Pre-Comp Review Questions- 7th Grade

Section 1- Units

1. Fill in the missing SI and English Units

Measurement	SI Unit	SI Symbol	English Unit	English Symbol
Time	second	**s**	**second**	s.
Temperature	**Kelvin**	K	Fahrenheit	**°F**
Length	**metre**	**m**	**Feet**	ft.
Volume (solid)	Cubic Metre	**m^3**	**Cubic Feet**	ft^3
Weight (Force)	**Newton**	N.	Pounds	**lbs**
Mass	Kilogram	**kg**	**slug**	sl

2. Fill in the missing metric prefix and/or numerical value

Metric Prefix	Symbol	Numerical Multiplier	Exponential Multiplier (scientific notation)
Tera	**T**	**1,000,000,000,000**	10^{12}
Giga	G	**1,000,000,000**	**10^9**
Mega	M	**1,000,000**	**10^6**
Kilo	**k**	**1,000**	**10^3**
Hecto	h	**100**	**10^2**
Deca	da	10	10^1
Base Unit	_______________	1	10^0
Deci	**d**	**0.1**	**10^{-1}**
Centi	**c**	**0.01**	10^{-2}
Milli	**m**	**0.001**	**10^{-3}**
Micro	µ	0.000001	**10^{-6}**
Nano	n	**0.000000001**	10^{-9}
Pico	**p**	**0.000000000001**	10^{-12}

3. Convert 643nm to cm
   $6.43 * 10^{-5}$ cm
4. Convert 12kg to hg
   120 hg *($1.2 * 10^3$)*

5. Convert 7.5µC to daC
   $7.5 * 10^{-7}$ daC

6. Convert 25km/h to m/s
   1 km = 1000 m; 1 hr = 3600 s
   1 km/hr = 1000/3600 m/s = 5/18 m/s
   To convert km/hr into m/s, multiply the number by 5 and then divide it by 18.
   6.94 m/s

7. Convert 343 m/s to mi/hr
   767 mi/hr

Section 2- Motion

For the following words, write the definition and equation when applicable, and indicate if the quantity is a vector or a scalar

1. Reference Point **When we try to define a location of our object we need another point from which we will tell the distance or direction or both to pin point the location. The another point is the reference point.**
2. Motion **A change in position of an object over time.**
3. Distance **How much ground an object has covered.**

Vector or Scalar? **Scalar**

Equation:

$speed, time, distance$

$$d = t \times s$$

4. Displacement **"How far an object is from a reference point", it is an object's overall change in position.**

   Vector or Scalar **Vector**

   Equation: **$s = s_f - s_i$**

   s = displacement

   s_i = initial position

   s_f = final position

5. Speed **How fast an object is moving.**

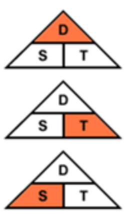
   Vector or Scalar **Scalar**

   Equation:

   $speed, time, distance$

   $$s = \frac{d}{t} \qquad t = \frac{d}{s}$$

   $$d = t \times s$$



6. Average Speed **Total distance travelled by an object divided by the time to cover that distance.**

   Vector or Scalar **Scalar**

   Equation:

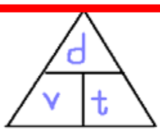
$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}}$$

7. Velocity **The rate at which an object changes its position.**

   Vector or Scalar **Vector**

   Equation:

$$v = \frac{d}{t}$$



d = displacement

8. Instantaneous Velocity **Velocity of an object in motion at a specific point in time.**

9. Average Velocity **Displacement divided by the time.**

   Equation:

$$A.V. = \frac{\text{change in position}}{\text{time traveled}}$$

10. Acceleration **The rate at which an object changes its velocity.**

    Vector or Scalar **Vector**

    Equation:

$$a = \frac{v_F - v_i}{t}$$

11. Directly Proportional **As one amount increases, another amount increases at the same rate.**

    Example of 2 quantities that are directly proportional:

    How much you earn is directly proportional to how many hours you work

    Work more hours, get more pay; in direct proportion.

    - **If you work 2 hours you get paid $40**
    - **If you work 3 hours you get paid $60**
    - **etc ...**

12. Inversely Proportional **When one value decreases at the same rate that the other increases.**

Example of 2 quantities that are inversely proportional:

Speed and travel time are Inversely Proportional because the faster we go the shorter the time.

- **As speed goes up, travel time goes down.**
- **And as speed goes down, travel time goes up.**

13. What are the 3 ways an object can accelerate?

1) increase speed 2) decrease speed 3) change direction

14. Indicate whether the object will be speeding up, slowing down, or not changing speed given the directions of velocity and acceleration

Velocity	Acceleration	Speeding up/ Slowing down/ No change
+	+	**Speeding up**
+	-	**Slowing down**
+	0	**No change**
-	+	**Slowing down**
-	-	**Speeding up**
-	0	**No change**

15. Give an example of when an object has a velocity of 0 m/s but is accelerating
When it is changing velocity from 0 m/s to either a positive or negative velocity, at the point it is at 0 m/s, it is still accelerating. For example: when you throw something up, it will eventually stop (0 m/s) and then accelerate back down.

Problems

16. A person hikes 2120 meters east in 25mins, takes a break for lunch for half hour, and hikes back 1640m west in 20 mins. What was the person's distance, displacement, average speed, and average velocity for the trip (in m/s)?
distance = 2120m + 1640m = **3760m**
displacement = 2120m (East) - 1640m (West) = **480m (East)**
time = 25mins + 30mins + 20mins = 75mins = 75 * 60 s = 4500s
average speed = distance / time = 3760m / 4500s = **0.84 m/s**
average velocity = displacement / time = 480m (East) / 4500s = **0.1 m/s (East)**

17. A person is walking on the moving walkway at the airport with a velocity of 2.4 m/s east and the walkway is moving at 1.6 m/s east. What is the person's resultant velocity?

2.4 m/s (East) + 1.6 m/s (East) = **4 m/s (East)**

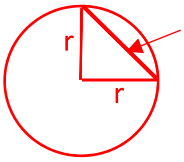
18. A car moves around a circular track with a radius of 10m. The car travels at a constant speed of 30 m/s. If the car travels ¾ of the way around the track, find the cars

a. distance travelled

C *(circumference)* = $2\pi r = 2\pi * 10m = 62.8m$ *(r = radius)*

¾ * 62.8m = **47.1m**

b. displacement



Pythagoras

Displacement^2 = $r^2 + r^2 = 2r^2$

Displacement = $\sqrt{2r^2} = \sqrt{(2 * 10^2)}$ = **14.14m**

c. average velocity

s = d / t, t = d / s = 47.1m / 30m/s = 1.57s

average velocity = displacement / time = 14.1m / 1.57s = **8.9 m/s**

d. If the car continues to drive and ends at the place it started, what will be its distance, displacement, and average velocity then?

distance = *circumference* = **62.8m**

displacement = **0m**, **average velocity** = **0 m/s**

19. An airplane starts from rest and reaches a speed of 70 km/h in 50s before taking off. What was the airplanes average acceleration (in m/s^2)?

70 km/h = 19.4 m/s

1 km = 1000 m; 1 hr = 3600 s

1 km/hr = 1000/3600 m/s = 5/18 m/s

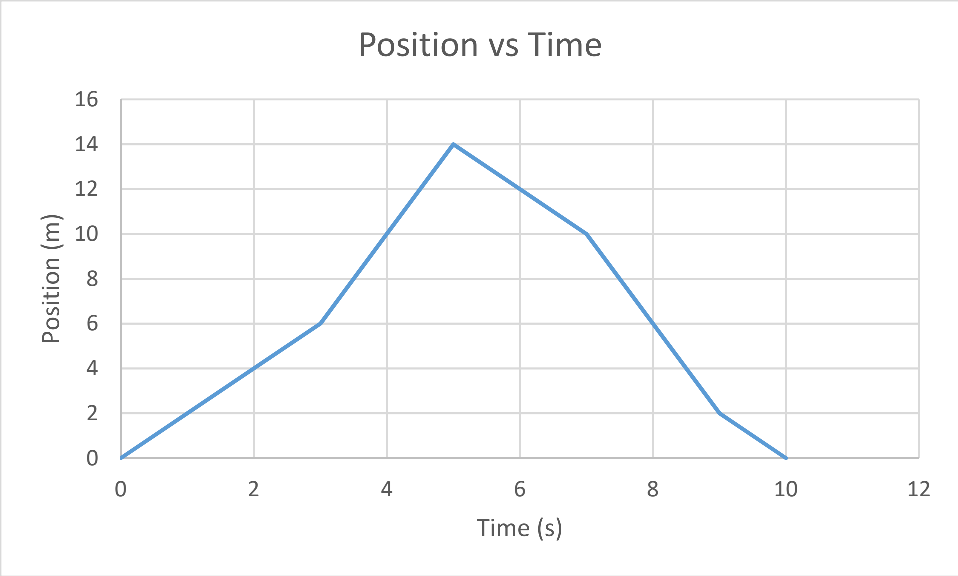
To convert km/hr into m/s, multiply the number by 5 and then divide it by 18.

acceleration = $(v_f - v_i)/t$ = (19.4 m/s - 0 m/s)/50s = **0.4 m/s^2**

20. An object is moving at a constant velocity of 10m/s east for 20s. What is the acceleration of the object?

constant velocity = no acceleration = **0 m/s^2**

21. Use the graph below to answer the following questions



a. What is the object's distance travelled between 0 and 4 sec?
10 m

b. What is the object's displacement between 0 and 4 sec?
10 m

c. What is the object's distance travelled between 4 and 8 sec?
4m + 4m + 4m= **12m**

d. What is the object's displacement between 4 and 8 sec?
6m - 10m = **-4m**

e. What is the object's distance travelled between 0 and 10 sec?
14m + 14m = **28m**

f. What is the object's displacement between 0 and 10 sec?
0m

g. In what time interval is the objects displacement negative: 0-3 sec, 3-5 sec, or 8-10sec?
8-10s

<u>Section 3- Forces and Newton's Laws</u>

For the following words, write the definitions and equations when applicable

1. Force - **A push or pull upon an object resulting from the object's interaction with another object.**

2. Newton's 1st law **An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.**

3. Inertia **The tendency of objects to keep moving in a straight line at a constant velocity.**

4. Newton's 2nd Law **The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.**

   Equation:

   $F = ma$

5. Newton's 3rd Law **For every action, there is an equal and opposite reaction.**
   Equation:
   $F_A = -F_B$

6. What is the statement we use to determine the action-reaction force pairs for N3L?

If one object A exerts a force FA on a second object B, then B simultaneously exerts a force FB on A, and the two forces are equal in magnitude and opposite in direction.

7. Weight **The force exerted on a body by gravity.**

Equation:
$W = mg$

g on Earth = **9.8 m/s2** *or* **9.8 N/kg**

8. Normal Force **The support force exerted upon an object that is in contact with another stable object.**
   Normal forces oppose **gravity**.

9. Tension Force **The force that is transmitted through a string, rope, cable or wire when it is pulled tight by forces acting from opposite ends.**
   Tension Forces oppose **forces on the other end string, rope, cable or wire.**

10. Newton's Law of universal gravitation (NLUG) equation

$$F_g = G\frac{m_1 m_2}{r^2}$$

F_g = **Force of gravity**

G= **Gravitational Constant 6.75 x 10^{-11} N m^2/kg^2**

m_1, m_2 = **masses of 2 objects**

r = **distance between the 2 objects**

11. Friction Force **The force exerted by a surface as an object moves across it or makes an effort to move across it.**

Equation:

$F_{frict} = \mu \bullet F_{norm}$

12. Static Friction **The friction that exists between an object and a surface on which it is not sliding.**

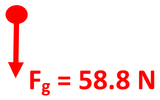
13. Kinetic Friction **The friction that exists between an object and a surface on which it is sliding.**

14. Net Force **When an object is subject to several forces, the resultant force is the force that alone would produce the same effect as all those forces.**
Equation:
R = F1 + F2 + ... *(vector sum)*

15. Conditions for Equilibrium
1. **The resultant force acting on the object is zero.**
2. **It is not turning or changing direction** *(net torque must be zero)*.

16. 4 steps in drawing a Free-Body Diagram
   a. **Identify the object you will draw a diagram for.**
   b. **Identify all the forces acting directly on the object and the object exerting them.**
   c. **Draw a dot to represent the object of interest and a vector to represent each force.**
      i **Each force should start from the dot and its length should be relative to its size.**
      ii **Label the type and strength of each force.**
   d. **If the object is stationary or is moving at a constant velocity, the vectors should graphically add up to zero. If the object is accelerating, the sum of the vectors should produce a vector in the same direction as the acceleration.**

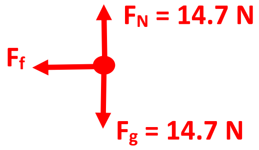
17. Draw a free-body diagram for 6kg object falling through the air



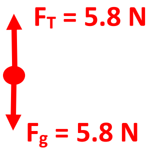
W = mg

on Earth = 9.8 m/s^2 or 9.8 N/kg

18. Draw a free body diagram for a 1.5kg soccer ball rolling along a rough surface



19. Draw a free body diagram for a pendulum with a mass of 60g suspended from a string.



20. What are the 4 fundamental forces in the universe? List from weakest to strongest

   1. **Gravitational Force**
   2. **Weak Nuclear Force**
   3. **Electromagnetic Force**
   4. **Strong Nuclear Force**

21. Contact force **Any force that requires contact to occur.**

   Examples:

   Frictional Force, Tension Force, Normal Force, Air Resistance Force, Applied Force, Spring Force

22. Action-at-distance Force **Any force that requires contact to occur.**

   Examples:

   Gravitational Force, Electrical Force, Magnetic Force

<u>**Problems**</u>

23. Two people are separated by a distance of 0.6m. Each person has a mass of 60kg.

   a. What is the gravitational force between the 2 people?

   $$F_g = G\frac{m_1 m_2}{r^2}$$

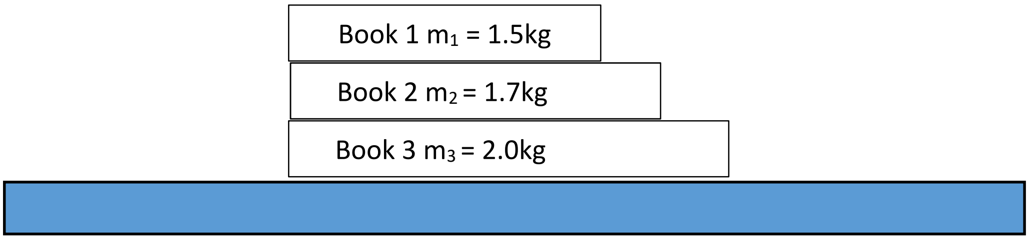
   G= **Gravitational Constant 6.75 x 10^{-11} N m^2/kg^2**

   = (6.75 x 10^{-11} * 60 * 60) / 0.6^2
   = 6.6726 * 10^{-7}

   b. If the distance between them is halved, what will the force between them be?

   *** 4**

24. There are 3 books stacked on a table as shown.



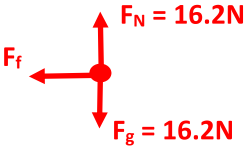
a. Find the Normal Force acting on each book.
F_{N1} = 14.7N, F_{N2} = 16.6N, F_{N3} = 19.6N *W = mg*

on Earth = 9.8 m/s^2 or 9.8 N/kg

b. If a person pushes down on the stack with a force of 10N, what will the normal force on book 2 be (hint- addition)?
F_{N2} = 16.6N + 10N = **26.6N**

25. A soccer ball is rolling in the grass. It has a mass of 1.65kg. The coefficient of friction between the ball and the grass is 0.8.

   a. Draw a free-body diagram for the soccer ball.



W = mg

on Earth = 9.8 m/s^2 or 9.8 N/kg

   b. Find the frictional force acting on the ball.
   F_{frict} = μ • F_{norm} = 0.8 * 16.2N = **13N**

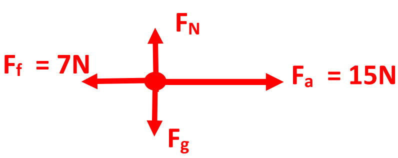
   c. Find the acceleration of the ball
   F = ma,
   a = F/m = -13N/1.65kg **= -7.9m/s²**

   d. If the ball has an initial velocity of 10 m/s, how much time will it take for the friction force to bring the ball to a stop?
   acceleration = $(v_f - v_i)/t$,
   t = $(v_f - v_i)$/acceleration = (0 – 10m/s)/-7.9m/s^2 **= 1.3s**

26. What are the units of all forces?
Newtons (N)

27. Bart is riding on his skateboard on a rough sidewalk (meaning there is friction). He is applying a force of 15N East and the force of friction acting on the skateboard is 7N west.

   a. Draw a free body force diagram for all of the forces acting on the skateboard



   b. Find the net force acting on the skateboard.
   15N - 7N = **8N**

c. If his mass and the mass of the skateboard is 55kg, find his net acceleration.

F = ma,

a = F/m = 8N/55kg **= 0.15m/s²**

d. Find the coefficient of friction.

$F_{frict} = \mu \bullet F_{norm}$

$\mu = F_{frict} / F_{norm}$ = 7N/539N **= 0.01**

*W = mg = 55kg * 9.8 m/s² = 539N*

on Earth = 9.8 m/s² or 9.8 N/kg

28. An astronaut on the moon weighs 165N. If the action force is the weight of the astronaut, what is the magnitude and direction of the reaction force and what object is the reaction force acting on? (Hint- fill in the blanks "The force on **the astronaut** by **moon** is equal in magnitude but opposite in direction of the force on **the moon** by **astronaut**." What is object 1 and object 2 in this case?)

Section 4- Work, Power, and Energy

For the following words, write the definition and include the equation when applicable

1. Work **Measure of energy transfer that occurs when an object is moved over a distance by an external force at least part of which is applied in the direction of the displacement.**

Equation:

$$\text{Work} = \text{Force} \bullet \text{Distance}$$
$$W = F \bullet d$$

2. Conditions for a force to do work
   a. **Must be some displacement in the body.**
   b. **The direction of force should not be perpendicular to the direction of motion.**

3. Fill in the blanks:
   a. The work needed to lift an object to a given height is equal to **height moved** times the **force required**.
   b. When an applied force is at angle to the direction of motion, the work done by the force **component in the same direction of the movement**.
   c. Forces that are perpendicular to the direction of motion do **not do any** work.
4. The units of work **are Joules (J)**.
5. If an object is subject to a **force**, it may be set in **motion**. This means that **work** has been done on the object and its **energy** has transferred forms. A moving object has the ability to do **work** on another object.

6. Power **Rate of doing work, the amount of energy transferred per unit time.**
   Equation:

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Force} \cdot \text{Displacement}}{\text{Time}}$$

$$\text{Power} = \text{Force} \cdot \frac{\text{Displacement}}{\text{Time}}$$

$$\boxed{\text{Power} = \text{Force} \cdot \text{Velocity}}$$

   Units: **Watt (W)**

7. Energy - **The capacity for doing work.**

   Units of energy **Joules (J)**

Forms of Energy

8. Gravitational Potential Energy **The energy an object has due to its position above Earth.**

   Equation:

$$E_P = mgh$$

E_P = Potential Energy
m = Mass
g = Gravitational Field Strength
h = Vertical Height

9. Chemical Potential Energy **Energy stored in the chemical bonds of a substance.**

   Example: **Food**

10. Kinetic Energy **The energy that it possesses due to its motion.**

    Equation:

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

$E_k = kinetic\ energy\ of\ object$
$m = mass\ of\ object$
$v = speed\ of\ object$

Problems-

11. An object with a mass of 53kg is lifted to a height of 4.2m.
    a. How much work is done to lift the object?
    *Weight = 53kg * 9.8 N/Kg = 519.4N*
    W = Fd = 519.4N * 4.2 = 2181.5 J **= 2.2 kJ**

    b. If the object is lifted in 1.1 mins, how much power was used to lift it?
    1.1mins = 66s
    P = W/t = 2181.5J / 66s **= 33W**

12. A person kicks a soccer ball with a mass of 0.8kg and gives it a velocity of 15 m/s.
    a. What is the kinetic energy of the ball?
    KE = ½ mv^2 = 0.5 * 0.8 * 15^2 **= 90J**

    b. If the velocity of the ball is doubled, by what factor does the kinetic energy of the ball increase? (hint, you don't need to recalculate KE)
    ***4**

    c. If the velocity of the ball is halved, by what factor is the kinetic energy of the ball reduced? (hint, you don't need to recalculate KE)
    /4

13. A person jumps from a burning building into one of the inflatable rescue mats set up by firefighters. Describe the energy transformations that occur from the time the person jumps to when they reach the lowest point in their motion (Assume they stop bouncing after one bounce and are at ground level)
    GPE – KE – GPE – KE – Sound & Heat

14. A battery converts **chemical potential** energy to **electrical** energy, which causes the electrons in a circuit to move and gain **kinetic** energy.

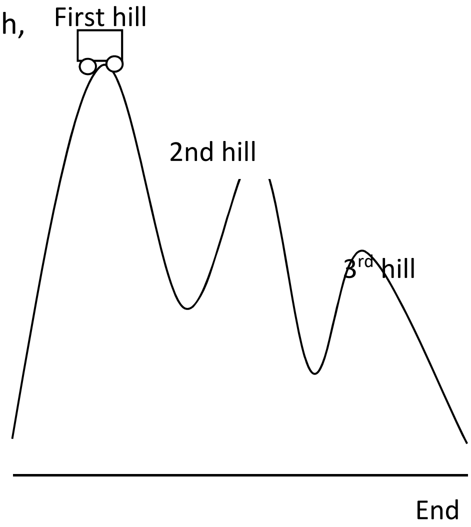
15. A ball with a mass of 0.8kg is launched from ground level with a velocity of 22.4 m/s.
    a. Find the balls total mechanical energy when it is first released.
    TME = KE only *(as at ground level so no GPE)* = ½ mv^2 = ½ * 0.8 * 22.4^2 **= 200.7J**

    b. Find the balls gravitational potential energy at a height of 3m
    GPE = mgh = 0.8kg * 9.8m/s^2 * 3m **= 23.5 J**

    c. Find the ball's velocity at a height of 3m
    $ME_i = ME_f$
    $TME = ME_i + ME_f$
    KE = TME - PE = 200.7J – 23.5J = 177.2J
    KE = ½ mv^2, **V** = √(2KE/m) **= 21m/s**

d. What will the maximum height of the ball be (hint, remember when the ball reaches its' maximum height, it comes to a stop)
TME = GPE only as stopped = 200.7J
GPE = mgh, **h** = GPE/mg = 200.7J / (0.8kg * 9.8m/s^2) **= 25.6m**

16. In the diagram, a 650 kg roller coaster car starts from rest at the top of the first hill of its track, which is 24m high, and glides freely to the end of the ride. [Neglect friction.]



a. Where will the car have the most gravitational potential energy? Why?
First hill as highest point.

b. Where will the car have the most kinetic energy? Why?
End as lowest point.

c. Calculate the total gravitational potential energy of the car and passenger at the top of the first hill.
GPE_1 = mgh = 650kg * 9.8m/s^2 * 24m **= 152880J**

d. If the 3rd hill is at a height of 12m, calculate the gravitational potential energy at that point
GPE_3 = ½ * GPE_1 = ½ * 152880J **= 76440J**

e. Find the velocity of the car and passengers on top of the 3rd hill
$ME_1 = ME_3$
TME = $ME_i + ME_f$
ME_1 = GPE only *(As car starts from rest at the top of the first hill.)*
$GPE_1 = KE_3 + GPE_3$
$KE_3 = GPE_1 - GPE_3$ = 152880J - 76440J = 76440J = ½ mv^2
v = √(2KE/m) = √(152880J/650kg) **= 15 m/s**

f. How fast will the car be going at the end of the ride?
$ME_1 = ME_{END}$
TME = $ME_i + ME_f$
ME_1 = KE only *(As car is at 0m.) =* 152880J = ½ mv^2
v = √(2KE/m) = √((2 * 152880J)/650kg) **= 22 m/s**