Instructions: This test has the same format as before. Part A consists of short answer questions where you are to pick the best word, phrase, or choice of answer which best answers or, in some cases, defines the statement. Part B consists of longer answer questions. Make your answers clear and concise. If you need more room turn over the test paper and continue on the back but please write "over" on front. For problems it is the procedure that will be checked, not only the answer, so please try to make it clear. So for this, the second poeets' test of the term. Good Luck!

Declaration: I elect to do a (term paper, lab project). Please circle.

1. (10) REVIEW QUESTION PLUS: Choose from the physical quantities which we have discussed - length, area, volume, time, mass, force, velocity (or speed), acceleration, period - to identify the following quantities taken from problems.

   mass  a) 25.2 slugs  
   b) 21.3 cubic ft  
   c) 7.48 m/sec²  
   d) 4.92 sec  
   e) 5 sec/cycle 

   length  f) 3.74 lb sec²/ft  
   g) 1.43 mi  
   h) 1.85 m/sec  
   i) 23.4 m²  
   j) 5.3 in/sec  

   mass  k) 23.2 kg  
   l) 78.3 N 

   force  m) 3.54 lb  
   n) 33.2 Hz  
   o) 7.1 kg m/sec²

2. (4) For the following two length measurements indicate the precision and number of significant figures for each, add them, and multiply them using the rules strictly. (Include units.)

   Precision  No. of significant figures
   a) 8.3 cm  to the nearest tenth cm 0.1 cm 2
   b) 414 cm  to the nearest unit cm 0 ± 1 cm 3
   c) The sum of 8.3 cm + 414 cm equals 422 cm
   d) The product of 8.3 cm times 414 cm equals 3400 cm²

3. (2) A short pendulum was observed to make 60.5 complete swings or cycles in 87.6 sec. Its period is ?.

   Period = \( \frac{87.6 \text{ sec}}{60.5 \text{ cycles}} = 1.448 \text{ cycles} \) using "1" Rule.

4. (2) A person weighing 120 lb here on earth goes to planet X having a radius twice that of the earth and mass twice as large. The person will weigh ? on the surface of that planet.

   \( F_{\text{new}} = \frac{(1)(2)}{(5)(5)} (120 \text{ lb}) = 240 \text{ lb} \)

5. (2) A person weighing 120 lb here on earth goes to planet Y having a radius one-half that of the earth and mass 8 times greater than the earth. The person will weigh ? on the surface of that planet.

   \( F_{\text{new}} = \frac{(1)(2)}{(5)(5)} (120 \text{ lb}) = 960 \text{ lb} \)

6. (2) A person 4000 mi from the center of the earth weighs 120 lb. How much will she weigh at a distance of 8000 mi from the center?

   \( F_{\text{new}} = \frac{(1)(2)}{(5)(5)} (120 \text{ lb}) = 30 \text{ lb} \)

7. (1) The discoverer of the Universal Law of Gravitation is ?.

   Newton

8. (1) Kepler claimed that the planets in our solar system move in a geometric orbit called a ?.

   ellipse

9. (2) When a comet is closer to the sun, its speed (a) is faster (b) is slower or (c) does not change from what it is when it is a long ways away from the sun. (Choose one.)
The "orbital velocity" of the planet Mercury is (less than, equal to, greater than) that of the earth. (Choose one.)

The model of Ptolemy placed the ? at the center of the Universe

The Third Law of Kepler states that \( F \) is proportional to \( \frac{1}{r^2} \).

The following statement is technically correct: "As a car rounds a corner, there is a force which pushes the person to the side, namely a force that pushes the person to the side of the car opposite the turn." (True False)

For an object undergoing circular motion held by a string, the force exerted by the string on the object is called the ? force.

Does an object undergoing circular motion moving at constant speed have a net force of zero acting on it? (Yes, No) Why or why not?

Does an object undergoing circular motion moving at constant speed have an acceleration of zero? (Yes, No) Why or why not?

An airplane moving at constant speed drops a care package. If you neglect air friction, at the moment just before the package hits the ground, the airplane is (a) ahead of the package, (b) just above the package, (c) behind the package.

Answer question #17 if friction is included.

In the absence of air friction, a bullet "A" is shot from a horizontal gun at the same time a bullet "B", at the same height, is released from rest. Assuming the ground to be perfectly level, which, if either, hits the ground first? Explain (1) In the absence of friction both A and B fall vertically at the same rate.

Neglecting friction and assuming that the projectile returns to the original elevation, the projection angle necessary in order to provide maximum range of a projectile is ?.

The mass of a 96 lb object is ? while the weight of a 96 lb object is ?.

\[ W = mg \]
\[ m = \frac{W}{g} = \frac{96 \text{ lb}}{32 \text{ ft/s}^2} = 3.0 \text{ slugs} \]

The mass of a 19.6 kg box is ? while the weight of a 19.6 kg object is ?.

\[ W = mg \]
\[ m = \frac{W}{g} = \frac{19.6 \text{ kg} \times 9.8 \text{ m/s}^2}{5} = 192 \text{ N} \]

Describe the "reaction" force to the force exerted by a table on a book.

Describe the "reaction" force to the weight of an object.

What causes ocean tides? (a) the moon (b) the sun (c) the earth

Mainly the moon (or the sun) exerting a gravitational force on the waters of the earth.

Gravity acts on all bodies of the earth and causes tides on both sides of the earth. The sun and moon pull on the waters of the earth, producing high and low tides.

What causes ocean tides? (a) the moon (b) the sun (c) the earth

Mainly the moon (or the sun) exerting a gravitational force on the waters of the earth.

Gravity acts on all bodies of the earth and causes tides on both sides of the earth. The sun and moon pull on the waters of the earth, producing high and low tides.
2. (a)(3) REVIEW QUESTION PLUS: A force of 200 N is applied to a full grocery cart whose mass is 50 kg. There is a friction force of 50 N acting in the opposite direction. (a) Draw a diagram illustrating the forces. (b) What is the "Net Force" on the grocery cart? (c) What is the acceleration of the cart?

\[
\begin{align*}
\text{(b)} & \quad F = ma \\
\text{a} & = \frac{F}{m} \\
\text{a} & = \frac{150 \text{ N}}{50 \text{ kg}} = 3 \text{ m/s}^2
\end{align*}
\]

(d) How fast will the cart be moving after 5.0 sec when starting from rest?

\[
\begin{align*}
v & = at \\
v & = (3 \text{ m/s}) \cdot (5 \text{ s}) = 15 \text{ m/s}
\end{align*}
\]

(e)(1) What distance will the cart move after 5.0 sec also starting from rest?

\[
\begin{align*}
d & = \frac{1}{2} at^2 \\
d & = \frac{1}{2} \left(3 \text{ m/s}^2\right) \cdot (5 \text{ s})^2 = 38 \text{ m}
\end{align*}
\]

3. (5) State Newton's Third Law and make up two specific examples of its use. Include diagrams and show and explain all forces. For every action force, there exist an equal and opposite reaction force. These forces always come in pairs and always act on two different objects.

(1) Book on table

(2) Touchy table book

4. (3) State the first two of the three Kepler's Laws and use diagrams where helpful. (Note: Kepler's Third Law is covered under question #12 before.)

(1) All planets revolve about the sun in an elliptical orbit with the sun at one focus.

(2) Equal areas are swept out in equal times.

5. (a)(3) What are three characteristics of a "direct proportion?" (b) (2) If it is claimed that the period of a pendulum is proportional to the square root of its length, how can one prove clearly and convincingly that this is indeed the case?

(a) (1) If one physical quantity is doubled, the other also doubles.

(a) (2) If one physical quantity is divided by the other, one always gets a constant (called the constant of proportionality).

(a) (3) If one graphs one physical quantity versus the other, a straight line whose slope equals the constant of proportionality.

(b) Make a graph and see whether or not T vs. L is a straight line.
6. (3) In a washing machine during a spin cycle, the clothes stay against the drum in a circular motion. However, in a dryer the clothes are tumbled and do not go in complete circular motion. Use what we have learned regarding projectile and circular motion to explain why this is.

The big difference here is speed. In a washing machine, the speed is huge and a large centripetal force exists (>> weight of clothes). In a dryer, the speed is slow. At the top, the weight of the clothes is greater than the centripetal force and the clothes separate & fall in projectile motion.

7. (5)(a) Explain what is meant by the term “terminal velocity.” (b) State and discuss the two forces upon which terminal velocity depend?

(a) Terminal velocity is the constant speed that results for a falling object when the downward weight force equals the upward friction force. When this occurs, the net force = 0 & a constant speed results.

(b) The weight force is proportional to the mass of the object. The frictional force is dependent upon the area and/or the shape of the object.

8. (7) What is friction? List and briefly discuss the three types of friction mentioned in class. Also list three ways of reducing friction.

Friction is a force that always opposes the motion of an object. The 3 types of friction are 1) Static friction (the largest!), 2) Sliding (or kinetic) friction, & 3) Rolling friction (the smallest!).

5 ways to reduce friction:
1. Lubricate
2. Use Roller Bearings
3. Streamline (design of the object to reduce friction)

Assume No Friction

9. (+3 points BONUS!) Suppose a hole were drilled through the center of the Earth to the other side. If you dropped a stone down the hole, what would happen? Hint: Remember an object is attracted by gravitational force toward the center of the earth. Analyze this motion as best you can; don't forget Newton's First & Second Laws.

The stone initially speeds up due to the earth's gravity at 9.8 m/s at the surface. But then it coasts at greater speed than the center (v = 0). It then slows down due to the earth's gravity opposing its motion and comes to rest momentarily on the other side. It then falls back to the center, picking up speed, coasting to the center, slows down, & returns to start.
10. Briefly discuss the following terms (2 points each):

**Tycho Brahe** A Danish gentleman who took some of the best astronomical data ever recorded to date, all without the aid of a telescope. This data was used (stolen?) by Kepler in order to develop his 3 LAWS.

**Theory section in writing up a laboratory report**

This section should include define all physical quantities measured in the lab report and layout and in some cases derive any equations used. A background for the experiment should be developed, all in a linear, flowing manner.

**Inherent errors (when writing up a laboratory report)**

Inherent errors are errors of an experiment that do not result from instruments but instead in the actual carrying out of the experiment itself. These errors include human reaction time, not knowing where the center of mass of an object is, not releasing objects from the same point, etc.

---

**Centrifugal force**

To a fictitious force. It's given to the tendency of an object to continue moving in a straight line while the surroundings move out from under the object.

**Apparent weightlessness**

The situation that occurs when both the person (or object) and the surroundings are falling at the same rate.

---

**Vector physical quantities as compared to scalar physical quantities**

Vector physical quantities always require a direction in addition to the magnitude (such as velocity, force, acceleration, displacement).

Scalar physical quantities require only a magnitude (mass, time, area, volume, total distance traveled, etc.).
Thus, on test - 

\[ g = 9.8 \frac{m}{s^2} = 32 \frac{ft}{s^2} \]

For an object moving at constant speed:

\[ a = 0 \]
\[ d = vt \]

For an object speeding up with constant acceleration and starting from rest:

\[ v = at \]
\[ d = \frac{1}{2} at^2 \]

\[ F = \frac{mM}{r^2} \]

\[ W = mg \]

\[ g = 9.8 \frac{m}{s^2} = 32 \frac{ft}{s^2} \]

\[ F = m \frac{v^2}{R} \]