2012 A/L Structured Essay Question No (01)

1. A student has decided to measure the density of a stone with a smooth surface but having an irregular shape, at home using the following items.

A rectangular container

A 30 cm ruler (foot ruler) with mm scale

Assume that he has access to the following items too.

A household glass measuring cylinder capable of measuring liquid volumes upto nearest 5 ml.

Electronic balance at a nearby retail shop.

(*a*) He started the experiment by determining the volume of the container using the 30 cm ruler.

(i) What are the measurements he has to take?

(1) ..... (say x_1)

(2) ..... (say x_2)

(3) ..... (say x_3)

(ii) When an ordinary 30 cm ruler (foot ruler) is used to take the above three measurements one measurement may be less accurate,

What is that measurement? .....

What is the reason for that? .....

.....

(*b*) He washed the stone thoroughly, dried it, and kept it inside the container as shown in figure (1). Then he filled the remaining volume of the container upto the brim with a measured amount of water using the measuring cylinder. Let the volume of water measured and added to the cylinder be V.

Figure (1)

(i) Write down an expression for the volume of the stone (V_0) in terms of V, x_1, x_2 and x_3.

V_0 = ...

(ii) If he has the option to choose a container with the same volume but having a narrow brim as shown in figure (2), explain as to why it is advantageous to select such a container?

Figure (2)

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(*c*) (i) What is the other measurement that he should take in order to determine the density of the stone?

..... (say P)

(ii) Hence write down an expression for the density (d_0) of the stone in terms of the symbols defined above.

d_0 = ...

(*d*) Suppose you want to estimate the mass of a huge rock that is situated on a flat land as shown in figure (3), using the knowledge that you have gained from the above experiment. Assume that you have ability and provisions to construct wooden boxes of any known volume, or wooden structures of known size, and access to sufficient quantity of fine sand instead of water.

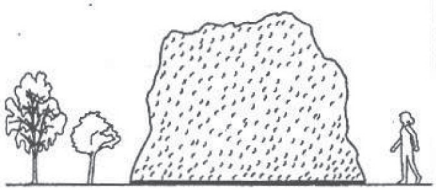

Figure (3)

(i) Write down the major steps of a method that you would suggest in order to measure the volume of the rock.

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(ii) What kind of measuring device can be constructed to measure the volume of sand using the materials given under (*d*) above?

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(iii) What is the other physical quantity that is needed to estimate the mass of the rock?

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(iv) Suggest a method to measure the quantity mentioned in (*d*) (iii) above.

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