: KE = \frac{1}{2}mv^2 = (1)(2)(1)^2 = 2$
$B: KE = \frac{1}{2}mv^2 = (1)(1)(2)^2 = 4$

Compared to the kinetic energy of block A, the kinetic energy of block B is

(A) one-half as great
(B) twice as great
(C) four times as great
(D) the same

20. The diagram below shows a 5.0 kilogram mass sliding 9.0 meters down an incline from a height of 2.0 meters in 3.0 seconds. The object gains 90. joules of kinetic energy while sliding.



$E_i = PE_{top} = mgh = (5.0kg)(-9.81\frac{m}{s^2})(2.0m) = 98J$
$W_{fric} = \Delta E_t = E_f - E_i = KE_{bottom} - PE_{top} = 90.J - 98J$

How much work is done against friction as the mass slides the 9.0 meters?

(A) 90. J (B) 45 J (C) 0 J (D) 8 J

21. A 1.0 kilogram mass gains kinetic energy as it falls freely from rest a vertical distance, d. How far would a 2.0 kilogram mass have to fall freely from rest to gain the same amount of kinetic energy?

(A) $\frac{d}{4}$ (B) d (C) $\frac{2}{d}$ (D) $\frac{d}{2}$

The KE comes from the PE = mgh
Double the mass, halve the distance to get same value

22. A 0.10 kilogram ball dropped vertically from a height of 1.0 meter above the floor bounces back to a height of 0.80 meter. The mechanical energy lost by the ball as it bounces is approximately

(A) 0.78 J (B) 0.20 J (C) 0.080 J (D) 0.30 J

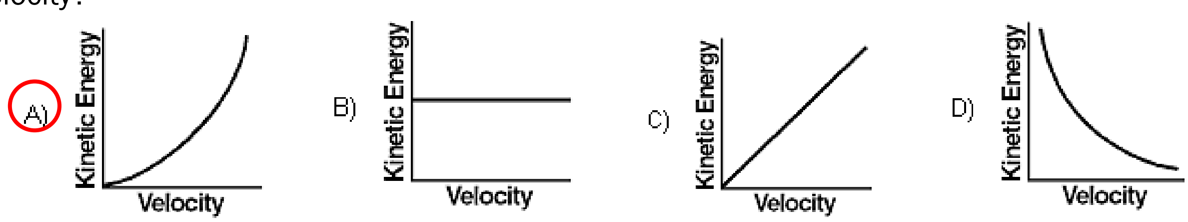
$E_{t\ lost} = E_f - E_i = PE_{bounce} - PE_{drop}$
$= mgh_{drop} - mgh_{bounce} = mg(h_{drop} - h_{bounce})$
$= (0.10kg)(-9.81\frac{m}{s^2})(1.0m - 0.80m)$

23. As a ball falls freely (without friction) toward the ground, its total mechanical energy

(A) increases (B) decreases (C) remains the same

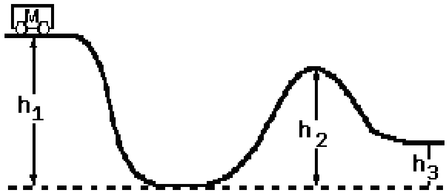
Total energy stays the same without external forces

24. Which graph *best* represents the relationship between the kinetic energy of a moving object and its velocity?



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

25. A cart of mass M on a frictionless track starts from rest at the top of a hill having height h_1, as shown in the diagram below.



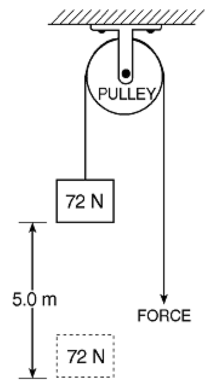
The KE comes from lost PE.
$E_t = PE_1$
$KE_2 = E_t - PE_2$
$= mgh_1 - mgh_2 = mg(h_1 - h_2)$

What is the kinetic energy of the cart when it reaches the top of the next hill, having height h_2?

(A) $M \bullet g \bullet (h_2 - h_3)$ (B) 0 (C) $M \bullet g \bullet h_1$ (D) $M \bullet g \bullet (h_1 - h_2)$

26. In the diagram below, 400. joules of work is done raising a 72 newton weight a vertical distance of 5.0 meters.

$W_{lift} = Fd = (72N)(5.0m) = {}^{+}360J$
$W_{fric} = W_{tot} - W_{lift} = 400.J - 360J$



How much work is done to overcome friction as the weight is raised?

(A) 400. J (B) 40. J (C) 360 J (D) 760 J

27. Which mass has the greatest potential energy with respect to the floor?

(A) 50 kg mass resting on the floor — PE=mgh = (50kg)(-9.81m/s²)(0m) = 0 J
(B) 2 kg mass 10 meters above the floor — PE=mgh = (2kg)(-9.81m/s²)(10m) = 196 J
(C) 10 kg mass 2 meters above the floor — PE=mgh = (10kg)(-9.81m/s²)(2m) = 196 J
(D) 6 kg mass 5 meters above the floor — PE=mgh = (6kg)(-9.81m/s²)(5m) = 294 J

28. As an object falls freely, the kinetic energy of the object

(A) decreases (B) increases (C) remains the same

PE becomes KE

29. A 4.0 x 10³ watt motor applies a force of 8.0 x 10² newtons to move a boat at constant speed. How far does the boat move in 16 seconds?

(A) 32 m (B) 3.2 m (C) 5.0 m (D) 80. m

$P = \frac{Fd}{t}$
$d = \frac{Pt}{F} = \frac{(4.0\times10^3 W)(16s)}{8.0\times10^2 N}$

30. If the time required for a student to swim 500 meters is doubled, the power developed by the student will be

(A) quadrupled (B) quartered (C) halved (D) doubled

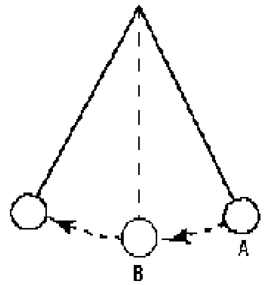
$P = \frac{W}{t} = \frac{1}{2}$

31. A 0.50 kilogram sphere at the top of an incline has a potential energy of 6.0 joules relative to the base of the incline. Rolling halfway down the incline will cause the sphere's potential energy to be

(A) 3.0 J (B) 6.0 J (C) 12 J (D) 0 J

Half the height means half the PE

32. In the diagram below, an ideal pendulum released from point A swings freely through point B



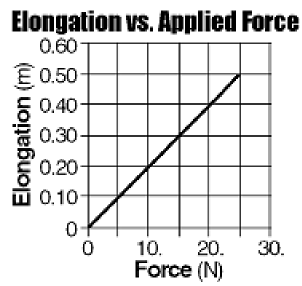
$PE_A = KE_B$
$KE_A = KE_A$

Compared to the pendulum's kinetic energy at A, its potential energy at B is

(A) half as great (B) the same (C) twice as great (D) four times as great

33. The graph below shows the relationship between the elongation of a spring and the force applied to the spring causing it to stretch.

Spring constant is the inverse of the slope or you can pick two points ON line and plug into Hooke's Law equation

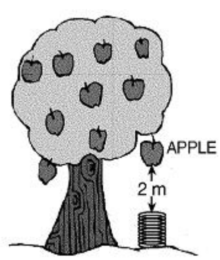


$$k = \frac{F}{x} = \frac{25N}{0.50m}$$

What is the spring constant of the spring?

(A) 0.020 N/m (B) 2.0 N/m (C) 25 N/m (D) 50. N/m

34. The diagram below shows a 0.1 kilogram apple attached to a branch of a tree 2 meters above the spring on the ground below.



$$E_i = E_f$$
$$PE_g = PE_{spring}$$
$$mgh = \tfrac{1}{2}kx^2$$
$$k = \frac{2mgh}{x^2} = \frac{2(0.1kg)(9.81\,\frac{m}{s^2})(2m)}{(0.1m)^2}$$

The apple falls and hits the spring, compressing it 0.1 meter from its rest position. If all of the gravitational potential energy of the apple on the tree is transferred to the spring when it is compressed, what is the spring constant of this spring?

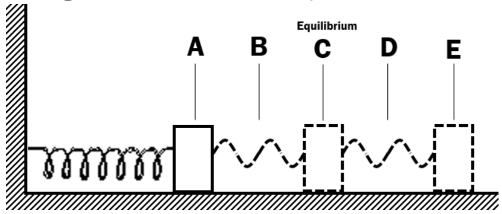
(A) 10 N/m (B) 40 N/m (C) 100 N/m (D) 400 N/m

35. A 500 kg car initially at rest and is pushed by a constant force for a distance of 30 m at which point the car has a kinetic energy of 18,000 J. The magnitude of the force is most nearly

(A) 500 N (B) 600 N (C) 1,500 N (D) 15,000 N (E) 540,000 N

Questions 36 through 42 refer to the following:

A block of mass *m* is attached to a spring and placed on a frictionless surface. The spring is compressed rightward to position A and is then allowed to oscillate freely. Position C represents the equilibrium position of the spring. [Note: There may be more than one correct answer.]



36. At which position(s) is the kinetic energy the greatest?

(A) A (B) B (C) C (D) D (E) E

37. At which position(s) is the elastic potential energy the greatest?

(A) A (B) B (C) C (D) D (E) E

38. At which position(s) is the total mechanical energy the greatest?

(A) A (B) B (C) C (D) D (E) E

39. At which position(s) is the restoring force the greatest?

(A) A (B) B (C) C (D) D (E) E

40. At which position(s) is the acceleration of the mass the greatest?

(A) A (B) B (C) C (D) D (E) E

41. At which position(s) is the speed of the mass the greatest?

(A) A (B) B (C) C (D) D (E) E

42. At which position(s) does the elastic potential energy equal the kinetic energy?

(A) A (B) B (C) C (D) D (E) E

43. How much energy does a 2,400-watt microwave oven use in 3 minutes?

(A) 432,000 J (B) 7,200 J (C) 800 J (D) 24 J (E) 13.3 J

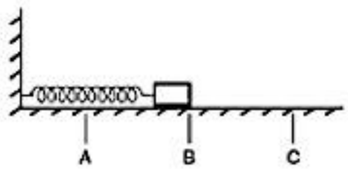
44. The work done on a system

(A) always changes the potential energy of the system
(B) always changes the kinetic energy of the system
(C) always changes the momentum of the system
(D) can change either the potential energy or kinetic energy of the system
(E) is not related to the energy of the system

45. A 0.5 kg ball is dropped from window that is 10 m above the sidewalk. What is the speed of the ball just before it strikes the sidewalk?

(A) 5 m/s (B) 10 m/s (C) 14 m/s (D) 28 m/s (E) 200 m/s

46. The diagram represents a mass on a spring fixed to a wall sliding on a surface of negligible friction. The mass oscillates between points A and C, and B is halfway between A and C.



The restoring force acting on the mass is greatest

(A) at B (B) at A and C (C) between A and B (D) between B and C (E) at A, B, and C

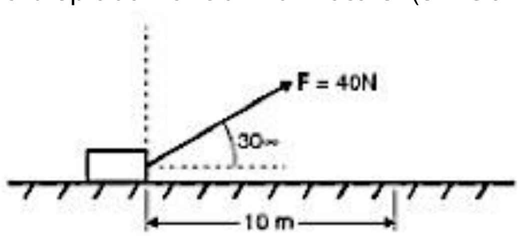
47. Drew lifts a 50 kg crate onto a truck bed 1 meter high in 2 seconds. Perry lifts fifty 1 kg boxes onto the same truck in a time of 2 minutes. Which of the following statements is true?

(A) Drew does more work than Perry does
(B) Perry does more work than Drew does
(C) They do the same amount of work, but Drew operates at a higher power level
(D) They do the same amount of work, but Perry operates at a higher power level
(E) Drew and Perry do the same amount of work and operate at the same power level

48. For an ideal spring, the slope of a force vs. displacement graph, as well as the area under the slope is equal to the

(A) slope: amplitude
area: spring constant
(B) slope: period
area: frequency
(C) slope: work done in stretching the spring
area: spring constant
(D) slope: amplitude
area: period
(E) slope: spring constant
area: work done in stretching the spring

49. A force of 40 N directed at 30° from the horizontal acts on a block of weight 50 N and pulls it across a level floor through a displacement of 10 meters. (sin 30° = 0.50, cos 30° = 0.87)



The work done on the block is most nearly

(A) 160 J (B) 200 J (C) 350 J (D) 400 J (E) 1,600 J

50. The time for one complete swing of a pendulum is called its period. The period of a pendulum for small swings near the Earth depends on its

(A) length only
(B) length and amplitude of swing only
(C) amplitude of swing and mass only
(D) amplitude only
(E) length, mass, and amplitude of swing

51. A machine can lift a 500 N weight up to a height of 2 m in 20 seconds. The power developed by this machine is

(A) 10,000 W (B) 1,000 W (C) 50 W (D) 40 W (E) 25 W

Answers:
10. W =+ 800 J
11. a. v = 5.0 m/s
b. KE = 750 J
c. W = - 750 J
12. W = +12,000 J or +13,000 J
13. v = +198 m/s
14. P = 850 W
15. a. PE = 7530 J
b. KE = 5910 J
c. 1620 J
d. W = +7530 J
16. a. k = 290 N/m
b. PE_s = 12 J
17. g = 14.1 m/s^2 down
18. a. 0.0439 J
b. 0.0439 J
c. 1.66 m/s

19. B
20. D
21. D
22. B
23. C
24. A
25. D
26. B
27. D
28. B
29. D
30. C
31. A
32. B
33. D
34. D
35. B
36. C
37. AE
38. ABCDE
39. AE
40. AE
41. C
42. BD
43. A
44. D
45. C
46. B
47. C
48. E
49. C
50. A
51. C