Take-Home Coding Challenge

Moisture Content Worksheet

Functional requirements for a data-entry worksheet in a web app are provided below. These requirements should be used to provide code solutions to the questions at the end of the document. The solutions can be provided in your chosen coding language - whatever you are most familiar and comfortable in.

We are not looking for a complete implementation of this worksheet but are interested in:

- Your approach to the problem, how you go about solving it.
- How you structure the solutions.
- Notes, comments and assumptions that you make.

You are not expected to spend more than **2 hours** on the questions.

Functional Requirements

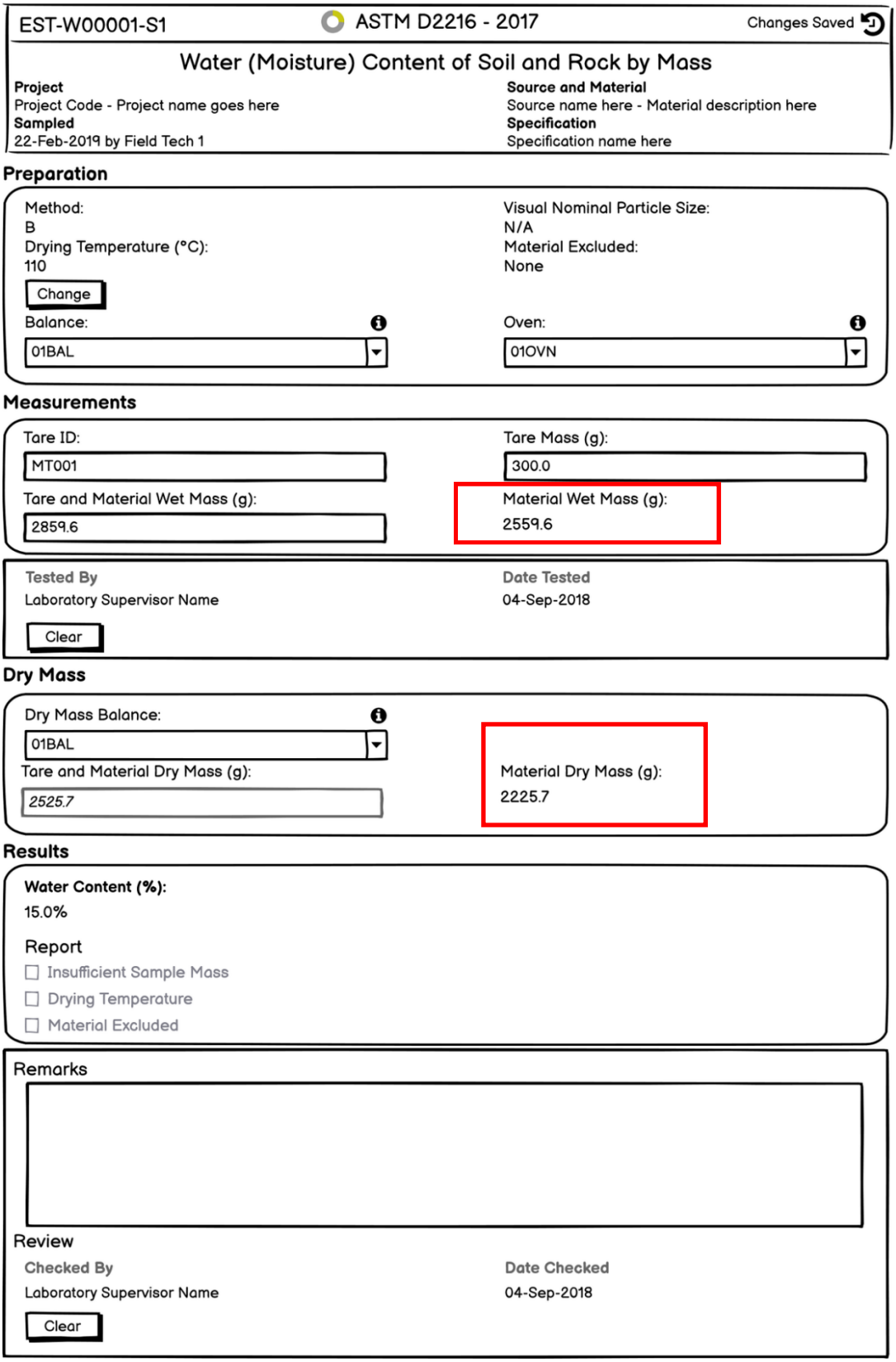
Worksheet Properties

Method	ASTM D2216
Revision Year	2019
Name	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
Short Name	Moisture Content

Background

Moisture content of soil and rock is an extremely useful measure of soil properties and is, as a result, a very commonly carried out test.

User interaction and design

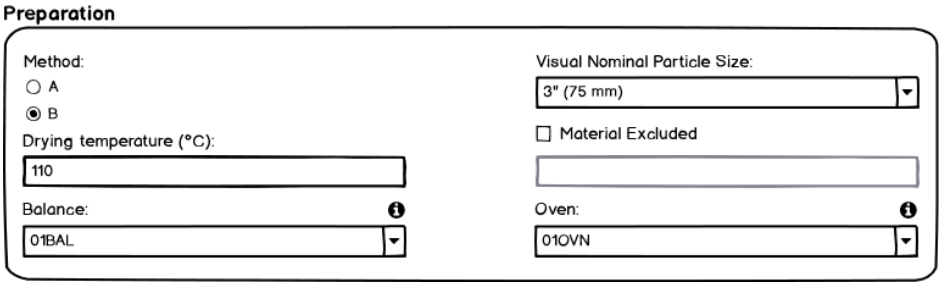


Preparation

The ASTM moisture content test method provides for

- Two different methods of carrying out the test
- Using a drying temperature other than the defined 110°C
- Minimum sample sizes given a nominal maximum particle size

The test methods also requires that the exclusion of any material is reported. These values are often not set, or are defaulted. As a result, the user should be presented with the most commonly used permutation of this information but not be required to navigate past it for data entry purposes. As a result, this information is shown in a read-only manner on the worksheet. The user can change these values if desired, the **Change** button will change the read-only values here to appropriate inputs.

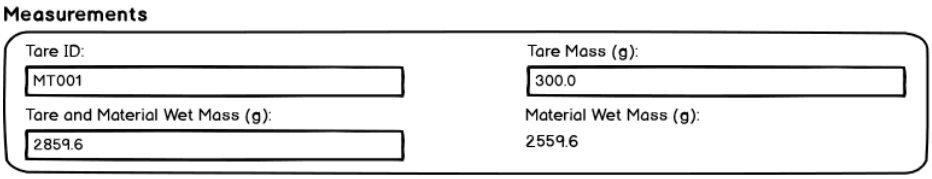


Prompt	Behaviour/Description	Unit	Symbol *(Used in Standard)*
Method	Radio buttons that define the rounding of the result for reporting purposes. Method A - result rounds to 0 Method B - result rounds to 0.0 (default)	N/A	
Visual Nominal Particle Size	Drop down that contains the standard sieve aperture sizes per Table 1 of the test method plus "N/A" (default). Displays the sieve size per the laboratory level **Sieve Units Format** setting. Affects warning messages that show to the user based on material wet mass.	N/A	
Drying Temperature	The test methods calls for 110 °C as the drying temperature (default value) but allows for different temperatures provided that this deviation from the test method is reported.	°C	

Material Excluded	A checkbox that allows the user to specify that some material was excluded from the expected sample. When checked, will enable the text box underneath the option to allow the user to specify what the excluded material actually is.	N/A	
Material Excluded	Text box that will contain a text description of material that was excluded from the test.	N/A	
Balance	Equipment drop down listing **Balance** equipment types available to this worksheet	N/A	
Oven	Equipment drop down listing **Oven** equipment types available to this worksheet	N/A	

Measurements

This section contains the actual measurements of interest that most users will be interested in populating on the test initially. The measurements section contains only the tare and wet masses since it is assumed that the individual completing this section of the test will be the one that should be identified as the "tested by", dry masses are most often going to be entered on the grid dry mass data entry page.



Prompt	**Behaviour/Description**	**Unit**	**Symbol *(Used in Standard)***
Tare ID	The ID of the container that the material is placed in for the moisture content test. As described in grid dry mass data entry, when material under test is put into an oven in order to dry out, it is placed in a container. The container has an identifier which is noted on the the worksheet for the test. Once the material is in the oven, the sample ID for the material is no longer known or retrievable simply by looking at the material or container, the container identifier is the only way to trace the dry mass result back to the appropriate test. This is that container identifier. A text string expected to be commonly less than 6 characters, up to 20.	N/A	

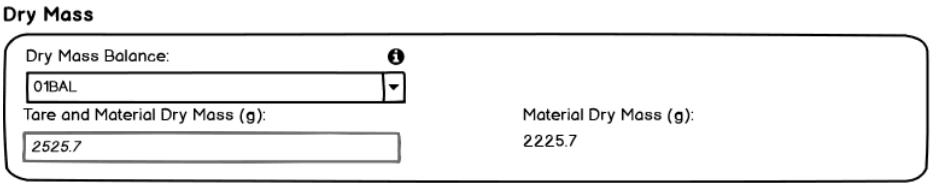
Tare Mass	The mass of the container or tare for the test. A blank or 0 value is not appropriate for this field. Moisture content tests are completed overnight and having a balance tared for this period of time is unrealistic.	g	**M_C**
Tare and Material Wet Mass	The mass of the container or tare plus wet material for the test. Numeric input.	g	**M_{CMS}**
Material Wet Mass	Calculated field as the difference of **Tare and Material Wet Mass** and **Tare Mass.**	g	M_{MS}

Tested By Section

This is an instance of a **Tested By** section defined in Tested By, Checked By and Remarks.

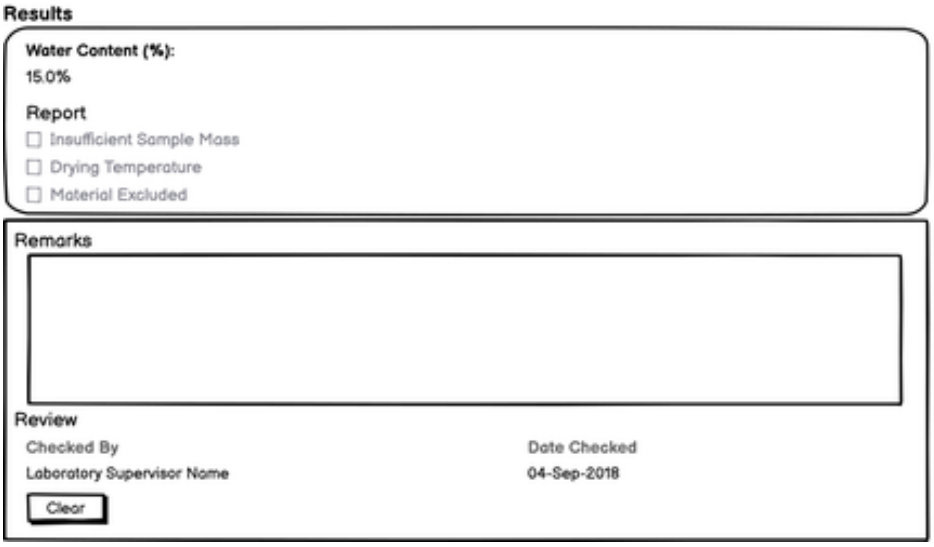
Dry Mass

This section comes underneath the **Tested By** section as it is assumed that the individual completing the wet masses section of the test will be the one that should be identified as the "tested by", dry masses are most often going to be entered on the grid dry mass data entry page.



Prompt	**Behaviour/Description**	**Unit**	**Symbol *(Used in Standard)***
Dry Mass Balance	Equipment drop down listing **Balance** (30005) equipment types available to this worksheet. Automatically set by the grid dry mass data entry page.	N/A	
Tare and Material Dry Mass	The mass of the container or tare plus dried material for the test.	g	**M_{CDS}**
Material Dry Mass	Calculated field as the difference of **Tare and Material Dry Mass** and **Tare Mass.**	g	

Results



Prompt	**Behaviour/Description**	**Unit**	**Symbol *(Used in Standard)***
Water Content	The result of interest, the water content of the material under test. $w = \frac{M_{CMS} - M_{CDS}}{M_{CDS} - M_C} \times 100$	%	**w**

Report

The checkboxes below should all be un-checked by default. See for more details.

Prompt	**Behaviour/Description**	**Unit**	**Symbol**
Insufficient Sample Mass	Enabled only if the material wet mass is less than the minimum mass given in Table 1 for the given maximum particle size. If checked, the report will include the following statement in addition to the result: Specimen mass < minimum required	N/A	N/A
Drying Temperature	Enabled only if drying temperature is not between 105°C and 115°C If checked, the report will include the drying temperature in addition to the result.	N/A	N/A

Material Excluded	Enabled only if material excluded is checked and has a value. If checked, the report will include the text in the material excluded field in addition to the result.	N/A	N/A

Review Section

This is an instance of a **Checked By and Remarks** section defined in Tested By, Checked By and Remarks.

Warning Messages

This test will provide the following warnings to the user under the appropriate field.

Criteria	Message	Shown Under	Severity	Effect
(M_C is null and (M_{CMS} is not null or M_{CDS} is not null)) or $M_C = 0$	Tare mass is expected, a missing or 0 tare mass may indicate an issue with the result.	Tare mass	Warning	No Effect
$M_C < 0$ or $M_{CMS} < 0$ or $M_{CDS} < 0$	Mass cannot be less than 0	Mass field that is < 0	Danger	Result not calculated
$M_C >= M_{CMS}$	Tare and wet mass must be greater than tare mass	Tare and Material Wet Mass	Danger	Result not calculated
$M_C >= M_{CDS}$	Tare mass is {greater than/equal to} tare and dry material mass, cannot calculate a result (select appropriate language depending on equality)	Tare and Material Dry Mass	Danger	Result not calculated
$M_{CDS} > M_{CMS}$	Dry mass greater than wet mass, cannot calculate a result	Tare and Material Dry Mass	Danger	Result not calculated

Questions

Please provide code solutions to the following questions in your chosen coding language.

1. Define a **Moisture Content** object model that includes the fields in the **Measurements**, **Dry Mass** and **Results** sections.
2. Write code that calculates **Material Wet Mass, Material Dry Mass** and **Water Content**.
3. Write appropriate unit tests for the calculations in question 2.