ICE - Average, Instantaneous Rate

The northernmost city in Australia is named Darwin (see Figure 1[1]) after the famous English naturalist Charles Darwin. Darwin was the only Australian city directly attacked by the Japanese in World War 2. It is also one of the few places in the world where you have a reasonable chance of being attacked by a crocodile while walking down the main street[2] (see Figure 2[3]).

Figure 1: Darwin is the northernmost city in Australia.

Figure 2: Saltwater crocodile. This photograph was taken by a tourist on a pleasure cruise.

Figure 3: A standard sized 40 oz beverage bottle and a 71 oz Darwin Stubbie.

Darwin is also the namesake of the legendary 2.25 liter beer bottles known as "Darwin Stubbies." (Two and one quarter liters is approximately equivalent to 71 fluid ounces. See Figure 3[4] for a comparison between a 40 oz bottle and a Darwin Stubbie.)

Enthusiastic (but inexperienced) Australian youths (variously "yobbos" or "drongos") regularly attempt to drain Darwin Stubbies in order to impress their friends ("mates" or "cobbers"). Success at this feat is usually followed by a loss of consciousness on the part of the youth, and various hoots of approval from his associates, including:

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[1] Image source: http://www.cnn.com/

[2] The last fatal crocodile attack on a human in Darwin was in 1971. However, crocodiles are regularly removed from the city's beaches.

[3] Image source: http://stephan.indosite.com/

[4] Image sources: http://altdotculture.com/ and http://www.kellys.com

- **"Bonza"**
- **"Beauty"**
- **"Cracker"** ***(not to be confused with the North American usage)***
- **"Pearler"**
- **"Scorcher"** ***or, favored in some circles,***
- **"Grouse."**

During one attempt that was captured on videotape, the volume of beverage left in the Darwin Stubbie after 't' seconds was quite well approximated by:

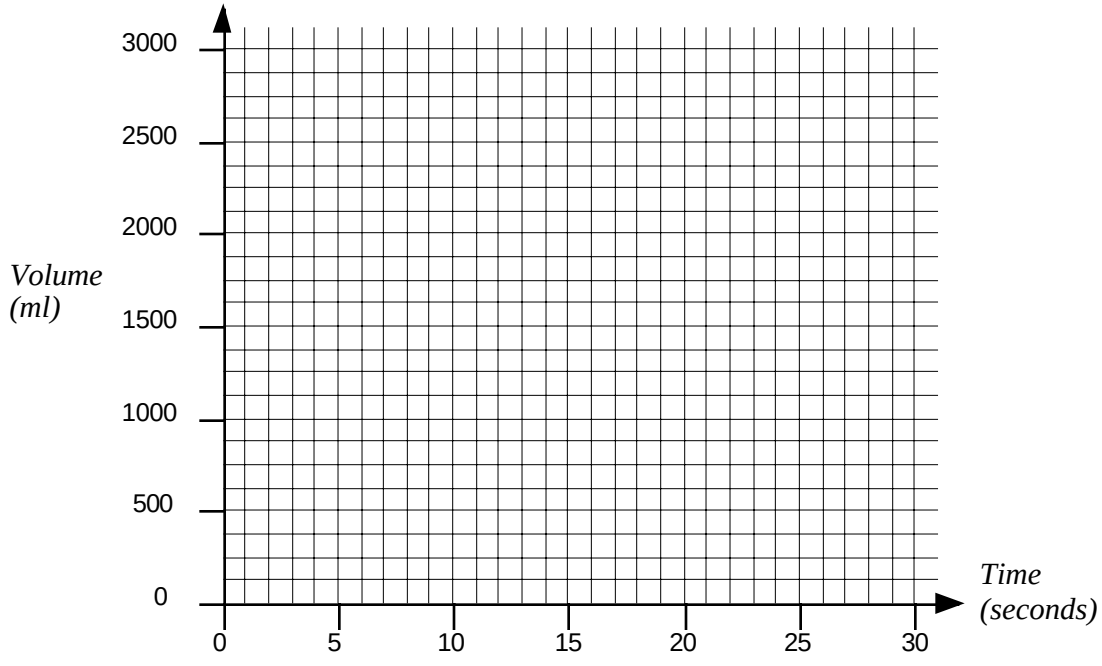
$$V(t) = 1250 + (10 - t)^3,$$

where the volume is measured in milliliters (ml).

- ***How much liquid is in the bottle initially?***

- ***How fast does beverage drain out of the bottle, on average, during the first 10 seconds?***

- ***Sketch a graph showing volume versus time. On you graph, draw a linw whose slope equals the average rate of change between*** $t = 0$ ***and*** $t = 10$***.***



- ***On the graph that you have plotted, sketch a line whose slope gives the instantaneous rate of change when*** $t = 15$***. What is the instantaneous rate of change equal to when*** $t = 15$***?***

- ***Use the equation for*** $V(t)$ ***to complete the table given below. Do the rates of change appear to be approaching a limit? If so, what is the value of the limit?***

Interval	t=5 to t=6	t=5 to t=5.5	t=5 to t=5.1	t=5 to t=5.01
Rate of change				

When people consume alcohol at a responsible rate, as much as 90% of the alcohol is broken down by an enzyme in the stomach called "alcohol dehydrogenase." Alcohol that is broken down in the stomach does not does note lead to as profound a state of intoxication as alcohol absorbed directly into the bloodstream. When alcohol is imbibed rapidly, this first step is skipped and much higher percentage of the alcohol is absorbed into the bloodstream.

In Australia, beer normally has an alcohol content of 5% by volume. (That is, 5% of the volume of the beverage consists of alcohol.) An average person has about 4700 ml of blood[5]. The percentage of blood that is comprised of alcohol is called the Blood Alcohol Level (or BAL). On average, a person can eliminate about 15 ml of alcohol per hour[6] although this rate varies a lot depending on the individual and circumstances involved. Some typical effects of alcohol consumption are listed in Table 1[7] (below).

BAL (%)	Symptoms
0.01-0.05	Behavior normal in most subjects
0.03-0.12	Mild euphoria, sociability, talkativeness, decreased inhibitions, dimunition of judgment and control. Loss of efficiency in performance tests.
0.09-0.25	Emotional instability. Impairment of perception and memory. Increased reaction time and decrease in sensory-motor coordination. Drowsiness.
0.18-0.30	Exaggerated emotional states. Decreased muscular coordination, staggering walk and slurred speech. Disorientation and mental confusion. Vomiting.
0.25-0.40.	Inertia and loss of motor functions. Marked decrease in response to stimuli. Inability to stand or walk. Vomiting and possible incontinence. Sleep or stupor.
0.35-0.50	Coma. Depressed reflexes. Subnormal body temperature. Impairment of circulation and respiration. Incontinence. Possible death.
0.45+	Death from respiratory arrest.

Table 1.

- ***Using the information provided above, what effects would you predict from the consumption of a Darwin Stubbie in the manner outlined?***

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[5] Source: Encyclopedia Brittanica, 2001.

[6] Source: http://www.intox.com/

[7] Source: K. M. Dubowski. "Stages of alcohol intoxication." Available on-line from: www.intox.com