High School Physics
2019 - 2020

Five Day
Instruction

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Week 1

Day	Worksheet Title
1	Force & Motion: Generate and interpret graphs and charts …
2	Force & Motion: Describe and analyze motion in one dimension …
3	Force & Motion: Analyze and describe accelerated motion …
4	Force & Motion: Calculate the effect of forces on objects …
5	Force & Motion: Develop and interpret fee-body force diagrams

Name____ Date____________

TEKS **1.P.4.A** **Physics**

FORCE AND MOTION

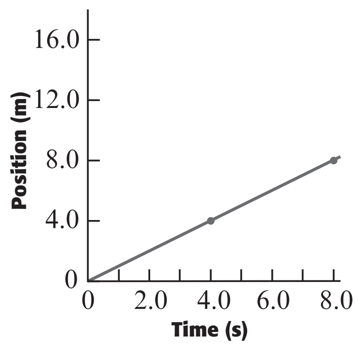
The student will demonstrate an understanding of the relationship of force and motion in one and two dimensions.

(P.4) **Science concepts.** The student knows and applies the laws governing motion in a variety of situations. The student is expected to (A) generate and interpret graphs and charts describing different types of motion, including the use of real-time technology such as motion detectors or photogates;

STANDARD REVIEW

A physicist may make use of real-time technologies, such as a motion detector, instead of a recording timer to determine velocity and acceleration. The motion detector measures the position of an object by sending sound waves toward the object and measuring the time that the waves take to echo back to the sensor.

The velocity of an object can be determined if the object's position is known at specific times along its path. One way to determine this is to make a graph of the motion. The figure below represents such a graph.



Notice that time is plotted on the horizontal axis and distance is plotted on the vertical axis. For any position-time graph, we can also determine the average velocity by drawing a straight line between any two points on the graph. The slope of this line indicates the average velocity between the positions and times represented by these points.

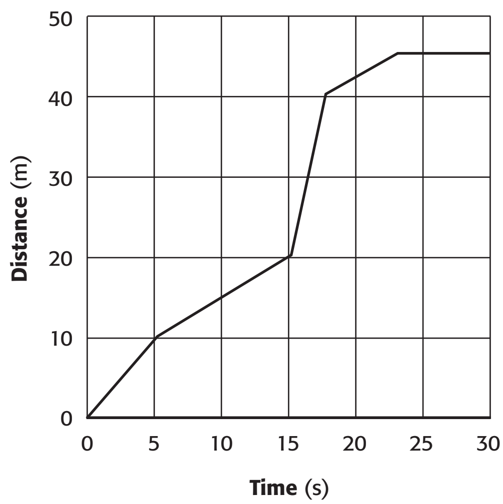
Name______________________________ Date__________

TEKS **1.P.4.A** **Physics**

STANDARD PRACTICE

The following graph shows the distance an object traveled along a straight path as a function of time. Use the graph to answer questions 1–4.

Distance Versus Time



1 During which of the following time periods did the object travel at a constant velocity?

A 0–5 s

B 0–15 s

C 15–20 s

D 20–25 s

2 Which of the following statements best describes the object's motion between the time period of 23 s to 30 s?

A The object is at rest.

B The object has a negative velocity.

C The object has a positive velocity.

D The object has a constant positive acceleration.

TEKS 1.P.4.A Physics

3 According to the data in the graph, during which time period was the average velocity the greatest?

A 0–10 s

B 10–17.5 s

C 17.5–30 s

D 0–30 s

4 What total distance in meters did the object travel during the time interval of 10 s to 25 s?

Name______________________________ Date__________

TEKS **1.P.4.B** **Physics**

FORCE AND MOTION

The student will demonstrate an understanding of the relationship of force and motion in one and two dimensions.

(P.4) **Science concepts.** The student knows and applies the laws governing motion in a variety of situations. The student is expected to (B) describe and analyze motion in one dimension using equations with the concepts of distance, displacement, speed, average velocity, instantaneous velocity, and acceleration;

STANDARD REVIEW

As any object moves from one position to another, the length of the straight line drawn from its initial position to the object's final position is called the displacement of the object. In everyday language, the terms *speed* and *velocity* are used interchangeably. In physics, velocity describes motion with both a direction and a numerical value (a magnitude) indicating how fast something moves. *Speed* has no direction, only magnitude. The quantity that describes the rate of change of velocity is called *acceleration*. The *average velocity* is defined as the displacement divided by the time interval during which the displacement occurred. For any position-time graph, we can also determine the average velocity by drawing a straight line between any two points on the graph. The slope of this line indicates the average velocity between the positions and times represented by these points.

To determine the velocity at some instant, we study a small time interval near that instant. As the intervals become smaller and smaller, the average velocity over that interval approaches the *instantaneous velocity,* the velocity at a specific point in time. One way to determine the instantaneous velocity is to construct a straight line that is *tangent* to the position-versus-time graph at that instant. The slope of this tangent line is equal to the value of the instantaneous velocity at that point.

Reference Information

Displacement

$\Delta d = d_f - d_i$

Average Velocity

$$v_{avg} = \frac{\Delta d}{\Delta t} = \frac{d_f - d_i}{t_f - t_i}$$

Average Acceleration

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

Displacement with Constant Acceleration

$$\Delta d = \frac{1}{2}\left(v_i + v_f\right)\Delta t$$

Velocity with Constant Acceleration

$v_f = v_i + a\Delta t$

Displacement with Constant Acceleration

$$\Delta d = v_i \Delta t + \frac{1}{2}a\left(\Delta t\right)^2$$

Final Velocity after Any Displacement

$$v_f^2 = v_i^2 + 2a\Delta d$$

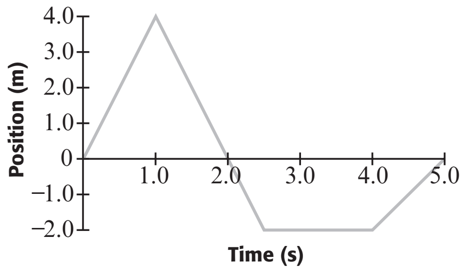
$$\text{average speed} = \frac{\text{distance traveled}}{\text{time of travel}}$$

Name____ Date____________

TEKS 1.P.4.B Physics

STANDARD PRACTICE

To answer questions 1–2, use the following position-time graph of a squirrel running along a clothesline.



1 What is the squirrel's displacement at time t = 3.0 s?

A −6.0 m

B −2.0 m

C +0.8 m

D +2.0 m

2 What is the squirrel's average velocity during the time interval between 0.0 s and 3.0 s?

A −2.0 m/s

B −0.67 m/s

C 0.0 m/s

D +0.53 m/s

3 A boat with an initial speed of 5.0 m/s accelerates at a uniform rate of 1.2 m/s^2 for 5.0 s. What is the final speed of the boat during this time?

A 6.0 m/s

B 6.2 m/s

C 11 m/s

D 26 m/s

4 If a snowmobile accelerates at the rate of −0.60 m/s^2 from its initial velocity of +3.0 m/s, how long will it take to reach a complete stop?

Name______________________________ Date__________

TEKS **1.P.4.C** **Physics**

FORCE AND MOTION

The student will demonstrate an understanding of the relationship of force and motion in one and two dimensions.

(P.4) **Science concepts.** The student knows and applies the laws governing motion in a variety of situations. The student is expected to (C) analyze and describe accelerated motion in two dimensions using equations, including projectile and circular examples;

STANDARD REVIEW

The cars on a rotating Ferris wheel are said to be in *circular motion*. Any object that revolves about a single axis undergoes circular motion. Suppose a car on a Ferris wheel is moving at a constant speed around the wheel. Even though the tangential speed is constant, the car still has an acceleration. Acceleration depends on a change in the velocity. Because velocity is a vector, acceleration can be produced by a change in the *magnitude* of the velocity, a change in the *direction* of the velocity, or both.

The acceleration of an object moving in a circular path and at constant speed is due to a change in direction. An acceleration of this nature is called a centripetal acceleration. The three equations showing the relationship between centripetal acceleration, a_c, tangential velocity, v_t and the radius of the circular motion, r, are given below:

$$a_c = \frac{v_t^2}{r} \qquad r = \frac{v_t^2}{a_c} \qquad v_t = \sqrt{a_c r}$$

Objects that are thrown or launched into the air and are subject to gravity are called *projectiles*. Some examples of projectiles are softballs, footballs, and arrows when they are projected through the air. The path of a projectile is a curve called a *parabola*. Many people mistakenly believe that projectiles eventually fall straight down in much the same way that a cartoon character does after running off a cliff. But if an object has an initial horizontal velocity in any given time interval, there will be horizontal motion throughout the flight of the projectile.

Reference Information

Pythagorean Theorem

$c^2 = a^2 + b^2$

Trig Functions for Right Triangles

$\tan\theta = \frac{\text{opp}}{\text{adj}} \qquad \sin\theta = \frac{\text{opp}}{\text{hyp}} \qquad \cos\theta = \frac{\text{adj}}{\text{hyp}}$

Horizontal Motion of a Projectile

$v_x = v_{x,i} = \text{constant}$

$\Delta x = v_x \Delta t$

Vertical Motion of a Projectile that Falls from Rest

$v_{y,f} = a_y \Delta t$

$v_{y,f}{}^2 = 2a_y \Delta y$

$\Delta y = \frac{1}{2} a_y (\Delta t)^2$

Projectiles Launched at an Angle

$v_x = v_{x,i} = v_i \cos\theta = \text{constant}$

$\Delta x = (v_i \cos\theta)\Delta t$

$v_{y,f} = v_i \sin\theta + a_y \Delta t$

$v_{y,f}{}^2 = v_i^2 (\sin\theta)^2 + 2a_y \Delta y$

$\Delta y = (v_i \sin\theta)\Delta t + \frac{1}{2} a_y (\Delta t)^2$

TEKS 1.P.4.C Physics

STANDARD PRACTICE

1 A soccer ball is kicked horizontally off a bridge with a height of 36 m. The ball travels 25 m horizontally before it hits the pavement below. What was the soccer ball's speed when it was first kicked?

A 2.5 m/s

B 3.7 m/s

C 6.8 m/s

D 9.2 m/s

2 A tether ball tied to a pole by a rope swings in a circular path with a centripetal acceleration of 2.7 m/s^2. If the ball has a tangential speed of 2.0 m/s, what is the diameter of the circular path in which it travels?

A 0.74 m

B 1.5 m

C 3.0 m

D 3.6 m

3 A rock is dropped at the same instant that a ball at the same elevation is thrown horizontally. Which statement below is correct?

A The speed of the rock and the ball will be the same as they hit ground level.

B The speed of the thrown ball will be greater than the speed of the dropped rock as they hit ground level.

C The speed of the dropped rock will be greater than the speed of the thrown ball as they hit ground level.

D The dropped rock will hit the ground first.

4 A sock stuck to the side of a clothes-dryer barrel has a centripetal acceleration of 28 m/s^2. If the dryer barrel has a radius of 27 cm, what is the tangential speed of the sock?

Name____ Date____________

TEKS **1.P.4.D** **Physics**

FORCE AND MOTION

The student will demonstrate an understanding of the relationship of force and motion in one and two dimensions.

(P.4) **Science concepts.** The student knows and applies the laws governing motion in a variety of situations. The student is expected to (D) calculate the effect of forces on objects, including the law of inertia, the relationship between force and acceleration, and the nature of force pairs between objects;

STANDARD REVIEW

Newton's first law of motion. In the 1630s, Galileo concluded correctly that it is an object's nature to *maintain its state of motion or rest*. Note that an object on which no force is acting is not necessarily at rest; the object could also be moving with a constant velocity. This concept was further developed by Newton in 1687 and has come to be known as Newton's first law of motion. Inertia is the tendency of an object not to accelerate. Newton's first law is often referred to as the *law of inertia* because it states that in the absence of a net force, a body will preserve its state of motion. In other words, Newton's first law says that *when the net external force on an object is zero, the object's acceleration (or the change in the object's velocity) is zero.*

Newton's second law of motion. From Newton's first law, we know that an object with no net force acting on it is in a state of equilibrium. We also know that an object experiencing a net force undergoes a change in its velocity. The relationships between mass, force, and acceleration are quantified in Newton's second law. *The acceleration of an object is directly proportional to the net force acting on the object and inversely proportional to the object's mass.* In equation form, we can state Newton's second law as follows: $\sum \mathbf{F} = m\mathbf{a}$. (Note that force, **F,** and acceleration, **a,** are both vector quantities.)

Newton's third law of motion. A force is exerted on an object when that object interacts with another object in its environment. Newton recognized that a single isolated force cannot exist. Instead, *forces always exist in pairs*. If two objects interact, the magnitude of the force exerted on object 1 by object 2 is equal to the magnitude of the force simultaneously exerted on object 2 by object 1, and these two forces are opposite in direction.

TEKS 1.P.4.D Physics

STANDARD PRACTICE

1 Two restaurant employees push a 730 kg wheeled dumpster along a horizontal surface. After they push the dumpster a distance of 5.5 m starting from rest, its speed is 0.75 m/s. What is the magnitude of the net force on the dumpster?

A 3.8 N

B 37 N

C 370 N

D 3700 N

2 If a small sports car collides head-on with a massive truck, which vehicle experiences the greater impact force?

A The small sports car

B The massive truck

C The impact forces are equal but opposite in direction

D Not enough information is given to determine

3 Which of the following terms is defined as the tendency of a moving object to resist a change in speed or direction?

A Kinetic friction

B Inertia

C Mass

D Static friction

4 A freight train has a mass of 1.5×10^7 kg. If the locomotive can exert a constant pull of 7.5×10^5 N, how long in seconds would it take to increase the speed of the train from rest to 85 km/h? (Disregard friction.)

TEKS 1.P.4.E Physics

FORCE AND MOTION

The student will demonstrate an understanding of the relationship of force and motion in one and two dimensions.

(P.4) **Science concepts.** The student knows and applies the laws governing motion in a variety of situations. The student is expected to (E) develop and interpret free-body force diagrams;

STANDARD REVIEW

A free-body diagram is used to analyze only the forces affecting the motion of a single object. Free-body diagrams are constructed and analyzed just like other vector diagrams. Each diagram should include all forces acting on the object, pointing in the correct directions and with the lengths roughly proportional to the magnitudes of the forces.

Free Body Diagramming Strategy

1. Identify the forces acting on the object and the directions of the forces.
2. Draw a diagram to represent the isolated object.
3. Draw and label vector arrows for all external forces acting on the object.

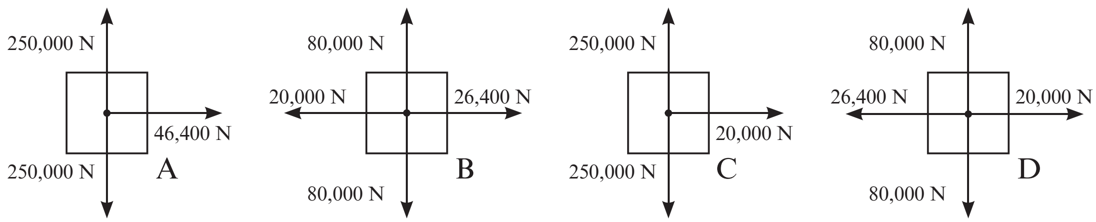
It is important to remember that a free-body diagram shows only the forces acting *on* the object.

Name____ Date_____________

STANDARD PRACTICE

Use the following text and free-body diagrams (A–D) to answer questions 1–2.

A truck pulls a trailer on a flat stretch of road. The forces acting on the trailer are the force due to gravity (250,000 N downward), the force exerted by the road (250,000 N upward), and the force exerted by the hitch connecting the trailer to the truck (20,000 N to the right). The forces acting on the truck are the force due to gravity (80,000 N downward), the force exerted by the road (80,000 N upward), the force exerted by the hitch (20,000 N to the left), and the force causing the truck to move forward (26,400 N to the right).



1 Which diagram above shows a free-body diagram in which all of the forces acting on the truck are represented?

A Free-body diagram A

B Free-body diagram B

C Free-body diagram C

D Free-body diagram D

2 Which diagram above shows a free-body diagram in which all of the forces acting on the trailer are represented?

A Free-body diagram A

B Free-body diagram B

C Free-body diagram C

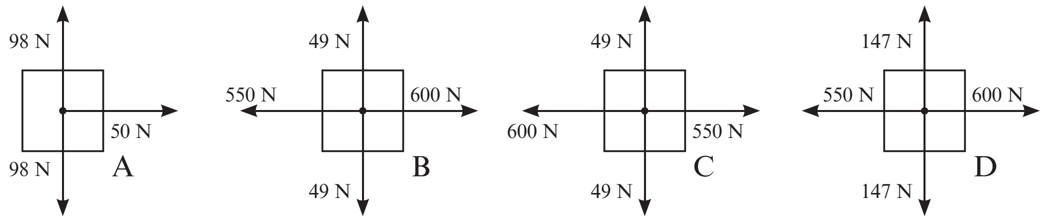
D Free-body diagram D

Name____ Date______________

TEKS 1.P.4.E Physics

Use the following information and free-body diagrams (A–D) for questions 3–4.

Four different boxes of physics textbooks are on a table. The weight of each box is balanced by an upward force or normal force provided by the table. Each box (A–D) is subjected to different horizontal forces as shown in the free-body diagrams below.



3 Which box of books experiences the greatest acceleration to the right?

A Box A

B Box B

C Box C

D Box D

4 What is the magnitude of the acceleration, in m/s^2, of the box of books labeled D?

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2019 - 2020

Five Day
Instruction

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Week 2

Day	Worksheet Title
1	Momentum & Energy: Investigate and calculate quantities using the work-energy theorem
2	Momentum & Energy: Investigate examples of kinetic and potential energy and their transformation
3	Momentum & Energy: Calculate the mechanical energy of …
4	Momentum & Energy: Demonstrate and apply the Laws of Conservation of Energy and conservation of momentum in one dimension
5	Momentum & Energy: Describe how the macroscopic properties of a thermodynamic system …

Name____ Date____________

TEKS 3.P.6.A Physics

MOMENTUM AND ENERGY

The student will demonstrate an understanding of momentum and energy.

(P.6) **Science concepts.** The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to (A) investigate and calculate quantities using the work-energy theorem in various situations;

STANDARD REVIEW

The *net* work done by a *net* force acting on an object is equal to the *change* in the kinetic energy of the object. This important relationship is known as the **work-energy theorem**, $W_{net} = \Delta KE$, where the kinetic energy can be calculated using $KE = \frac{1}{2}mv^2$.

When you use this theorem, you must include all the forces that do work on the object in calculating the net work done. You can calculate the net work done using the following equation, $W_{net} = F_{net} d \cos\Theta$.

From the work-energy theorem, we see that the speed of the object increases if the net work done on it is positive, because the final kinetic energy is greater than the initial kinetic energy. The object's speed decreases if the net work is negative, because the final kinetic energy is less than the initial kinetic energy. The work–kinetic energy theorem allows us to think of kinetic energy as the work that an object can do while the object changes speed or as the amount of energy stored in the motion of an object.

TEKS 3.P.6.A Physics

STANDARD PRACTICE

1 When the force on an object and the object's displacement are in different directions, which component of the force does work?

A The horizontal component

B The normal component

C The component that is parallel to the displacement

D The component that is perpendicular to the displacement

2 A man has three friends help him push his stalled car on a horizontal surface. The friends push with a constant total force of 1200 N. How far must the car be pushed, starting from rest, so that its final kinetic energy is 4200 J? (Disregard friction.)

A 2.6 m

B 3.5 m

C 8.3 m

D 11 m

3 Which of the following is equal to the net work done on a body?

A The change in mechanical energy of the body

B The change in the position of the body

C The change in the kinetic energy of the body

D The change in the potential energy of the body

4 A 2.0×10^3 kg car accelerates from rest under the actions of two forces. One is a forward force of 1140 N provided by traction between the wheels and the road. The other is a 950 N resistive force due to various frictional forces. How far in meters must the car travel for its speed to reach 2.0 m/s?

Name____ Date______________

TEKS 3.P.6.B Physics

MOMENTUM AND ENERGY

The student will demonstrate an understanding of momentum and energy.

(P.6) **Science concepts.** The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to (B) investigate examples of kinetic and potential energy and their transformations.

STANDARD REVIEW

Kinetic energy is energy of motion and depends on speed and mass. Like all forms of energy, kinetic energy can be used to do work. The faster something is moving, the more kinetic energy it has. Also, the greater the mass of a moving object, the greater its kinetic energy is. In equation form, kinetic energy is $KE = \frac{1}{2}mv^2$.

Potential energy is stored energy. Chemical energy, electrical energy, and nuclear energy can be considered forms of potential energy because the energy is stored in particles of matter. This potential energy can be transformed into kinetic energy or other forms of potential energy. *Gravitational potential energy* is the energy an object has because of its position. It depends on weight (mass times acceleration due to gravity where $g = 9.8\ \text{m/s}^2$) and height (h). In equation form, gravitational potential energy is $PE_g = mgh$.

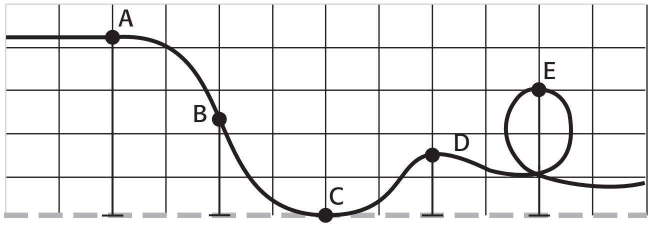
Elastic potential energy is energy stored in the position of particles of an object. For example, a stretched spring has potential energy because work has been done to change its shape. The energy of that work is turned into potential energy that can be transformed back into kinetic energy when the spring is released. In equation form, elastic potential energy is $PE_{elastic} = \frac{1}{2}kx^2$.

The *law of conservation of energy* states that energy cannot be created or destroyed. In other words, the total amount of energy in the universe never changes, although energy may change from one form to another. In equation form this law can be expressed as $E_i = E_f$. Conservation of energy is an important concept for roller coaster designer Steve Okamoto. Steve says, “Studying math and science is very important. To design a successful coaster, I have to understand how energy is converted from one form to another as the cars move along the track. I have to calculate speeds and accelerations of the cars on each part of the track. They have to go fast enough to make it up the next hill! I rely on my knowledge of geometry and physics to create the roller coaster’s curves, loops, and dips.”

TEKS 3.P.6.B Physics

STANDARD PRACTICE

1 The diagram below shows a roller coaster track. Points *A–E* indicate locations of the roller coaster car at different times as it travels along the track.



Which statement below is correct concerning the roller coaster along points A–E?

A The gravitational potential energy is maximum at E.

B The gravitational potential energy is maximum at C.

C The kinetic energy at C is less than the kinetic energy at B.

D The kinetic energy at E is less than the kinetic energy at D.

2 During a field investigation, a student studies kinetic and potential energy by observing apples on a tree. What type of energy do these apples have when on the tree?

A Kinetic energy

B Nuclear energy

C Elastic potential energy

D Gravitational potential energy

3 A tire swing is released from some initial height such that the speed of the tire at the bottom of the swing is 2.5 m/s. What is the initial height of the tire? Note: $g = 9.8 \text{ m/s}^2$

A 0.13 m

B 0.16 m

C 0.32 m

D 3.1 m

4 A toy spring with a spring constant of 6.4 N/m has a relaxed length of 20.0 cm. When a ball is attached to the end of the spring and allowed to come to rest, the vertical length of the spring is 75.0 cm. What is the elastic potential energy stored in the spring?

Name____ Date____________

TEKS **3.P.6.C** **Physics**

MOMENTUM AND ENERGY

The student will demonstrate an understanding of momentum and energy.

(P.6) **Science concepts.** The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to (C) calculate the mechanical energy of, power generated within, impulse applied to, and momentum of a physical system;

STANDARD REVIEW

Analyzing situations involving kinetic, gravitational potential, and elastic potential energy is relatively simple. We can ignore other forms of energy if their influence is negligible or if they are not relevant to the situation being analyzed. In most situations that we are concerned with, these other forms of energy are not involved in the motion of objects. In dealing with moving objects, we will find it useful to define a quantity called *mechanical energy*. The mechanical energy is the sum of kinetic energy and all forms of potential energy associated with the motion of an object or group of objects.

The work-kinetic energy theorem allows us to think of kinetic energy as the work that an object can do while the object changes speed or as the amount of energy stored in the motion of an object. The rate at which work is done is called *power*. More generally, power is the rate of energy transfer by any method.

Momentum is a word we use every day in a variety of situations. In physics this word has a specific meaning. The linear momentum of an object of mass m moving with a velocity $\boldsymbol{v}$ is defined as the product of the mass and the velocity. Consider a soccer player stopping a moving soccer ball. In a given time interval, he must exert more force to stop a fast ball than to stop a ball that is moving more slowly. We see that a change in momentum is closely related to force. The *impulse* is the product of the applied force and the time interval the force acts, which is equal to an object's change in momentum.

Reference Information

Momentum
$\boldsymbol{P} = m\boldsymbol{v}$

Impulse-Momentum Theorem
$\boldsymbol{F}\Delta t = \Delta \boldsymbol{p}$ or $\boldsymbol{F}\Delta t = \Delta \boldsymbol{p} = m\boldsymbol{v}_f - m\boldsymbol{v}_i$

Total Mechanical Energy
$ME = KE + PE$

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

Gravitational Potential Energy
$PE = mgh$

Average Power
$P_{ave} = W/\Delta t$

Work-Kinetic Energy Theorem
$W_{net} = \Delta KE$

STANDARD PRACTICE

1 A 150 g pinball rolls towards a springloaded launching rod with a velocity of 2.0 m/s to the west. The launching rod strikes the pinball and causes it to move in the opposite direction with a velocity of 10.0 m/s. What impulse was delivered to the pinball by the launcher?

A 0.75 kg•m/s to the east

B 1.2 kg•m/s to the east

C 1.8 kg•m/s to the east

D 3.0 kg•m/s to the east

2 A cart with a mass of 25.0 kg is rolling with a speed of 14 m/s. What is the magnitude of the momentum of the cart?

A 1.8 kg•m/s

B 11 kg•m/s

C 39 kg•m/s

D 350 kg•m/s

3 A mover pushes a 245 kg piano so that it accelerates uniformly from rest to 1.5 m/s in 5.00 s. What is the power delivered by the mover in this time interval?

A 55 W

B 110 W

C 280 W

D 540 W

4 A 755 N diver drops from a board 10.0 m above the water's surface. What is the diver's total mechanical energy, in joules, when he is 5.00 m above the surface of the water?

Name____ Date____________

TEKS **3.P.6.D** **Physics**

MOMENTUM AND ENERGY

The student will demonstrate an understanding of momentum and energy.

(P.6) **Science concepts.** The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to (D) demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension;

STANDARD REVIEW

Imagine that two cars of different masses moving with different velocities collide head on. The momentum of the cars after the collision can be predicted. This prediction can be made because momentum is always conserved, or, in other words, always remains constant. Some momentum may be transferred from one car to the other, but the total momentum remains the same. This principle is known as the *law of conservation of momentum*. In an *elastic collision* two objects collide and return to their original shapes with no loss of total kinetic energy. After the collision, the two objects move separately. In an elastic collision, both the total momentum and the total kinetic energy are conserved. When two objects collide and move together as one mass, the collision is called a *perfectly inelastic collision*. In an inelastic collision, kinetic energy is converted to internal elastic potential energy when the objects deform. Some kinetic energy is also converted to sound energy and internal energy. In an inelastic collision, the total kinetic energy does not remain constant when the objects collide and stick together.

Reference Information

Momentum $g = 9.81\ \text{m/s}^2$
$\mathbf{P} = m\mathbf{v}$

Impulse-Momentum Theorem
$\mathbf{F}\Delta t = \Delta \mathbf{p}$ or $\mathbf{F}\Delta t = \Delta \mathbf{p} = m\mathbf{v}_f - m\mathbf{v}_i$

Conservation of Momentum
$m_1\mathbf{v}_{1,i} + m_2\mathbf{v}_{2,i} = m_1\mathbf{v}_{1,f} + m_2\mathbf{v}_{2,f}$

Perfectly Inelastic Collision
$m_1\mathbf{v}_{1,i} + m_2\mathbf{v}_{2,i} = (m_1 + m_2)\mathbf{v}_f$

Conservation of Mechanical Energy
$\frac{1}{2}m_1 v_{1,i}^2 + \frac{1}{2}m_2 v_{2,i}^2 = \frac{1}{2}m_1 v_{1,f}^2 + \frac{1}{2}m_2 v_{2,f}^2$

Gravitational Potential Energy
$PE_g = mgh$

Name____ Date______________

TEKS **3.P.6.D** **Physics**

STANDARD PRACTICE

1 After pushing away from each other, two objects have equal but opposite momentum. Which of the following is true for the total momentum of the system?

A It is twice the momentum of one object.

B It is zero.

C It is less than the initial momentum.

D It is greater than the initial momentum.

2 A 72.0 kg stuntman jumps from a moving car to a 2.50 kg skateboard at rest. If the velocity of the car is 15.0 m/s to the east when the stuntman jumps, what is the final velocity of the stuntman and the skateboard?

A 0.521 m/s to the east

B 14.5 m/s to the east

C 15.5 m/s to the east

D 432 m/s to the east

3 A 0.400 kg bead slides on a straight frictionless wire and moves with a velocity of 3.50 cm/s to the right, as shown below. The bead collides elastically with a larger 0.600 kg bead that is initially at rest. After the collision, the smaller bead moves to the left with a velocity of 0.70 cm/s.

What is the total kinetic energy of the system of beads after the collision?

A 1.40×10^{-4} J

B 2.45×10^{-4} J

C 4.70×10^{-4} J

D 4.90×10^{-4} J

4 The ballistic pendulum is an apparatus used to measure the speed of a projectile. An 8.0 g bullet is fired into a 2.5 kg ballistic pendulum bob, which is initially at rest, and becomes embedded in the bob. The pendulum then rises to a vertical distance of 6.0 cm. What was the initial speed of the bullet (in m/s)?

TEKS 3.P.6.E Physics

MOMENTUM AND ENERGY

The student will demonstrate an understanding of momentum and energy.

(P.6) **Science concepts.** The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to (E) describe how the macroscopic properties of a thermodynamic system such as temperature, specific heat, and pressure are related to the molecular level of matter, including kinetic or potential energy of atoms;

STANDARD REVIEW

According to kinetic theory, all matter is made of particles—atoms and molecules—that are constantly in motion. Because they are in motion, all particles of matter have kinetic energy. *Temperature* is a measure of average kinetic energy. Particles of matter are constantly moving, but they do not all move at the same speed. As a result, some particles have more kinetic energy than others have. When you measure an object's temperature, you measure the average kinetic energy of the particles in the object. The more kinetic energy the particles of an object have, the higher the temperature of the object.

For a monatomic gas, temperature can be understood in terms of the translational kinetic energy of the atoms in the gas. For other kinds of substances, molecules can rotate or vibrate, so other types of energy are also present. For example, a carbon dioxide molecule with vibrational energy is like a plucked guitar string. It contains both kinetic and potential energies due to the way the bonds between atoms in the molecule stretch and bend like a spring.

To measure temperature, we use a simple physical property of substances: most substances expand when their temperature increases. Thermometers use the expansion of liquids such as mercury or colored alcohol to measure temperature. These liquids expand as their temperature increases and contract as their temperature falls. As the temperature rises, the particles in the liquid inside a thermometer gain kinetic energy and move faster.
With this increased motion, the particles in the liquid move farther apart. So, the liquid expands and rises up the narrow tube.

The *specific heat capacity* of a substance is defined as the energy required to change the temperature of 1 kg of that substance by 1°C. Every substance has a unique specific heat capacity. This value tells you how much the temperature of a given mass of that substance will increase or decrease, based on how much energy is added or removed as heat.

Pressure is a measure of how much force is applied over a given area. But what is providing this force? In kinetic theory, gas particles are likened to a collection of billiard balls that constantly collide with one another. This simple model is successful in explaining many of the macroscopic properties of a gas. For instance, as these particles strike a wall of a container, they transfer some of their momentum during the collision. The rate of transfer of momentum to the container wall is equal to the force exerted by the gas on the container wall, in accordance with the impulse-momentum theorem.

TEKS 3.P.6.E Physics

STANDARD PRACTICE

1 A group of students painted four cans, placed 500 grams of water in each can, and measured the temperature of the water as shown in Figure 1.They placed the cans on a sunny windowsill for two hours and then measured the temperature again (Figure 2).

FIGURE 1

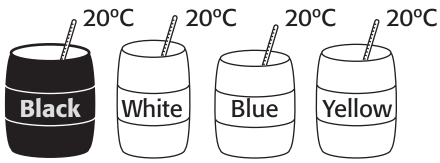
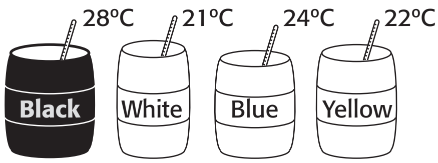


FIGURE 2



Which statement correctly describes the significance of the temperature changes shown?

A The water molecules in the white can slowed down the most.

B The water molecules in the black can had the largest increase in average kinetic energy.

C The water molecules in the blue can have a lower average potential energy than the water molecules in the white can.

D The water molecules in the yellow can are moving at half the speed of the water molecules in the blue can.

2 Which of the following statements is true of the cans in Figure 2?

A All of the particles in the blue can have the same kinetic energy.

B The average kinetic energy of molecules in the white can is greater than in the yellow can.

C The kinetic energy of every particle in the black can is greater than that of every particle in the white can.

D The temperature of the black can indicates the average kinetic energy of water molecules in the can.

Name______________________________ Date__________

TEKS 3.P.6.E Physics

3 A student measured out 1 kg samples of each substance below on a triple beam balance. Next, the student heated each sample on a hot plate, increasing the temperature of each sample by 10°C as measured with a Celsius thermometer. Based on the given specific heat capacities, which substance required more heat input for this temperature increase?

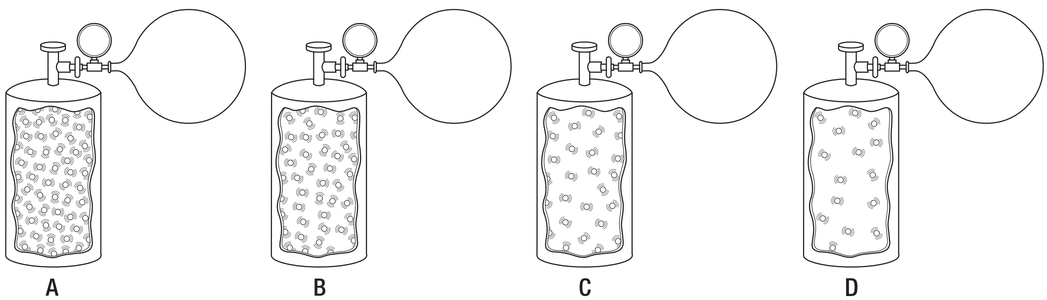
A Water, $c_p = 4.186 \times 10^3$ J/kg•°C

B Silver, $c_p = 2.34 \times 10^2$ J/kg•°C

C Copper, $c_p = 387$ J/kg•°C

D Aluminum, $c_p = 899$ J/kg•°C

4 The following graphic shows a full tank of helium (A), the same tank after it has filled 10 balloons (B), the same tank after it has filled 20 balloons (C), and the same tank after it has filled 30 balloons (D). In which tank is the greatest pressure being exerted on the tank's inner surface?



A Tank A

B Tank B

C Tank C

D Tank D