Name: _____ Period: _____

Instructor: Mr. Rodriguez Course: Conceptual Physics A

Term: Winter 2024-25

# Midterm Exam Review

Be sure to show your work, include units when appropriate, and box your answers.

**Learning Standard 1**

*Scientific Measurement and Estimation* **Score:** _____ /10 **Grade:**

Topics include:

- The metric system
- Scientific notation
- Significant figures
- Averages
- Percent Error

| Prefix | Symbol | Meaning | Expanded Form | Scientific Form |
|---|---|---|---|---|
| giga- | G | one billion | 1,000,000,000 | $\times 10^{9}$ |
| mega- | M | one million | 1,000,000 | $\times 10^{6}$ |
| kilo- | k | one thousand | 1,000 | $\times 10^{3}$ |
| hecto- | h | one hundred | 100 | $\times 10^{2}$ |
| – | – | one | 1 | $\times 10^{0}$ |
| centi- | c | one hundredth | 0.01 | $\times 10^{-2}$ |
| milli- | m | one thousandth | 0.001 | $\times 10^{-3}$ |
| micro- | $\mu$ | one millionth | 0.000001 | $\times 10^{-6}$ |
| nano- | n | one billionth | 0.000000001 | $\times 10^{-9}$ |

**Table 1:** Metric Prefixes Conversion Chart

## LS 1 Sample Questions

1. In your own words, provide at least **two** reasons as to why the metric system is useful to scientists.

   **Solution:** The metric system is the preferred unit system of scientists because

   1. Nearly all countries use it worldwide (save for USA, Myanmar, and Libya) making it a common language for expressing scientific information.
   2. All of the base units use the same set of prefixes (*e.g.*, kilo-, centi-).
   3. All conversions are connected by factors of ten (*e.g.* $1\,\text{km} = 10^3\,\text{m}$).

2. Place either a $<$, $>$, or $=$ sign in the blank.
   (a) 1 kg $>$ 10 g
   (b) 500 g $<$ 1 kg
   (c) 2 m $=$ 200 cm
   (d) 1 mm $<$ 0.1 m
   (e) 1 L $=$ 1000 mL
   (f) 1 cm $=$ 10 mm

3. Fill in the blank with the correct number.
   (a) 1 kg = 1000 g
   (b) 5 kg = 5000 g
   (c) 250 g = 0.25 kg
   (d) 1 m = 100 cm
   (e) 1 km = 1000 m
   (f) 15 mm = 1.5 cm

4. Express each of the following in scientific notation:
   (a) 500 = $5.00 \times 10^2$
   (b) 0.00000012 = $1.2 \times 10^{-7}$
   (c) 7500 = $7.5 \times 10^3$
   (d) 0.02 = $2.0 \times 10^{-2}$
   (e) 123000 = $1.23 \times 10^5$

5. Express each of the following in decimal (expanded) form:
   (a) $4.56 \times 10^2$ = 456
   (b) $7.5 \times 10^{-3}$ = 0.0075
   (c) $3.14 \times 10^5$ = 314000
   (d) $9.8 \times 10^{-8}$ = 0.000000098
   (e) $1.2 \times 10^1$ = 12
   (f) $8.25 \times 10^3$ = 8250

**Learning Standard 2**

*Linear Motion* **Score:** _____ /10 **Grade:**

Topics include:

- Position ($x$), time ($t$), displacement ($\Delta x$), speed ($v = \frac{\Delta x}{\Delta t}$), velocity ($\mathbf{v}$), and acceleration ($a = \frac{\Delta v}{\Delta t}$).
- Interpreting ticker tape data.
- Interpreting graphs of motion (position vs. time, speed vs. time).
- Converting frequency in Hertz to periods of time in seconds or microseconds.
- Free fall due to gravity ($g = 9.8\,\mathrm{m/s^2}$)
- Kinematics equations:

**1D Kinematics Equations**

$$x(t) = \frac{1}{2}at^2 \qquad \text{(position as a function of time)}$$

$$v(t) = at \qquad \text{(velocity as a function of time)}$$

## LS 2 Sample Questions

6. Speed represents a change in an object's _____**position**_____ divided by its change in _____**time**_____.

7. Acceleration represents a change in an object's _____**speed**_____ divided by its change in _____**time**_____.

8. The difference between speed and velocity is that speed is a _____**scalar**_____ quantity whereas velocity is a _____**vector**_____ quantity.

9. You drop your phone from a height of 10 m. Take the acceleration of gravity to be $g = 10\,\mathrm{m/s^2}$.

(a) How long does it take to hit the floor?

**Solution:** Start by identifying the **knowns** and the **unknowns**.

**Known:**

- The height is $x = 10\,\mathrm{m}$.
- The acceleration is $g = 10\,\mathrm{m/s^2}$.

**Unknown:**

- The amount of time ($t$) it takes hit the floor.

Now we just need to choose the relevant equation. Looking back to the previous page in the Kinematics Equation box, we see that $x = \frac{1}{2}at^2$ contains the relevant variables. Now we solve for $t$:

$$\frac{1}{2}gt^2 = x \qquad \text{(position equation)}$$
$$gt^2 = 2x \qquad \text{(multiply both sides by 2)}$$
$$t^2 = \frac{2x}{g} \qquad \text{(divide both sides by } a\text{)}$$
$$t = \sqrt{\frac{2x}{g}} \qquad \text{(take square root of both sides)}$$
$$t = \sqrt{\frac{2 \times (10\,\mathrm{m})}{(10\,\mathrm{m/s^2})}} \qquad \text{(plug in numbers)}$$
$$t \approx \boxed{1.4\,\mathrm{s}} \qquad \text{(simplify)}$$

(b) How fast is it going once it hits the floor?

**Solution:** This time we need the other equation: $v = at$.

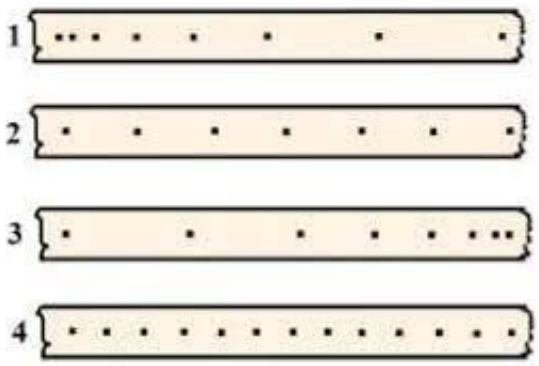
**Known:**

- The time is $t = 1.4\,\mathrm{s}$.
- The acceleration is $g = 10\,\mathrm{m/s^2}$.

**Unknown:**

- The speed $v$ when it hits the floor.

$$v = at \qquad \text{(speed equation)}$$
$$v = (10\,\mathrm{m/s^2})(1.4\,\mathrm{s}) \qquad \text{(plug in numbers)}$$
$$v = \boxed{14\,\mathrm{m/s}} \qquad \text{(simplify)}$$




10. The above image shows samples from four different ticker tape trials of an object's motion. The starting point of each is on the left-hand side. Fill in the blank below:

    (a) Sample ____**1**____ represents an object accelerating.

    (b) Sample ____**3**____ represents an object decelerating.

    (c) Samples ____**2**____ and ____**4**____ represent an object moving with constant speed.

    (d) Of the samples that represent constant speed, sample ____**4**____ represents an object moving with a higher speed than sample ____**2**____.

| Learning Standard 3 | | |
|---|---|---|
| *Newton's Laws and Forces* | **Score:** _____ /10 | **Grade:** |

Topics include:

- Inertia
- Newton's Three Laws
- $\mathbf{F} = m\mathbf{a}$
- Action-reaction pairs
- Mass ($m$), force ($\mathbf{F}$), and acceleration ($\mathbf{a}$).
- Net force ($\Sigma F$)
- Free-body diagrams (force arrow diagrams)
- Mass ($m$) vs. Weight ($mg$)
- The normal force ($F_N$)
- Pulling forces ($F_p$)
- Static and kinetic coefficients of friction ($\mu_S$ and $\mu_K$)
- The kinetic friction force ($F_{fr} = \mu_K F_N$)

## LS 3 Sample Problems

11. Inertia is an object's tendency to _____**resist a change in motion**_____.

12. State Newton's First Law in your own words.

13. Newton's Second Law says that the net force on an object ($\Sigma F$) is equal to the object's _____**mass**_____ times its _____**acceleration**_____.

14. You are pushing a crate with a mass of $m = 75\,\text{kg}$.
    (a) How much force will you need to push with to accelerate the crate at $0.25\,\text{m/s}^2$?

    (b) If you pushed a crate of twice the mass with the same amount of foce, what would its acceleration be?

15. Newton's Third Law says that every _____**action force**_____ has an equal and opposite _____**reaction force**_____.

16. Give **two** examples of action-reaction pairs.

17. Is your **mass** the same on Earth as it is on the Moon? What about your **weight**? Why or why not?

18. A book is sitting on your desk. It has a mass of $m = 0.5\,\text{kg}$. Take the acceleration of gravity to be $g = 10\,\text{m/s}^2$.

    (a) What is the **weight** of the book?

    (b) What is the **normal force** ($\mathbf{F}_N$) that must be provided by the table to keep the book from moving downwards?

    (c) Say that the coefficient of static friction between the book and the surface of the table is $\mu_S = 0.35$. How much force would you need to push with to get the book to begin to move?

    (d) Once the book is moving, you find that you require less force to push it along at a constant speed. Why?

| Learning Standard 4 | | |
|---|---|---|
| *Momentum* | **Score:** _____ /10 | **Grade:** |

Topics include:

- Momentum ($\mathbf{p} = m\mathbf{v}$)
- The law of conservation of momentum
- Elastic and inelastic collisions
- Solving for unknown masses and velocities in collision problems

## LS 4 Sample Problems

1. Define momentum in your own words and explain what factors influence it.

2. Write the equation for momentum ($p$) and define each variable. What are the units of momentum?

3. State the Law of Conservation of Momentum.

4. A 1,500 kg car is traveling at 15 m/s. What is its momentum? Show your calculations and include units.

5. A 2 kg object moving at 3 m/s collides with a stationary 4 kg object. After the collision, the objects stick together. What is their final velocity? (Assume a perfectly inelastic collision and conservation of momentum.)

6. Describe the difference between elastic and inelastic collisions. Provide a real-world example of each.

7. A 3 kg ball moving at 6 m/s strikes a 1 kg ball at rest. After the collision, the 3 kg ball moves at 2 m/s. What is the velocity of the 1 kg ball after the collision? (Assume the collision is elastic.)

8. Two objects of different masses have the same momentum. What can you conclude about their velocities? Explain your reasoning.