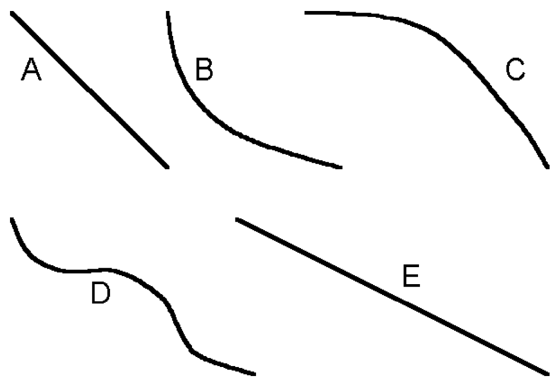
Name: ________________________ Class: ___________________ Date: __________ ID: A

Unit 2- Energy and Momentum Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following is not a unit of energy?
a. J
b. $kg \cdot m^2 / s^2$
c. N·m
d. W·s
e. $kg \cdot m / s^2$

____ 2. As a student lifts a 4.5-kg book bag 120 cm into the air, the amount of work that the force of gravity does on the bag is
a. 5.4 J
b. 53 J
c. 540 J
d. –5.4 J
e. –53 J



____ 3. A race is set up with five balls placed at the top of the five ramps shown below and released at the same instant. Each ramp drops the same vertical height. That ramp that will allow the ball to arrive at the bottom last is
a. A
b. B
c. C
d. D
e. E

____ 4. A 5.0-kg cat travelling at 1.3 m/s [E] has a momentum of
a. 6.5 m/s [E]
b. 6.5 m/s [W]
c. 3.8 m/s [E]
d. 3.8 m/s [W]
e. none of the above

____ 5. A bullet with a momentum of 2.8 kg·m/s [E] is travelling at a speed of 187 m/s. The mass of the bullet is
a. 0.015 g
b. 0.067 g
c. 15 g
d. 67 g
e. not enough information

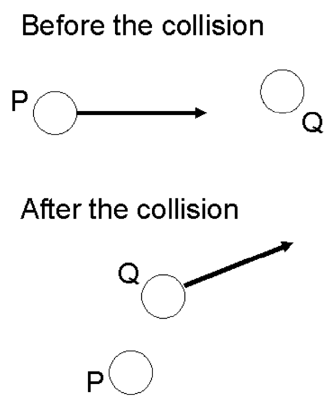
____ 6. A net force of 12 N changes the momentum of a 250-g ball by 3.7 kg·m/s. The force acts for
a. 0.31 s
b. 0.81 s
c. 1.2 s
d. 3.2 s
e. 44 s

____ 7. A shell is fired from a gun mounted on a battleship. Which of the following statement is NOT true?
a. There will be a force to push the boat in the opposite direction of the shell.
b. The recoil spring on the barrel is to minimize the force on the deck of the ship.
c. Neglecting fluid friction, the momentum of the boat and shell have the same magnitude.
d. To calculate the speed of the boat we would need to know the recoil length of the gun.
e. A larger mass of shell will increase the recoil force felt by the ship.

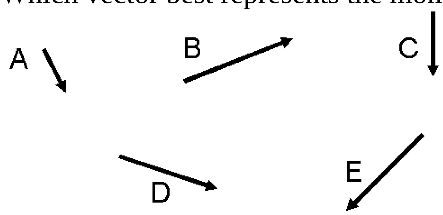
____ 8. A 55-kg person carrying a 5.0-kg ball slides along a horizontal frictionless surface. He tosses the ball perpendicular to his direction of travel relative to himself.
a. His path will not change.
b. The ball will have a smaller angle from the original path than he will.
c. His speed does not change.
d. He speeds up.
e. He slows down.

____ 9. Two young sisters with a combined mass of 75 kg ride on a cart of mass 30.0 kg travelling at 2.0 m/s. If they jump off together so they land with zero speed relative to the ground, the change in speed of the cart is
a. 0 m/s
b. 2.0 m/s
c. 4.0 m/s
d. 5.0 m/s
e. 7.0 m/s

____ 10. Two objects strike a glancing blow. The diagram below shows the momenta of some of the objects are shown before and after the collision.



Which vector best represents the momentum of object P after the collision?



a. A
b. B
c. C
d. D
e. E

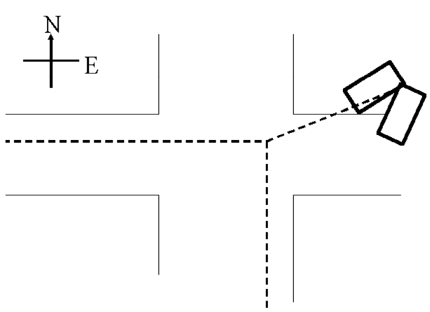
Completion
Complete each statement.

11. No work is done when the angle between the force and the displacement is ____________________.

12. To indicate a downward vertical displacement we place a _________________________ in front of the numerical value.
13. Gravitational potential energy is due to ____________________ above Earth's surface.
14. Friction causes kinetic energy to transform into ____________________ energy.
15. Thermal energy occurs when the ____________________ inside an object begin to speed up.
16. A spring with a force constant of 34 N/m is ____________________ to stretch than a spring with a force constant of 42 N/m.
17. A rotating object possesses ____________________ momentum.
18. A ball is dropped and bounces back to its original height. The collision between the ball and the ground was ____________________.
19. A ball is dropped and bounces back to 90% of its original height. The collision between the ball and the ground was ____________________.
20. If you squeeze a rubber ball and it springs back slowly, a collision involving that ball will most likely be ____________________.

Short Answer

21. Will a spring-operated bathroom scale (that gives a reading in kilograms) give the correct mass reading on the Moon?
22. When a car travels down a highway, only about 25% of the chemical potential energy from the gasoline is converted to kinetic energy. Name two other forms of energy that are produced.
23. Give two observations that would enable you to conclude that the bounce of a superball is not a completely elastic collision.
24. A 0.25-kg snowball moving at 15 m/s [E] collides and sticks with a 1.9-kg toy truck travelling at 2.8 m/s [W]. Neglecting friction, calculate the velocity of the snowball–truck system after the collision.



25. By observing the aerial diagram of an accident scene between two identical cars, which car was travelling more quickly?

Name: ________________________ **ID: A**

Problem

26. A 1.00-kg mass and a 2.00-kg mass are set gently on a platform mounted on an ideal spring of force constant 40.0 N/m. The 2.00-kg mass is suddenly removed. How high above its starting position does the 1.00-kg mass reach?

27. An 87-g box is attached to a spring with a force constant of 82 N/m. The spring is compressed 11 cm and the system is released.
(a) What is the speed of the box when the spring is stretched by 7.0 cm?
(b) What is the maximum speed of the box?

28. A bullet with a mass of 45 g is fired into a 8.3-kg block of wood resting on a floor against a spring. This ideal spring (k = 76 N/m) has a maximum compression of 28 cm. What was the initial speed of the bullet?

Unit 2- Energy and Momentum Test
Answer Section

MULTIPLE CHOICE

1. ANS: E PTS: 1 REF: K/U OBJ: 4.1
   STA: EM1.01
2. ANS: E PTS: 1 REF: K/U OBJ: 4.3
   STA: EM1.01
3. ANS: C PTS: 1 REF: K/U OBJ: 4.3
   STA: EM1.01
4. ANS: E PTS: 1 REF: C OBJ: 5.1
   STA: EM1.01
5. ANS: C PTS: 1 REF: K/U OBJ: 5.1
   STA: EM1.01
6. ANS: A PTS: 1 REF: K/U OBJ: 5.1
   STA: EM1.01
7. ANS: D PTS: 1 REF: MC OBJ: 5.2
   STA: EM3.01
8. ANS: D PTS: 1 REF: K/U OBJ: 5.4
   STA: EM1.03
9. ANS: D PTS: 1 REF: K/U OBJ: 5.2
   STA: EM1.03
10. ANS: A PTS: 1 REF: I OBJ: 5.4
    STA: EM1.03

COMPLETION

11. ANS: 90°

    PTS: 1 REF: K/U OBJ: 4.1 STA: EM1.01
12. ANS: negative sign

    PTS: 1 REF: C OBJ: 4.3 STA: EM1.01
13. ANS:
    elevation
    position

    PTS: 1 REF: C OBJ: 4.3 STA: EM1.01
14. ANS: thermal

    PTS: 1 REF: C OBJ: 4.4 STA: EM1.01

15. ANS:
molecules
atoms
particles

PTS: 1 REF: K/U OBJ: 4.4 STA: EM1.03

16. ANS: easier

PTS: 1 REF: K/U OBJ: 4.5 STA: EM1.08

17. ANS: angular

PTS: 1 REF: K/U OBJ: 5.1 STA: EM1.01

18. ANS: elastic

PTS: 1 REF: C OBJ: 5.3 STA: EM1.04

19. ANS: inelastic

PTS: 1 REF: C OBJ: 5.3 STA: EM1.04

20. ANS: inelastic

PTS: 1 REF: C OBJ: 5.3 STA: EM1.04

SHORT ANSWER

21. ANS:
No, the spring scale is calibrated with the assumption that the gravitational field strength is 9.8 N/kg. On the moon, the value is less than 9.8 N/kg, so the scale reading will be too small.

PTS: 1 REF: MC OBJ: 4.5 STA: EM1.08

22. ANS:
thermal, sound, electrical, electromagnetic, gravitational potential energy if going uphill

PTS: 1 REF: K/U OBJ: 4.5 STA: EM1.01

23. ANS:
- The ball does not reach its original height after the bounce. (some loss of energy)
- Sound is produced. (sound energy must come from original kinetic energy)

PTS: 1 REF: K/U OBJ: 5.3 STA: EM1.04

24. ANS:
Choose east as the +*x* direction.
$m_s v_s + m_t v_t = (m_s + m_t) v_{st}$

$$v_{st} = \frac{m_s v_s + m_t v_t}{m_s + m_t}$$

$$= \frac{(0.25\ \text{kg})(15\ \text{m/s}) + (1.9\ \text{kg})(-2.8\ \text{m/s})}{0.25\ \text{kg} + 1.9\ \text{kg}}$$

$$v_{st} = -0.73\ \text{m/s}$$

The final velocity is 0.73 m/s [W].

PTS: 1 REF: K/U OBJ: 5.2 STA: EM1.02

25. ANS:
The eastbound car had more momentum. Since the cars are identical, the eastbound car must have been moving faster.

PTS: 1 REF: I OBJ: 5.4 STA: EM1.03

PROBLEM

26. ANS:
Calculate the original compression:

$$F = kx$$

$$mg = kx$$

$$x = \frac{mg}{k}$$

$$= \frac{(3.00\ \text{kg})(9.80\ \text{m/s}^2)}{(40.0\ \text{N/m})}$$

$$x = 0.735\ \text{m}$$

Using conservation of energy,

$$E_{\text{T1}} = E_{\text{T2}}$$

$$\tfrac{1}{2}kx^2 = mg\Delta y$$

$$\Delta y = \frac{kx^2}{2mg}$$

$$= \frac{(40\ \text{N/m})(0.735\ \text{m})^2}{2(1.00\ \text{kg})(9.80\ \text{m/s}^2)}$$

$$\Delta y = 1.10\ \text{m}$$

The 1.00-kg mass reaches a maximum height of 1.10 m above its start position.

PTS: 1 REF: K/U OBJ: 4.5 STA: EM1.03

27. ANS:
(a) The total energy is conserved, so
Noting that all the original energy is elastic potential,

$$E_T = E'_T$$

$$\frac{1}{2}kx^2 = \frac{1}{2}kx'^2 + \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{k}{m}(x^2 - x'^2)}$$

$$= \sqrt{\frac{82\ \text{N/m}}{0.087\ \text{kg}}\left((0.11\ \text{m})^2 - (0.070\ \text{m})^2\right)}$$

$$v = 2.6\ \text{m/s}$$

The speed at a stretch of 7.0 cm is 2.6 m/s.

(b) The total energy is conserved.
All of the original energy is elastic potential, and all of the final energy will be kinetic,

$$E_T = E'_T$$

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

$$v = \sqrt{\frac{k}{m}x^2}$$

$$= \sqrt{\frac{82\ \text{N/m}}{0.087\ \text{kg}}(0.11\ \text{m})^2}$$

$$v = 3.4\ \text{m/s}$$

The maximum speed is 3.4 m/s.

PTS: 1 REF: K/U OBJ: 4.5 STA: EM1.08

28. ANS:

First use conservation of energy after the collision until the maximum compression:

$$E_T = E'_T$$

$$\tfrac{1}{2} m v_{bw}^2 = \tfrac{1}{2} k x^2$$

$$v_{bw} = \sqrt{\frac{kx^2}{m}}$$

$$= \sqrt{\frac{(76\ \text{N/m})(0.28\ \text{m})^2}{8.345\ \text{kg}}}$$

$$v_{bw} = 0.8450\ \text{m/s}$$

Now use conservation of momentum for the collision:

$$p = p'$$

$$m_b v_b = (m_b + m_w) v_{wb}$$

$$v_b = \frac{(m_b + m_w) v_{wb}}{m_b}$$

$$= \frac{(0.045\ \text{kg} + 8.3\ \text{kg})(0.8450\ \text{m/s})}{0.045\ \text{kg}}$$

$$v_b = 1.6 \times 10^2\ \text{m/s}$$

The impact speed of the bullet was 1.6×10^2 m/s.

PTS: 1 REF: K/U OBJ: 5.3 STA: EM1.02