

# Calc 1: Related Rates & Review

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## DIRECTIONS

Problems 1-6: Related Rates — draw a diagram, write an equation, differentiate with respect to time.  
Problems 7-9: Mean Value Theorem — find  $c$  in  $(a,b)$  where  $f'(c) = [f(b)-f(a)]/(b-a)$ . Problem 10: find  $k$  so the function is continuous (factor and simplify the limit).

### 1 Related Rates (MC):

Conical reservoir: depth 20ft, top radius 10ft. Surface falls at  $\frac{1}{2}$  ft/hr. Rate water leaves (ft<sup>3</sup>/hr) when depth = 8ft?

Answer: \_\_\_\_\_

### 2 Related Rates (MC):

Box:  $h=10$ in, length grows 2in/s, width shrinks 4in/s. Rate of volume change when  $l=8$ in and  $w=6$ in?

Answer: \_\_\_\_\_

### 3 Related Rates:

A 20ft ladder leans against a house. Its foot is 12ft from the house and moving away at 2ft/s. How fast is the top sliding down?

Answer: \_\_\_\_\_

### 4 Related Rates:

Conical paper cup: diameter = height = 4in. Water leaks at  $\frac{1}{2}$  in<sup>3</sup>/s. Rate the level drops when the surface diameter = 2in?

Answer: \_\_\_\_\_

### 5 Related Rates:

Car A goes east 40mph, Car B goes south 60mph (90mi from intersection at noon). At what rate is the distance between them changing at 1pm?

Answer: \_\_\_\_\_

### 6 Related Rates (3 parts):

For  $V = \pi r^2 h$  (cylinder), find  $dV/dt$  in terms of: (a)  $dh/dt$  when  $r$  is constant (b)  $dr/dt$  when  $h$  is constant (c) both  $dh/dt$  and  $dr/dt$  when neither is constant

Answer: \_\_\_\_\_

### 7 Find $c$ (MVT) on $[1, 4]$ :

$$f(x) = x^2 - 5x + 4$$

Answer: \_\_\_\_\_

### 8 Find $c$ (MVT) on $[1, 3]$ :

$$f(x) = 3x^2 + 4x - 3$$

Answer: \_\_\_\_\_

### 9 Find $c$ (MVT) on $[-2, 4]$ :

$$f(x) = x^3 - 1$$

Answer: \_\_\_\_\_

### 10 Find $k$ (Continuity at $x = 3$ ):

$$f(x) = \frac{x^2 - 2x - 3}{x - 3}, \quad x \neq 3$$

Answer: \_\_\_\_\_

# Answer Key & Solutions

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## TEACHER NOTES

#1:  $V=(\pi/3)r^2h$ ,  $r=h/2$  so  $V=(\pi/12)h^3$ ;  $dV/dt=(\pi/4)h^2*dh/dt$ ; at  $h=8$ :  $8\pi$ . #3:  $x^2+y^2=400$ ;  $2x(dx/dt)+2y(dy/dt)=0$ ;  $y=16$ ,  $dy/dt=-3/2$ . #4:  $r=h/2$  (similar triangles);  $V=(\pi/12)h^3$ ; at  $h=2$ :  $dh/dt=1/(2\pi)$ . #5: at 1pm  $A=40mi$ ,  $B=30mi$ ,  $D=50mi$ ;  $dD/dt=-4mph$ . #6 full answer: (a)  $\pi r^2 dh/dt$ , (b)  $2\pi r h dr/dt$ , (c) both combined.

### 1 Related Rates (MC):

Conical reservoir: depth 20ft, top radius 10ft. Surface falls at  $\frac{1}{2}$  ft/hr...

$$= 8\pi \text{ ft}^3/\text{hr} \text{ (Choice B)}$$

### 2 Related Rates (MC):

Box:  $h=10in$ , length grows 2in/s, width shrinks 4in/s. Rate of volume cha...

$$= -200 \text{ in}^3/\text{s} \text{ (Choice D)}$$

### 3 Related Rates:

A 20ft ladder leans against a house. Its foot is 12ft from the house and...

$$= \frac{3}{2} \text{ ft/s}$$

### 4 Related Rates:

Conical paper cup: diameter = height = 4in. Water leaks at  $\frac{1}{2}$  in<sup>3</sup>/s. Rate...

$$= \frac{1}{2\pi} \text{ in/s}$$

### 5 Related Rates:

Car A goes east 40mph, Car B goes south 60mph (90mi from intersection at...

$$= -4 \text{ mph}$$

### 6 Related Rates (3 parts):

For  $V = \pi r^2 h$  (cylinder), find  $dV/dt$  in terms of: (a)  $dh/dt$  when  $r$  is con...

$$= \frac{dV}{dt} = \pi r^2 \frac{dh}{dt} + 2\pi r h \frac{dr}{dt} \text{ (c)}$$

### 7 Find c (MVT) on [1, 4]:

$$f(x) = x^2 - 5x + 4$$

$$= c = \frac{5}{2}$$

### 8 Find c (MVT) on [1, 3]:

$$f(x) = 3x^2 + 4x - 3$$

$$= c = 2$$

### 9 Find c (MVT) on [-2, 4]:

$$f(x) = x^3 - 1$$

$$= c = 2$$

### 10 Find k (Continuity at $x = 3$ ):

$$f(x) = \frac{x^2 - 2x - 3}{x - 3}, x \neq 3$$

$$= k = 4$$