Name: _____ Period: _____

Instructor: Mr. Rodriguez Score:_____/??

Final Exam

Conceptual Physics A
Fall 2024

Learning Standard 3.1: The Law of Conservation of Energy

Multiple Choice: Circle **one** option per question.

1. (2 points) Which of the following statements best describes the law of conservation of energy?

   A. Energy can be created or destroyed, but it cannot change from one form to another.
   B. Energy can be transferred or transformed but is always lost in the process.
   C. Energy cannot be created or destroyed; it can only change from one form to another.
   D. Energy can only be conserved in closed systems, and is always constant in open systems.

2. (2 points) What are the SI (metric) units of energy?

   A. Newtons (N)
   B. kilograms (kg)
   C. Joules (J)
   D. meters per second (m/s)

Fill in the Blank: For each blank space, choose **one** item from the word bank below that best fits.

Word Bank

- Chemical
- Electrical
- Elastic
- Gravitational Potential
- Kinetic
- Light
- Sound
- Thermal

3. (3 points) Use the word bank above identify which types of energy are converted into which other types of energy by each machine.

   (a) A **loudspeaker** converts _____ energy into _____ energy.

   (b) A **solar panel** converts _____ energy into _____ energy.

   (c) A **car engine** converts _____ energy into _____ energy.

   (d) A **flashlight** converts _____ energy into _____ energy.

   (e) A **slingshot** converts _____ energy into _____ energy.

   (f) A **waterfall turbine generator** converts _____ energy into _____ energy.

Free Response Questions: Answers must be in **complete sentences** to receive full credit.

4. (3 points) Use your knowledge of the law of conservation of energy to explain how *all* energy on Earth actually came from the Sun at one point or another. Make sure to include the following terms in your argument: *solar, plants, animals, chemical energy, humans, fossil fuels.*

5. (3 points) You are sitting on a jet plane on your way from San Francisco to New York City. While aboard the plane, the plane moves at a constant velocity of $\mathbf{v} = 600\,\text{mph}$ eastward. You take a coin and flip it directly upwards, after which is falls perfectly back in your hand. Explain in physics terms why the coin falls back into your hand rather than flying away from you at $\mathbf{v} = -600\,\text{mph}$.

Learning Standard 2.2: Newton's Second Law of Motion

Multiple Choice: Circle **one** option per question.

6. (2 points) What is Newton's Second Law?

   A. All objects move in straight lines forever.
   B. The force exerted on an object is equal to its mass times its acceleration.
   C. An object will only change its state of motion or rest if acted upon by an external force.
   D. For every action, there is an equal and opposite reaction.

7. (2 points) In everyday life, we often alter the motion of the objects around us by either **pushing** or **pulling** them.

   (a) What physical quantity corresponds to such a push or a pull?

   A. Weight
   B. Velocity
   C. Force
   D. Mass

   (b) What are the SI **units** of this quantity?

   A. newtons (N)
   B. kilograms (kg)
   C. meters per second (m/s)
   D. joules (J)

Free Response Questions: Answers must be in **complete sentences** to receive full credit.

8. (3 points) You are on a spaceship deep in outer space, far away from any planets or stars (*i.e.*, there is **no gravity**). In your large and otherwise empty spaceship, there are two unmarked, equally sized boxes floating next to you. One box is full of Q-tips, and the other is full of bricks. Explain how you can use Newton's Second Law to determine which box is full of Q-tips and which box is full of bricks.

9. (3 points) You are building a house out of hay. With your acute physical senses, you have discerned that you need to apply 3 N of force to accelerate one bale of hay at $2\,\mathrm{m/s^2}$. How much force would you need to accelerate 200 bales of hay at once at $2\,\mathrm{m/s^2}$?

Learning Standard 2.3: Newton's Third Law of Motion

Multiple Choice: Circle **one** option per question.

10. (2 points) What is Newton's Third Law?

    A. An object will only change its state of motion or rest if acted upon by an external force.
    B. For every action, there is an equal and opposite reaction.
    C. All objects move in straight lines forever.
    D. The force exerted on an object is equal to its mass times its acceleration.

11. (2 points) When you use your arms to throw a baseball upwards from the surface of the Earth, the ball briefly accelerates upwards at the beginning of your toss. During this moment, which of the following quantities associated with the baseball has the **same** magnitude as a corresponding quantity associated with you?

    A. The force exerted by your arms on the ball.
    B. The acceleration of the baseball towards you.
    C. The velocity of the baseball.
    D. The mass of the baseball.

Free Response Questions: Answers must be in **complete sentences** to receive full credit.

12. (3 points) A BART train going 80 mph on the subway collides head on with a speck of dust.
    (a) How do the forces on the BART train and the speck of dust compare?

    (b) How do their accelerations compare during the impact?

13. (3 points) You are on a tall ladder pushing upwards with all your might against the ceiling of the physics classroom. What is the action force? What is the corresponding reaction force?

Learning Standard 2.4: Free Body Diagrams

'Twas the night before Christmas, when all through the house... Not a creature was stirring, not even a mouse....
The Grinch has stolen all of the presents in Whoville! The Grinch has not thought his plan through very carefully, however, and now he needs to bring the presents back to his lair... He decides to employ his little dog Max to pull the sleigh.

14. (2 points) While Max the dog pulls to the left, he creates a tension force **T** in the reigns of the sleigh. As the sleigh budges forwards on the snowy ground, the friction between the pavement and the bottom the sleigh generates a force $\mathbf{F_{fr}}$ opposing the motion of the sleigh. Draw arrows to represent the **four** forces acting on the sleigh below. Be sure to label each of the four forces as well.

15. (2 points) The Grinch, in his cunning and duplicitous ways, managed to steal 50 PlayStations, 30 pairs of Jordans, 500 Macbook Airs, 200 Airpods, and 100 Starbucks gift cards.

PRESENT TYPE	PER UNIT MASS (kg)
PlayStation	10
Pair of Jordans	5
Macbook Air	12
Airpods	0.5
Starbucks gift card	0.1

Use the chart above to calculate the total mass (m) of the presents in kilograms.

16. (2 points) Use your result from the previous problem to calculate the magnitude of the normal force (**N**) that must be supplied by the snowy ground to keep the sleigh from falling downwards through the Earth. Take the acceleration of gravity to be $g = 10\,\mathrm{m/s^2}$.

17. (2 points) Instilled with the strength of Christmas spirit, Max is able to pull with a force of 1200 N, while the friction opposing his motion is $\mathbf{F_{fr}} = 700\,\mathrm{N}$. What is the **net horizontal force** ($\sum \mathbf{F}$) on the sleigh?

18. (2 points) Using your results for the mass (m) and the net force ($\sum \mathbf{F}$) from the previous questions, calculate the acceleration ($\mathbf{a}$) on the sleigh.