FULL NAME: **COMPANY:**

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Basic Concepts and Pre-Program Math Review

Certification as a CCT requires proficiency with basic math, particularly algebra. You are strongly encouraged to complete the following review prior to attending the CCT program. Completing this review will introduce you to, or remind you of, some basic concepts routinely used in mix design development and troubleshooting. More importantly, it will help you assess whether you currently have the math skills needed to successfully complete the CCT program and serve as a CCT.

Check your work. The solutions are provided at the end of this review.

1. Fractions, decimals and percentages are all used to define portions or ratios.

   For example: 1/10 (one-tenth), in decimal notation is 0.10, in percentage notation is 10%.

   Fill in the blanks in the following table:

Fractional Notation	**Decimal Notation**	**Percent Notation**
	0.20	
		12.5

2. The **moisture content** of aggregates, the amount of water in and on the aggregates, often varies between 0% and 10%.

   Express 5% moisture as a decimal: ___________________________________
   Express 4.5% moisture as a decimal: _________________________________

3. Water commonly fills all or a portion of the pores in aggregate particles. The amount of water needed to completely fill (but not overfill) all the pores is referred to as the **absorption** for that aggregate. When all pores are filled, but no excess water is present on the surface of the aggregates, the aggregate is in a **saturated surface dry condition.**

   For example: If it takes 1 lb. of water to completely fill (but not overfill) the pores of 100 lbs. of dry aggregate, the absorption of that aggregate is: 1 lb. / 100 lbs., expressed as 0.01 or 1%.

   An aggregate sample weighs 1850 grams (g) in an SSD condition and weighs 1828 g when oven dry. Calculate the % absorption: _________________________________

4. The **unit weight** of a material defines how much it weighs per unit of volume. Typically, the units of volume used in the concrete industry are cubic feet ($ft.^3$ or cf) and cubic yards ($yd.^3$ or cy).

   For example: 105.0 lbs. of aggregate that completely fills (but does not overfill) a bucket with a known volume of 1 cubic foot has a unit weight of 105.0 pounds per cubic foot (pcf).

$$\frac{105.0\ lbs}{1cf} = 105.0pcf$$

   Calculate the unit weight of 35.65 lbs. of concrete contained in the base of a pressuremeter having a volume of 0.249045 cubic feet (cf): ______________________

5. The **specific gravity** of a material defines the unit weight of that material relative to the unit weight of water. In the concrete industry, it is commonly assumed that the unit weight of water is 62.4 pcf and its specific gravity is 1.00.

   For example: If a solid piece of rock, measuring exactly 1 ft. x 1 ft. x 1 ft., weighs 166.6 lbs., its unit weight is 166.6 pcf. Its specific gravity, defined by the unit weight of water, is:

$$\frac{166.6\ pcf}{62.4\ pcf} = 2.67$$

   Calculate the specific gravity of 23.54 lbs. of aggregate that occupies a volume of 0.14235 cf.: ____________________________________ (report to two decimal places)

6. It has been determined that 44% (0.44) of the volume of a cubic yard of concrete should be comprised of a dry-rodded coarse aggregate. The dry-rodded unit weight of the coarse aggregate is 105.3 pcf.
   a. ***Calculate the volume of dry-rodded coarse aggregate per cubic yard, expressed in units of cubic feet: _______________*** (hint: 27 cf = 1 cy)
   b. ***Calculate the oven-dry weight of coarse aggregate per cubic yard: _______ lbs.***

7. **Free moisture** is defined as the moisture (water) on the surface of aggregates which is available to mix with the cement and aid in workability during placement. It is determined by subtracting the aggregate absorption from the total moisture content. That is: **Total Moisture – Absorption = Free Moisture.**

   For example: A total moisture content of 5.4% has been determined for a fine aggregate that has an absorption value of 1.9%. The percentage of free moisture is:

5.4% - 1.9% = 3.5%

Calculate the free moisture percentage for a coarse aggregate having a total moisture content of 2.4% and an absorption of 1.0%: ________________________________

8. The Fineness Modulus (FM) of an aggregate is a numeric value determined by adding the cumulative percent of material retained on a specific set of sieves and dividing the sum by 100. The higher the FM value, the coarser the aggregate. For fine aggregate, the sieves included in the FM determination are noted in bold italic font in the following table.

Determine the fine aggregate FM using the following abbreviated gradation test results:

Sieve	% Retained	% Passing	Cumulative % Retained
3/8"	0.0.	100	0
No. 4	3.4	97	3
No. 8	17.3	79	21
No. 16	13.2	66	34
No. 30	14.8	51	49
No. 50	26.1	25	75
No. 100	22.5	3	97
No. 200	1.7	1.0	
PAN	0.1		

The fine aggregate FM based on the data above is: ______ (report to 2 decimal places)

9. Solve for "X": X = 4,000 + (1.34 x 623), X =________ (round to nearest whole number)
hint: solve the portion of the equation inside the ( ) first

10. Solve for "X": X = 3,500 + (2.33 x 623) – 500, X =_____ (round to whole number)

11. Solve for "X": X = $\dfrac{\text{1850 lbs.}}{\text{2.67 x 62.4 lbs./cf.}}$ X = _________ (round to 3 decimal places)

12. When combining two or more aggregates to make a blended or composite aggregate, the specific gravity of the composite aggregate is determined based on the proportion

(in decimal notation) of each individual aggregate in the blend. The equation for determining the composite aggregate's specific gravity is shown below, where:

a. G_1 and P_1 are the specific gravity and percentage of Aggregate 1,
b. G_2 and P_2 are the specific gravity and percentage of Aggregate 2, and
c. G_3 and P_3 are the specific gravity and percentage of Aggregate 3.

Composite aggregate specific gravity $G_{123} = \dfrac{1}{\dfrac{P_1}{G_1} + \dfrac{P_2}{G_2} + \dfrac{P_3}{G_3}}$

<u>For example:</u> Determine the composite specific gravity of a three-aggregate blend using:

70% Aggregate 1 with a specific gravity of 2.75, (here $P_1 = 0.70$ and $G_1 = 2.75$)

20% Aggregate 2 with a specific gravity of 2.65, (here $P_2 = 0.20$ and $G_2 = 2.65$)

10% Aggregate 3 with a specific gravity of 2.69, (here $P_3 = 0.10$ and $G_3 = 2.69$)

Hint: record all intermediate values to at least 3 decimal places and round the final specific gravity value to 2 decimal places.

$$G_{123} = \frac{1}{\frac{0.70}{2.75} \quad \frac{0.20}{2.65} \quad \frac{0.10}{2.69}} = \frac{1}{0.2545 + 0.0755 + 0.0372} = 2.72$$

Calculate the composite aggregate specific gravity for a three-aggregate blend using:

60% Aggregate 1 with a specific gravity of 2.73,
20% Aggregate 2 with a specific gravity of 2.67,
20% Aggregate 3 with a specific gravity of 2.69
G_{123} = _______________ (report to 2 decimal places)

13. A mix design has a total batch mass of 3915 pounds per cubic yard (pcy). ***What is the unit weight of the material expressed in pcf?***

14. ***What cubic foot volume does 5% air occupy in a cubic yard of concrete?***

15. An additional 25 lbs. of Portland cement will be added to an existing mix design. To maintain a volume of 27.00 cf, a portion of the fine aggregate will be removed. No other modifications to the mix design will be made. The specific gravity of the Portland cement (S_{cement}) is assumed to be 3.15. The SSD specific gravity of the fine aggregate S_{faSSD} is 2.68.

a. ***Determine the volume (in cf) of cement to be added: (report to two decimal places)***
b. ***Determine the weight (in lbs.) of fine aggregate to be removed to maintain 27.00 cf: (report to the nearest whole number)***