M8.A.2.2 Represent or solve problems using rates, ratios, proportions and/or percents. (M8.A Numbers and Operations; Reference: 2.1.8.D, 2.3.8.D)

M8.B.1.1 Convert measurements. (M8.B Measurement; Reference: 2.3.5.D)

M8.D.2.2 Create and/or interpret expressions, equations, or inequalities that model problem situations. (M8.D Algebraic Concepts; Reference: 2.8.8.C)

Grammy, Nicole, and Raj have formed a team to compete in the Robolympics. Their team, "ABSASQ" (they thought it sounded cool), has a robot built and most of the basic programming done. As the day of the competition draws close, a flurry of last-minute adjustments begins…

Mechanical Mania

Ripping open a box of new parts with music blaring, internet messaging chiming, and a frenzied grin forming on her face, the team's builder and robot technician extraordinaire, Nicole, is ready to set to work again. With a few last adjustments, and a few dozen other last adjustments, the robot will be ready to compete at last. An expert at what she does, Nicole is ready to do whatever it takes to make her team's robot the best of show at the Robolympics.

1. Nicole has just unpacked a new Resource Set for her robot, which includes 3 new kinds of wheels. However, her favorite ruler is nowhere to be found, lost in the chaos of shredded paper and cardboard. Oh, the irony. The only one she *can* find is her little brother's, and lacks metric markings. The rest of the robot's measurements have been taken in metric, so the only thing left to do is convert these as well.

Measurement (in)	2.2 inches	1.5 inches	4.0 inches
Conversion (cm)	**A**	**B**	**C**

A =
B =
C =

2. ***<LightningBoltz>*** *hi*
<MechanicoleEngineer_4545> *Hi! ^.^*
<LightningBoltz> *we found out it was low battery power causing our problem*
<MechanicoleEngineer_4545> *What do you mean?*
<LightningBoltz> *when the battery was strong, the robot could push more and go faster, but when the voltage got low, it got weaker*
<MechanicoleEngineer_4545> *O_o*
<MechanicoleEngineer_4545> *I'll go check now. Thanks!*
<LightningBoltz> *np*

   Finally, a possible solution to the robot's pushing problem. About a week ago, during testing for the StrongBot event, the robot mysteriously stopped being able to push the weight. Afterwards, Nicole took the robot apart and completely rebuilt it, and it was still

not able to push as much as it had before. Grammy said that she hadn't put it back together in quite the same way, but Nicole was sure she had.

But, a tip from an online friend who was having a similar problem could resolve this issue at last. Replacing the batteries, Nicole finds that the robot can push a 1.8kg weight when its battery charge is fresh at 7.2V. Assuming that the robot's pushing ability is directly proportional to the amount of charge its battery can maintain:

a. How much would the same robot be able to push after its battery has been partially drained and can only provide 6V of voltage?
b. Would that explain the robot's sudden inability to push the weight before?
c. What is the lowest the battery can be in order to push the 1.5kg weight during the StrongBot event?

3. Grammy always writes such confusing e-mails. His latest reads, "Distance traveled is directly proportional to both the circumference of the wheels on the robot, and the number of rotations the wheels make. You can assume there are no other factors in the equation." All Nicole wanted to know was how the size of the wheels affected how far it moved. Sheesh.

   Putting her Grammy cap on, Nicole decodes the message into a single equation:

   (Find the equation)

The Programmer's Predicament

Grammy is the team's main programmer. A stickler for orderly, neat work, Grammy is always looking for formulas, rules, and other patterns that can make work simpler and more sensible. While he gets along with Nicole, they have… differences in opinion… on occasion. As Grammy walks into the robot lab, he find that Nicole has changed the robot design again.

4. Grammy's program, *ForwardRun*, runs for a set number of motor rotations. The old robot with 2.5cm wheels (in diameter) moved 85 inches using this program. This new design features 4cm wheels, which Nicole claims are necessary to provide the robot with better traction. How far does the new robot travel using the *ForwardRun* program?

5. Having worked with Nicole before, Grammy anticipated this turn of events. In the program, he has a single value, called *D*, which determines the number of Degrees that the robot will run. The robot traveled *D* degrees of motor rotation before. In order to make the robot travel the same distance it did before the change, how must Grammy change *D*? Express your answer as an equation, or a series of instructions describing how Grammy should calculate the new *D*.

6. Grammy long ago recognized that there is a pattern to the relationship between rotations and distance traveled. In order to make his programming tasks easier, he always keeps a table of rotations and distances for reference. This too must be updated every time Nicole "upgrades" the robot. Fill in the missing items.

Distance	18.2 cm	1 cm	10 cm	100 cm
Rotation Setting	720 degrees	**A**	**B**	**C**

(continued…)

Distance	**D**	**E**	**F**	**G**
Rotation Setting	100 degrees	1000 degrees	1 rotation	10 rotations

A =
B =
C =
D =
E =
F =
G =
H =

7. Finally, Nicole has also provided a series of additional measurements for movements on the Robolympics course. Nicole's way of expressing measurements, however, has always bothered Grammy. Nicole records things in *rotations*, but the program has to be entered in *degrees*. While Nicole's measurements are technically correct, they're very inconvenient. In order to save time and headaches having to convert every measurement manually, Grammy writes a program to automatically convert any measurement in *rotations* to the same measurement in *degrees*. At the core of the program is a simple

equation…

Let R = the measurement in rotations
Let D = the measurement in degrees

D = (??? in terms of R)

Raj Gets Ready

Some philosophies say that the world is a place of balance, where a cosmic glue of sorts keeps opposites from floating apart, or colliding. For Team ABSASQ, that glue is Raj, and as he would be all too happy to tell you, it means being stretched and squashed into all kinds of weird situations. Nevertheless, he keeps the team in balance, and balances the budget as well.

8. Bills, bills, and deadlines. And those two just won't stop getting on each other's cases. Raj unpacks another expense report and sighs. Every day the project team continues to work costs another $30. The team had fundraised $500 to start with. $190 has already been spent on materials, $10 has been set aside for pizza, and the team has already worked 3 days. How much longer does the team have to finish the project before funding runs out?

9. The team may not be done by then, but Raj isn't sure how much more money will have to be raised. Write an equation that describes the relationship between total budget size and the total number of days of work that the project can sustain.

   Let B = the total budget
   Let D = the number of days of work

   D = (??? in terms of B, remembering to account for the $190 equipment and $10 pizza)

10. Nicole wants more money to buy parts. Grammy wants a faster computer so his programs don't take so long to compile. Raj wants a pair of noise-cancelling headphones so he can get his work done. He knows that if he buys either of them something, the other will want something of equal value.
    a. First things first. Nicole wants extra parts that cost 99 cents each for the first dozen, and 89 cents for each additional part beyond that. What equation models the total cost C of her parts (assuming she buys at least 12)?
    b. Grammy will have to receive the same amount in parts. He wants more memory for his computer. Thankfully, his computer uses very inexpensive components, and can add memory in 128MB increments for $9.99 (per 128MB). Write a formula, in terms of the number of parts that Nicole orders, that tells Raj how many MB of memory Grammy can get.
    c. If the budget for this round of funding is $200, how many parts can Nicole get, and how much memory can Grammy get?
    d. Finally, noise-cancelling headphones were too expensive, but darned if Raj isn't getting himself some earplugs. They cost $1.99 per pair, plus a flat $2.99 for shipping and handling. Write the equation that determines the cost, based on how many pairs he orders (he quietly wonders if he can wear 2 or 3 at a time…)

The Big Day

The robot is built. The programs are written. The team has packed and driven to the Robolympics.

11. Nicole and Grammy are bored on the ride. Raj is sitting serenely in the front passenger seat with four sets of earplugs held in with tape. Nicole challenges Grammy to a game of spotting out-of-state license plates, but Grammy says nothing until the very end of the trip, then raises this challenge instead:

    "We passed X cars on the way here. 79% of them had license plates from this state. Three had license plates that were damaged or unreadable from where I was sitting. In terms of X, how many of them had plates that were definitely out-of-state?"

12. As the team arrives at the Robolympics, there are several other events running. One of them is the RoboRace, a speed-based event. Competing team *Socket Rocket*'s robot runs the 14m qualifying track in 21 seconds. A second team's robot, *Rhoderunner* travels only 75% as fast as *Socket Rocket*'s. Assuming that it can maintain this rate of travel, how long would it take for *Rhoderunner* to complete a lap around the the 400m Olympic-sized track that the final race will be held on?

13. Even though their robot will not be running in the race event, the team decides to see how their robot would have done. During a 3 second test run, the team's robot traveled 48 cm.
    a. What was the robot's speed?
    b. How long would it take to travel exactly one meter at this speed?
    c. How long would it have taken to run the 400m course?

14. The team buys a small box of candies, but in order to prevent arguments, Raj counts and divides the pieces before distributing them based on how much money each had contributed. Nicole gave $1.25, and Grammy only had $1.00. Raj wasn't hungry, and so only put in 25 cents. If there were 100 pieces of candy in the box, how many should each team member receive?