Name: 6A\_1



A box is free to move along a flat, level surface as shown in the diagram above. If the

box moves 1 meter, which force would do the greatest amount of work on the box?

A) 25 N

B) 35 N

C) 40 N

D) 45 N

E) 50 N

Correct: C

Name: 6A\_2

The motor of a 1 kg battery powered car creates a constant force of 8 N directed as

shown. If the car starts from rest, what is its speed after 1 meter of forward motion? You

may assume no friction.

A) 1 m/s

B) 4 m/s

C) 8 m/s

D) 9.8 m/s

E) 16 m/s

Correct: B

Explanation: The work done is Fd = (8 N)(1 m) = 8 J. If this is converted into kinetic

energy the final speed is 4 m/s.

Name: 6A\_3

A bicyclist and rider with a combined mass of 85 kg are moving with speed of 10 m/s on

a straight, level road. How much force must the brakes supply to stop the cyclist in 20

meters?

A) 21.2 N

B) 42.5 N

C) 212 N

D) 425 N

E) 4,250 N

Correct: C

Explanation: The work done equals the kinetic energy: Fd = 1/2 mv2.

Name: 6A\_4

If a force of 100 N is continuously applied to an object that moves a distance of 10

meters, which of the following statements is ALWAYS true about the effect of this

force?

A) The total energy of the object is 1,000 J.

B) The potential energy of the object increases by 1,000 J.

C) The kinetic energy of the object increases by 1,000 J.

D) The total energy of the object increases by 1,000 J.

E) The total energy of the object may increase or decrease by up to 1,000 J.

Correct: E

Explanation: the total energy may increase or decrease depending on the initial speed or

position but the total change in energy cannot exceed the work done.

Name: 6A\_5

A circus act includes a lever that launches a performer upward when two other

performers jump on the opposite end. Suppose two 90 kg men drop 3.3 m onto one end of

the lever. How high can this launch a 45 kg woman if she does not contribute any

additional energy from her muscles?

A) 6.6 m

B) 13.2 m

C) 19.6 m

D) 32.3 m

E) 39.2 m

Correct: B

Explanation: Assuming no friction the maximum possible height occurs when the

potential energy lost by the falling men is 100% transferred to the woman.

Name: 6A\_6

In one second, 2,500 kg of water drops 20 meters over a certain waterfall. How much

energy could potentially be extracted in one second from a small hydroelectric power

plant at this site? Assume the turbine is 100% efficient at extracting the energy of moving

water. *(The best real turbines capture about 90% of the energy)*

A) 196 J.

B) 24,500 J.

C) 50,000 J.

D) 245,000 J.

E) 490,000 J.

Correct: E

Explanation: the total energy may increase or decrease depending on the initial speed or

position but the total change in energy cannot exceed the work done.

Name: 6A\_7

What is the minimum force needed to accelerate a 5 kg bowling ball up to a speed of 15

m/s in 2 meters.

A) 18.8 N

B) 37.5 N

C) 98.0 N

D) 281 N

E) 562 N

Correct: D

Explanation: the kinetic energy of the ball is 562 J which must be acquired by a force of

281 N acting over 2 meters.

Name: 6A\_8

A sliding block experiences a friction force of 6 N. If the block has a mass of 3 kg and a

speed of 6 m/s, how far will it travel before it stops?

A) 9 m

B) 18 m

C) 36 m

D) 54 m

E) 108 m

Correct: A

Explanation: the kinetic energy of the block is 54 J which is the work done by the friction

force of 6 N acting over 9 meters.

Name: 6A\_9

Which of the following statements is FALSE?

A) Work done by a force can decrease kinetic energy.

B) Work done by a force can increase kinetic energy.

C) Work done by a force can convert potential energy into kinetic energy.

D) Work done by a force can be stored as energy.

E) Work done by a force always increases the total energy of a system.

Correct: E

Explanation: Work can decrease the total energy of the system.

Name: 6A\_10

Which of the following statements is NOT true?

A) A force does no work when applied to a rigid object that does not move,

regardless of the strength of the force.

B) An object's gravitational potential energy decreases when the object gets closer to

the ground.

C) Potential energy and kinetic energy always add up to the same amount of total

energy.

D) If an object cools off, the heat energy it loses must be gained by something else.

E) When the speed of an object increases, its kinetic energy also increases.

Correct: C

Explanation: This is only true when there is no friction and there are no other forms of

energy involved, such as elastic energy, heat energy, or pressure energy.

A force is applied that causes a ball to increase its speed. Which of the following

statements about the ball is TRUE?

A) Energy is conserved so the total energy of the ball remains unchanged.

B) The work increases the potential energy of the ball.

C) The work increases the kinetic energy of the ball.

D) The work increases the kinetic energy of the ball but also reduces the ball's

potential energy to compensate.

E) You cannot determine if the energy changes without knowing the mass of the ball.

Correct: C

Name: 6A\_12

A pitching machine applies a force to a baseball and throws the ball. The ball's speed

increases from zero to 30 m/s when it leaves the machine. The ball follows a curved arc

reaching a maximum height of 15 meters as shown in the diagram. Which of the graphs

shows the correct relationship between the work done on the ball, its kinetic energy, and

its potential energy at point (X) in its motion? Assume the potential energy is relative to

the ball's height when it was launched.

A) A

B) B

C) C

D) D

E) E

Correct: B

Explanation: Graph A has no potential energy. Graph C shows the sum of potential and

kinetic energies is greater than the work done. Graph D shows the wrong relationship

between potential and kinetic energy. Graph E shows the sum of potential and kinetic

energies greater than the work done.

Name: 6A\_13

A pitching machine applies a force to a baseball and throws the ball. The ball has a mass

of 0.14 kg and follows a curved arc reaching a maximum height of 15 meters at a speed

of 25 m/s as shown in the diagram. How much work was done on the ball by the pitching

machine?

A) 20.6 J

B) 40.0 J

C) 43.8 J

D) 64.4 J

E) 375 J

Correct: D

Name: 6A\_14

Which of the following IS possible to accomplish with 80 J of energy?

A) Push with a force of 4 N for 25 meters

B) Push with a force of 8 N for 100 meters.

C) Push with a force of 40 N for 25 meters.

D) Push with a force of 80 N for 10 meters.

E) Push with a force of 160 N for 0.25 meters

Correct: E

Name: 6A\_15

The graphs represent the state of a system before and after a change. What is the

minimum amount of work that must be done to the system to accomplish the change?

A) 0 J

B) 10 J

C) 20 J

D) 40 J

E) 50 J

Correct: B

Explanation: The net increase in energy is 30 - 20 = +10 J

Name: 6B\_1

The graph above claims to represent the potential and kinetic energy of a marble rolling

along a track that changes slope. The marble is said to have no external or internal source

of additional energy. Which time shows behavior that is impossible without additional

energy?

A) between 0 and 5 seconds.

B) between 5 and 10 seconds.

C) between 10 and 15 seconds.

D) between 15 and 20 seconds.

E) between 20 and 25 seconds.

Correct: C

Explanation: During this period the kinetic energy decreases by 40 J but the potential

energy increases by 60 J.

Name: 6B\_2

A 10 kg wagon is started from rest at the top of a hill according to the diagram above.

Which variable has a value of zero at the moment the wagon is released?

A) h0

B) v0.

C) h.

D) g.

E) m.

Correct: B

Explanation: At the moment of release, the initial velocity is zero if the wagon starts at

rest.

Name: 6B\_3

A 10 kg wagon is started from rest at the top of a frictionless hill according to the

diagram above. What is the approximate kinetic energy of the wagon at a height of 2.5

meters?

A) 980 J.

B) 490 J.

C) 245 J.

D) 50 J.

E) 25 J.

Correct: C

Name: 6B\_4

A ball is thrown straight down with an initial speed of 5 m/s. Assume zero air friction.

One second later, the kinetic of the ball is

A) less than the initial kinetic energy.

B) equal to the ball's initial potential energy.

C) equal to the ball's initial kinetic energy.

D) equal to the potential energy lost by the ball as it fell.

E) greater than the initial kinetic energy.

Correct: E

Name: 6B\_5

Which of the diagrams above best represents how you would use the conservation of

energy to predict the maximum height reached by a ball thrown up in the air.

A) A

B) B

C) C

D) D

E) None of the above.

Correct: A

Name: 6B\_6

Which of the following best describes potential energy?

A) energy of position.

B) energy of motion.

C) total energy not used.

D) energy that is measured in joules.

E) the difference between energy used and energy available.

Correct: A

Name: 6B\_7

The Moon has much weaker gravity than Earth. Consider a 1 kg object thrown upward

with an initial speed of 5 m/s on the Moon and on Earth. Which of the following

statements is NOT true?

A) When first thrown, the object's kinetic energy is the same on Earth and Moon.

B) The object's maximum potential energy is the same on Earth and Moon.

C) The object's maximum height is the same on Earth and on the Moon.

D) At the same height, both objects have the same total energy.

E) At the same speed, both objects have the same total energy.

Correct: C

Explanation: This is a difficult problem. Kinetic energy is independent of gravity so is the

same, therefore potential energy, and total energy are also the same, at any height or any

speed. However, the maximum height is different because the moon's weaker gravity

means the same potential energy on Earth occurs at a greater height on the Moon.

Name: 6B\_8

A 2 kg ball is dropped from a height of 20 meters. Neglecting air friction, how fast is the

ball going when it hits the ground?

A) 9.8 m/s.

B) 14.0 m/s.

C) 19.6 m/s.

D) 196 m/s.

E) 392 m/s.

Correct: C

Name: 6B\_9

A car on a frictionless roller coaster ride starts at a height of 30 meters. What is the speed

of the car after two hills when its height is 12 meters?

A) 10.8 m/s.

B) 13.3 m/s.

C) 15.3 m/s.

D) 18.8 m/s.

E) 24.2 m/s.

Correct: D

Explanation: The decrease in potential energy is from the drop of 18 m, which creates an

equal increase in kinetic energy.

Name: 6B\_10

A cyclist racing at a speed of 20 m/s comes to a hill that is 20 meters (60 feet) high when

his chain snaps so he can no longer pedal. Assuming no friction, what happens?

A) He coasts part way up but cannot get to the top and rolls back down.

B) He coasts all the way up to the top but has zero velocity when he gets there so he

stops.

C) He coasts up to the top with enough speed to keep going at 2.8 m/s.

D) He coasts up to the top with enough speed to keep going at 5.6 m/s.

E) We need the cyclist/bicycle mass to solve the problem.

Correct: C

Name: 6B\_11

A spring is used to launch a ball into the air. If the ball has a mass of 0.25 kg, and the

spring is compressed 10 cm, what is the maximum height the ball can reach?

A) 0.76 m

B) 3.1 m

C) 6.1 m

D) 12.2 m

E) 27.6 m

Correct: B

Name: 6B\_12

A ball is launched by a spring. The ball has a mass of 0.5 kg and the spring has a spring

constant of 30,000 N/m. How far must the spring be compressed so the ball has a launch

speed of 20 m/s (45 mph)?

A) 5.8 cm

B) 8.2 cm

C) 14.0 cm

D) 20.4 cm

E) 5.8 m (5,800 cm)

Correct: B

Name: 6B\_13

A car with a mass of 1,200 kg has four springs that are part of its shock absorbing system.

If the spring constant is 10,000,000 N/m and the springs are deflected 12 cm (0.12 m),

how much energy is stored in the springs? How does this compare to the kinetic energy

of the car ar a speed of 14 m/s (33 mph)?

A) 7,200 J and is negligible compared to the kinetic energy of the car.

B) 72,000 J and is about half the kinetic energy of the car.

C) 72,000 J and is more than the kinetic energy of the car.

D) 144,000 J, which is about equal to the kinetic energy of the car.

E) 144,000 J, which is more than twice the kinetic energy of the car.

Correct: B

Name: 6C\_1

A conveyor belt lifts 150 kilograms of rocks every second up a height of 10 meters.

What is the minimum power required by this conveyor belt? You may assume no friction.

A) 160 W

B) 1,500 W

C) 7,350 W

D) 14,700 W

E) 29,400 W

Correct: D

Explanation: The change in potential energy is 14,700 joules in one second.

Name: 6C\_2

An investment company proposes to build a small hydroelectric dam that produces

50,000 watts of electric power from a river in which 2,000 kilograms of water *per minute*

flow down a slope that drops 40 meters. Which choice best evaluates this proposal from

the perspective of physics?

A) The dam could be bigger because the potential energy change in the falling water

is 100,000,000 joules per second. This is much more than the claimed 50,000

watts of electric power.

B) The dam could be bigger because the potential energy change in the falling water

is 784,000 joules per second. This is much more than the claimed 50,000 watts of

electric power.

C) The dam is just about right because the change in potential energy of the falling

water is around 60,000 joules per second. This allows for some losses due to

friction.

D) The dam is impossible because the change in potential energy of the falling water

is only about 53,000 joules per second, and during periods of low rainfall the

power would decrease below 50,000 watts.

E) The dam is impossible because the change in potential energy of the falling water

is only about 13,000 joules per second.

Correct: E

Explanation: There are 33.3 kilograms *per second* flowing down the river. That makes a

potential energy change of 13,067 J/sec.

How much power is required to propel a 1,000 kg car with a force of 100 N at a constant

speed of 30 m/s?

A) 100 watts

B) 130 watts

C) 3,000 watts

D) 30,000 watts

E) 450,000 watts

Correct: C

Explanation:100 N x 30 m/s = 3,000 N-m/s = 3,000 J/s = 3,000 watts.

Name: 6C\_4

Between 0 and 10 seconds, the graph above shows the potential and kinetic energy of a

bicycle rider descending a hill. How much power did the cyclist exert on this descent?

A) 200 watts

B) 300 watts

C) 400 watts

D) 600 watts

E) 1,000 watts

Correct: A

Explanation: The cyclist gains 6,000 J of kinetic energy but loses only 4,000 J of

potential energy so the difference is 2,000 J expended over 10 seconds for a power of 200

watts.

Name: 6C\_5

A 100 kg experimental vehicle travels at a constant speed of 50 m/s on a frictionless,

level track that is 1,000 meters long. It takes the vehicle 20 seconds to cover the length of

the track. What is the power required to maintain the vehicle's speed?

A) 0 watts

B) 625 watts

C) 1,000 watts

D) 6,250 watts

E) 49,000 watts

Correct: A

Explanation: moving at constant speed on a frictionless track requires no change in

energy, and no work is done therefore the power required is zero. The power is NOT zero

to accelerate the vehicle however.

Name: 6C\_6

An elevator lifts 700 kg to a height of 20 stories, or 35 meters. If the elevator takes 15

seconds, what is the minimum power is required from the elevator motor? Neglect

acceleration during starting and stopping.

A) 47 watts

B) 1,630 watts

C) 9,150 watts

D) 16,000 watts

E) 240,000 watts

Correct: D

Explanation: This is mainly a potential energy problem. The change in potential energy is

240,100 J divided by 15 seconds gives 16,007 watts. A very sharp student will realize

that the change in kinetic energy from rest to maximum speed is 1,800 J. This occurs

during the initial two or three seconds so the extra power required for acceleration is

around 600 watts.

Name: 6C\_7

Which of the following force vs. time graphs has the same total impulse as the example?

A) A

B) B

C) C

D) D

E) E

Correct: A

Explanation: Impulse is the area under the force vs. time graph.

Name: 6C\_8

Which delivers the greatest impulse.

A) A force of 2 N for 20 seconds

B) A force of 4 N for 40 seconds

C) A force of 8 N for 10 seconds

D) A force of 10 N for 5 seconds

E) A force of 20 N for 2 seconds

Correct: B

Explanation: Impulse is force multiplied by time and (B) is the largest at 160 N-s

Name: 6C\_9

A 2 kg stone ejected by a volcano has a speed of 90 m/s. The momentum of the stone is

closest to:

A) 2 kgm/s

B) 90 kgm/s

C) 180 kgm/s

D) 360 kgm/s

E) 8,100 km/s

Correct: C

Name: 6C\_10

A forensic reconstruction of an automobile accident indicates that one vehicle had a

momentum of 40,000 kgm/s. If the mass of the vehicle is 1,200 kg, what is the vehicle's

most likely speed just before the accident?

A) 0.3 m/s

B) 3.3 m/s

C) 33.3 m/s

D) 330 m/s

E) 3,300 m/s

Correct: C

Name: 6C\_11

A spring is extended 6 cm from its free length of 15 cm. What is the potential energy of

the spring?

A) 2.7 J

B) 5.4 J

C) 16.9 J

D) 33.1 J

E) 27,000 J

Correct: A

Name: 6C\_ 12

If you know that the kinetic energy of a 5 kilogram ball is 150 Joules, you also know the

object's

A) speed.

B) direction.

C) potential energy.

D) height.

E) force.

Correct: A

Explanation: Since Ek=1/2 mv2, knowing Ek and m uniquely determines v, the speed,

although not the direction (velocity).

Name: 6C\_13

A 1 kg large rubber ball hits the floor with a speed of -10 m/s (down). The ball bounces

back with a speed of +9 m/s (up). The ball is in contact with the floor for 0.25 seconds.

What is the average force exerted by the floor on the ball during the impact?

A) 4.7 N

B) 19 N

C) 36 N

D) 40 N

E) 76 N

Correct: E

Explanation: The change in momentum is 19 kgm/s over 0.25 s gives an average force of

76 N.

Name: 6C\_14

When serving, a tennis ball is almost motionless when it is slammed by the racquet. A

force sensor in an experimental tennis racquet measures a force of 80 N during the impact

with a 0.058 g tennis ball. The impact lasts for 0.04 seconds. If the ball was at rest

initially, what is its speed after the impact with the racquet?

A) 3.2 m/s

B) 4.6 m/s

C) 27 m/s

D) 55 m/s

E) 1,379 m/s

Correct: D

Explanation: The impulse is 3.2 N-s, which results in the same change in momentum.

Dividing by 0.058 g gives the speed of 55 m/s.

Name: 6D\_1

A small meteoroid with a mass of 2 kg collides with a satellite with a mass of 100 kg.

The speeds are different, but in the same direction, as shown in the diagram. Assume the

meteoroid punches through the outer shell of the satellite and is trapped inside so the

collision is *inelastic*. What is the speed of the satellite after the collision?

A) 225 m/s.

B) 2,549 m/s.

C) 3,333 m/s.

D) 6,667 m/s.

E) 17,000 m/s.

Correct: D

Explanation: The increase in momentum is 40,000 kgm/s making the total momentum of

the system 340,000 kgm/s. Dividing by the total mass gives a speed of 3,333 m/s.

Name: 6D\_2

Two laboratory carts collide in a perfectly elastic collision. What is the speed and

direction of cart B after the collision?

A) -1 m/s

B) 1 m/s

C) 2 m/s

D) 4 m/s

E) -4 m/s

Correct: D

Explanation: conserve linear momentum and energy.

Name: 6D\_3

Which is NOT true of a perfectly *inelastic* two-body collision?

A) The total momentum after the collision is the same as it was before the collision.

B) The total kinetic energy after the collision is the same as it was before the

collision.

C) The momentum of one body may be completely transferred to the other body.

D) The kinetic energy of one body may be completely transferred to the other body.

E) The total mass of the two bodies remains unchanged by the collision.

Correct: B

Explanation: Kinetic energy is not conserved in inelastic collisions.

Name: 6D\_4

A clay ball collides with a rubber ball and the two balls stick together. What is the speed

of the combination of balls after the collision in the diagram?

A) -5.0 m/s

B) -2.5 m/s

C) 0.0 m/s

D) +2.5 m/s

E) +5.0 m/s

Correct: C

Explanation: The total momentum of the system is zero

Name: 6D\_5

The total momentum of the system above is:

A) -13 kgm/s

B) -3 kgm/s

C) 0 kgm/s

D) +3 kgm/s

E) +13 kgm/s

Correct: D

Explanation: The total momentum of the system is the vector sum of the momenta of

each particle.

Name: 6D\_6

There is a value of the unknown speed, *v*, for which the total momentum of the system is

zero. What is the *kinetic energy* of the system when the total momentum is zero?

A) 0 J

B) 4 J

C) 8 J

D) 12 J

E) 24 J

Correct: D

Explanation: The total momentum of the system is zero when v = -2 m/s. This makes the

total kinetic energy 12 joules.

Name: 6D\_7

Two skaters perform a routine in which they skate toward each other and one catches the

other, moving together after the catch. What is the speed of the pair after the collision?

A) -1.8 m/s

B) -0.3 m/s

C) 0.0 m/s

D) +0.3 m/s

E) +1.8 m/s

Correct: B

Explanation: This is an inelastic collision that conserves momentum.

Name: 6D\_8

A 2 kg laboratory cart rolls 1.5 meters down a ramp. The height of the cart changes by

0.3 meters between the start and the point where it is shown on the diagram. What is the

speed of the cart at this point if there is no friction?

A) 1.7 m/s

B) 2.4 m/s

C) 5.4 m/s

D) 5.9 m/s

E) 29.4 m/s

Correct: B

Explanation: final kinetic energy = initial potential energy.