Conceptual Physics: Form TR7.19A   Name ______________________________

MACHINES/WAVES   Date ________________ Period _____

Test Review № 7

Inclined Planes. An inclined plane is a ramp. It makes work easier because the incline helps to support the weight of the object as it is raised and because the work is done over a greater distance when an object is pushed up an incline rather than lifted. As a result, a smaller force can be used. That doesn't mean you get to do less work using an incline. In fact, you may have to do more, because of friction. The input distance of an incline is its length, while the output distance is its height. The equations for calculating the work output (W_{out}), the work input (W_{in}), the work overcoming friction (W_f), the actual mechanical advantage (AMA), the ideal mechanical advantage (IMA), and the efficiency (Eff) of an incline are shown to the right.

$$W_{out} = F_{out} \times d_{out}$$
$$W_{in} = F_{in} \times D_{in}$$
$$W_f = W_{in} - W_{out}$$
$$AMA = F_{out}/F_{in}$$
$$IMA = d_{in}/d_{out}$$
$$Eff = (W_{out}/W_{in}) \times 100$$
$$Eff = (AMA/IMA) \times 100$$

Momentum. Momentum (p) is the product of mass (m) and velocity (v). The greater the mass and velocity of an object is, the greater its momentum is. During a collision, such as the one between a bowling ball and a bowling pin, the total momentum of the objects is conserved (unless, of course, there are outside forces such as friction.) There are two types of collisions in which momentum can be conserved – one where objects bounce off each other, and another where objects stick together. The mathematics for "sticking together" is less complex.

$$p = mv$$

Sample Problem

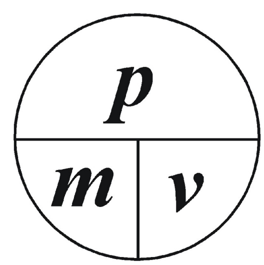
You are standing still on skates. Your mass is 40 kg. Some one tosses you a 5 kg back pack with a velocity of 3 m/s east. What is your velocity after you catch the back pack?

Step 1: Find the total momentum by adding the momentums of each object

- $p_{total} = p_{backpack} + p_{yours}$
- $p_{total} = m_{backpack}v_{backpack} + m_{yours}v_{yours}$
- p_{total} = (5 kg)(3m/s east) + (40 kg)(0 m/s) = 15 kg•m/sec east

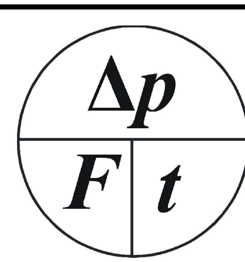
Step 2: Use the total momentum and the total mass to solve for the velocity.

- $p_{total} = m_{total}v_{total}$
- 15kg•m/s east = (5 kg + 40 kg)v_{total}
- 15kg•m/s east = (45 kg)v_{total}
- 0.33 m/s east = v_{total}



Recall that Newton's second law is $F = ma$. Since acceleration is the change in velocity over time, any change in acceleration is also a change in velocity, so, changes in velocity also require a force. Therefore, to change an object's momentum requires an unbalanced force, because the object's momentum only changes when it's velocity changes. A few algebraic substitutions show that force is the change in momentum over time.

Definitions	*Substitutions*
• $F = ma$	$F = \frac{m\Delta v}{t}$
• $a = \frac{\Delta v}{t}$	$F = \frac{\Delta p}{t}$
• $\Delta p = m\Delta v$	



Sample Problem

A bowling ball applies a force to a bowling pin of 175 N for 0.25 s. What is the change in the bowling ball's momentum?

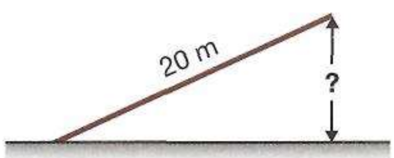
$\Delta p = Ft = (-175\ N)(0.25\ s) = -43.75\ ^{kg\cdot m}/_{s}$ [Note: The force on the bowling ball is negative because it is a reaction force and opposite in direction from the force applied by the bowling ball.]

Harmonic motion. Harmonic motion is motion that repeats in identical or nearly identical cycles. A **cycle** is a unit of motion that repeats. A system in harmonic motion is an **oscillator**. It oscillates. Systems at rest are in **equilibrium**. A system at rest at relatively high potential energy is in **unstable equilibrium**. When disturbed, forces act to pull it away from equilibrium. A system at rest at relatively low potential energy is in **stable equilibrium**. When disturbed, forces act to pull it back toward equilibrium. Because of inertia it may move past the equilibrium point and begin oscillating back and forth. As a result, systems in stable equilibrium undergo harmonic motion when they are disturbed. Equilibrium is maintained by restoring forces. A **restoring force** is any force that acts to pull a system back toward equilibrium. The time it takes to complete a cycle is called the **period**. The number of cycles per second is the **frequency**. Frequency is the inverse of the period, and is measured in **Hertz** (**Hz**). The **amplitude** is the size of the cycle, or how far the system moves from its resting state. Larger amplitudes have higher energy. The gradual loss of amplitude by an oscillator due to friction is called **damping**. The **natural frequency** is the frequency at which a system tends to oscillate when disturbed. The natural frequency results from the interaction between the restoring force and inertia. A force that oscillates in strength and direction is a **periodic force**. When the frequency of a periodic force matches the natural frequency, the amplitude of the motion increases. This is called **resonance**.

Answer the questions below by circling the number of the correct response

1. What is the mechanical advantage of a 6-m long ramp that extends from a ground-level sidewalk to a 2-m high porch? (1) 1 (2) 2 (3) 3 (4) 4

2. The mechanical advantage of the ramp is 10. What is the height? (1) 2 m (2) 5 m (3) 10 m (4) 20 m



3. Two objects have the same mass. They will have the same momentum if they also have the same (1) weight, (2) speed, (3) velocity, (4) acceleration.

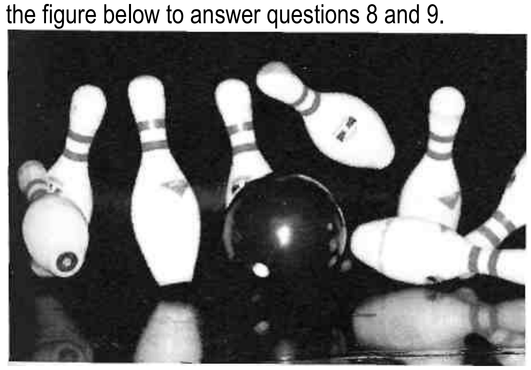
4. What is the momentum of a 57 kg cheetah running north at 27 m/s? (1) 1,539 kg•m/s (2) 84 kg•m/s (3) 30 kg•m/s (4) – 30 kg•m/s

5. A sports car and a moving van are traveling at a speed of 30 km/h. Which vehicle will be easier to stop and why? (1) the moving van, because it has more mass (2) the moving van, because it has greater acceleration (3) the sports car , because it has less mass (4) the sports car , because it has lower acceleration

6. A hunter uses a blowgun to hunt for supper. A force of 2.0 newtons is applied to a 0.05-kilogram dart for 0.75 seconds. The speed of the dart as it leaves the blowgun is about: (1) 0.13 m/s. (2) 1.5 m/s. (3) 30 m/s. (4) 300 m/s.

7. The time required to stop a 200-kilogram wagon moving at 5 m/s with a 40-newton force is: (1) 1 second. (2) 5 seconds. (3) 80 seconds. (4) 25 seconds.

Use the figure below to answer questions 8 and 9.



8. What happens to the momentum of the bowling ball when it hits the pins? (1) It increases. (2) It decreases. (3) It remains the same. (4) There isn't enough information to tell

9. What happens to the speed of the ball? (1) It increases. (2) It decreases. (3) It remains the same. (4) There isn't enough information to tell

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10. What is the momentum of a 0.145 kg baseball pitched at 40.2 m/s? (1) 5.83kg·m/s (2) 0.0036 kg·m/s (3) 277.2 kg·m/s (4) 40.35 kg·m/s

11. Jonathan throws a 0.2 kg snowball at 7 m/s at Rachel. Rachel throws a 0.15 kg snowball at 12 m/s at Jonathan. The snowballs collide in mid air and stick together. What is the final momentum of the new snowball? (1) 1.4 kg·m/s toward Rachel (2) 0.4 kg·m/s toward Jonathan (3) 1.8 kg·m/s toward Jonathan (4) 3.2 kg·m/s toward Rachel

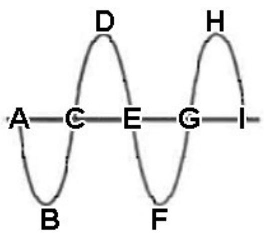
12. What force is required to stop a 7.3 *kg* bowling ball in 5.0 *s* if it is thrown at a speed of 8.5 $^{m}/_{s}$? (1) 12.4 N (2) 4.3 N (3) 5.8 N (4) 3.2 N

13. A pitcher exerts a force of 832.8 *N* on a 0.145 *kg* baseball for 0.007 *s* just as the ball is released. How fast is the pitch? (1) 17,251 m/s (2) 40.2 m/s (3) 1.2×10^{-6} m/s (4) 5,479 m/s

14. How long does a cue stick pushed with a force of 1.5 *N* need to be in contact with a 0.165 *kg* cue ball at rest in order for it to take off with a speed 13.4 $^{m}/_{s}$? (1) 0.018 s (2) 121.8 s (3) 7.9 s (4) 1.47 s

15. A ping pong ball that is in contact with the ping pong paddle for a mere 0.00156 *s* is smashed with a force of 54 *N*. It takes off at 31.25 $^{m}/_{s}$. What is its mass? (1) 0.0009 kg (2) 1.1×10^{6} kg (3) 0.0027 kg (4) 0.0036 kg

Answer questions 16-18 by referring to the diagram to the right which shows a long spring at one instant in time that is stretched between two friends and shaken back and forth to produce harmonic motion.



16. Which of the following points represents the equilibrium position? (1) B (2) D (3) G (4) H

17. Which interval represents the amplitude of the motion? (1) AC (2) CD (3) BD (4) AI

18. Which interval represents the length of one cycle? (1) AB (2) AC (3) AD (4) AE

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19. The natural frequency of a vibrating string can be changed by changing the (1) way the string is plucked, (2) the tension in the string, (3) the periodic force applied to the string, (4) the amplitude of the vibration.

20. A system in harmonic motion is called a(n) (1) oscillator, (2) vibrator, (3) cycler, (4) pendulum.

21. A force that returns a system to equilibrium is called a (1) damping force, (2) periodic force, (3) restoring force, (4) resonant force.

22. A force that reduces the amplitude of a system in harmonic motion is called a (1) damping force, (2) periodic force, (3) restoring force, (4) resonant force.

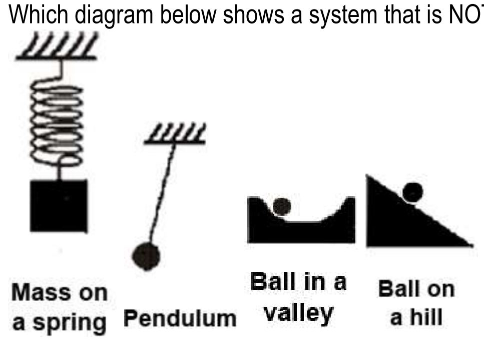
23. What two factors cause a system to oscillate? (1) the damping force and the periodic force, (2) the restoring force and inertia, (3) the periodic force and resonance, (4) the damping force and friction.

24. An object in unstable equilibrium could be (1) at rest at the top of a hill, (2) at rest in a valley, (3) rolling off a hill, (4) oscillating in a valley.

25. An object in stable equilibrium could be (1) at rest at the top of a hill, (2) at rest in a valley, (3) rolling off a hill, (4) oscillating in a valley.

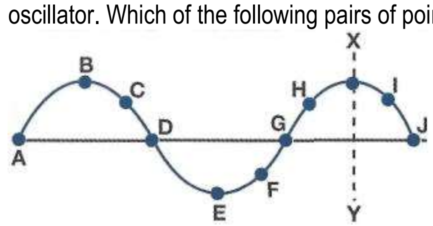
26. A swinging pendulum has an amplitude of 5 centimeters. Which statement about the pendulum must be TRUE? (1) The pendulum moves 5 centimeters every second. (2) The pendulum moves a maximum of 5 centimeters away from its equilibrium position. (3) The pendulum completes one cycle every 5 centimeters of motion. (4) The pendulum has a string length of 5 centimeters.

27. Which diagram below shows a system that is NOT stable?



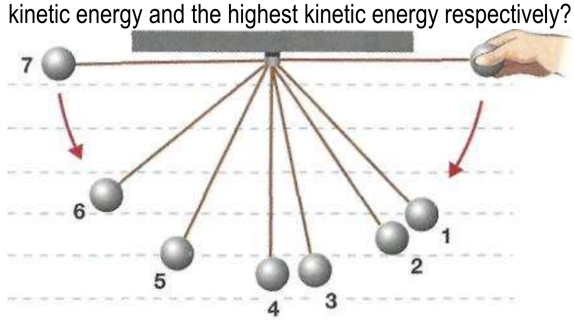
(1) Mass on a spring (2) Pendulum (3) Ball in a valley (4) Ball on a hill

28. The diagram below shows the position versus time for a harmonic oscillator. Which of the following pairs of points are in phase?



(1) A and B (2) A and E (3) A and F (4) A and G

29. Referring to the diagram below, which pair of spheres have the lowest kinetic energy and the highest kinetic energy respectively?



(1) 7 and 4 (2) 6 and 1 (3) 3 and 1 (4) 4 and 2

30. Which of the following will INCREASE the natural frequency of a vibrating string? (1) Making the string longer, and keeping the tension the same (2) Making the string shorter, and keeping the tension the same (3) Keeping the length the same, and decreasing the tension (4) Keeping the length the same, and keeping the tension the same

Answers

1. 3	**7.** 4	**13.** 2	**19.** 2	**25.** 2
2. 1	**8.** 2	**14.** 4	**20.** 1	**26.** 2
3. 3	**9.** 2	**15.** 3	**21.** 3	**27.** 4
4. 1	**10.** 1	**16.** 3	**22.** 1	**28.** 4
5. 3	**11.** 2	**17.** 2	**23.** 2	**29.** 1
6. 3	**12.** 1	**18.** 4	**24.** 1	**30.** 2