

**MATH 221: Calculus and Analytic Geometry**  
**Prof. Ram, Fall 2006**

**HOMEWORK 11: SELECTED ANSWERS**

**Problem A. Volumes by washers.**

- |                                   |                                     |
|-----------------------------------|-------------------------------------|
| (4) $8\pi/3$ cubic units          | (5) $\pi^2/2$ cubic units           |
| (6) $\pi/30$ cubic units          | (7) $\pi r^2 h/3$ cubic units       |
| (8) $2\pi h^2 r/3$ cubic units    | (9a) $\pi h^2(a - h/3)$ cubic units |
| (9b) $6/\pi$ inches per minute    | (10) $81\pi/10$ cubic units         |
| (11) $16\pi/15$ cubic units       | (12) $128\pi/7$ cubic units         |
| (13) $(4/3)\pi ab^2$ cubic units  | (14) $512\pi/15$ cubic units        |
| (15) $16a^3/3$ cubic units        | (16) $\pi/9$ cubic units            |
| (17) $\pi$ cubic units            | (18) $32\pi/5$ cubic units          |
| (19) $8a^3/3$ cubic units         | (20) $8a^3/3$ cubic units           |
| (21) $\pi\sqrt{3}/16$ cubic units | (22) $8\pi/3$ cubic units           |

**Problem B. Finding volumes by cylindrical shells.**

- |                                       |                                |
|---------------------------------------|--------------------------------|
| (4) $(\sqrt{3}/2)\pi a^3$ cubic units | (5) $2\pi^2 a^2 b$ cubic units |
| (6) $8\pi/3$ cubic units              | (7) $8\pi/3$ cubic units       |
| (8) $56\pi/15$ cubic units            | (9) $2\pi/3$ cubic units       |
| (10) $256\pi/5$ cubic units           | (11) $48\pi/5$ cubic units     |
| (12) $117\pi/5$ cubic units           | (13) $108\pi/5$ cubic units    |
| (14) $\pi/3$ cubic units              | (15) $64\pi/5$ cubic units     |
| (16) $5\pi/3$ cubic units             | (17) $4\pi/3$ cubic units      |

(18)  $4\pi/15$  cubic units

(19)  $8\pi$  cubic units

(20)  $224\pi/15$  cubic units

**Problem C. Practical volumes.**

(1)  $72\pi/35$  cubic units

(2)  $2\sqrt{3}a^3$  cubic units

(3)  $(\pi/3)(2r^3 - 3r^2h + h^3)$  cubic units

(4)  $(1/3)\pi b(r^2 + rR + R^2)$  cubic units, where  $R = r(h - b)/h$ .

(5)  $\sqrt{3}a^3/12$  cubic units

(6)  $16r^3/3$  cubic units

(7) 24 cubic units

(8)  $\sqrt{3}/2$  cubic units

(9)  $5\pi r^3/12$  cubic units

(10)  $16r^3/3$  cubic units

(12) They both contain the *same* amount of wood.

(13) At  $1 - (1/3)^{1/3}$  and  $1 - (2/3)^{1/3}$ .

(14)  $r = \frac{h \sin \theta}{\sin \theta + \cos 2\theta}$ .