	A	B	C	D
=				
1	R1	**225**	ohms	
2	R2	**350**	ohms	
3	dr1	**0.4**	ohms/sec	
4	dr2	**0.6**	ohms/sec	
5				
6	R	?		
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

A1 "R1"

Two resistors are connected in parallel.

The total resistance, R, can be measured in ohms (Ω) is given by . $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}$

9. If R_1 is increasing at a rate 0.4 Ω/s and R_2 is increasing at a rate 0.6 Ω/s, how fast is their total resistance changing when the resistors are R_1 = 225 Ω and R_2 =350 Ω, respectively?

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2} \rightarrow \frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{23}{3150}$$

$$\frac{d}{dt}\left(\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}\right) \rightarrow \frac{0\cdot R-\frac{dR}{dt}\cdot 1}{(R)^2}=\frac{0\cdot R_1-\frac{dR_1}{dt}\cdot 1}{(R_1)^2}+\frac{0\cdot R_2-\frac{dR_2}{dt}\cdot 1}{(R_2)^2}$$

$$\rightarrow \frac{-1}{R^2}\cdot\frac{dR}{dt}=\frac{-1}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{-1}{R_2{}^2}\cdot\frac{dR_2}{dt}$$

$$\rightarrow \frac{dR}{dt}=-R^2\left(\frac{-1}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{-1}{R_2{}^2}\cdot\frac{dR_2}{dt}\right)$$

$$\rightarrow \frac{dR}{dt}=\frac{R^2}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{R^2}{R_2{}^2}\cdot\frac{dR_2}{dt}$$

$$\frac{dR}{dt}=\frac{R^2}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{R^2}{R_2{}^2}\cdot\frac{dR_2}{dt}$$

$$\frac{1}{R}=\frac{1}{225}+\frac{1}{350}=\frac{23}{3150}$$

$$R=\frac{3150}{23} \text{ (total resistance)}$$

$$R_1=225$$

$$R_1=350$$

$$\frac{dR_1}{dt}=0.4=\frac{2}{5}$$

$$\frac{dR_2}{dt}=0.6=\frac{3}{5}$$

$$\frac{\mathbf{dR}}{dt}=\frac{127}{529}\approx 0.2401$$

$$\frac{dR}{dt}=\frac{R^2}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{R^2}{R_2{}^2}\cdot\frac{dR_2}{dt}$$

$$=\frac{\left(\frac{1600}{13}\right)^2}{(225)^2}\cdot(0.4)+\frac{\left(\frac{1600}{13}\right)^2}{(350)^2}\cdot(0.6)$$

$$=\frac{\frac{9922500}{529}}{50625}(0.4)+\frac{\frac{9922500}{529}}{122500}(0.6)$$

$$=\frac{196}{529}(0.4)+\frac{81}{529}(0.6)$$

$$=\frac{196}{529}\left(\frac{2}{5}\right)+\frac{81}{529}\left(\frac{3}{5}\right)$$

$$=\frac{127}{529}\approx 0.240075614367$$

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}\rightarrow\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{23}{3150}\qquad R=\frac{3150}{23}\qquad \frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}\rightarrow R^{-1}=R_1^{-1}+R_2^{-1}$$

$$\frac{d}{dt}\left(R^{-1}=R_1^{-1}+R_2^{-1}\right)\rightarrow \frac{\mathbf{dR}}{dt}(-1R^{-2})=\frac{dR_1}{dt}(-1R_1^{-2})+\frac{dR_2}{dt}(-1R_2^{-2})$$

$$\frac{\frac{\mathbf{dR}}{dt}(-1R^{-2})}{-1R^{-2}}=\frac{\frac{dR_1}{dt}(-1R_1^{-2})+\frac{dR_2}{dt}(-1R_2^{-2})}{-1R^{-2}}$$

$$\frac{\mathbf{dR}}{dt}=\frac{dR_1}{dt}\cdot\frac{-R_1^{-2}}{-R^{-2}}+\frac{dR_2}{dt}\cdot\frac{-R_2^{-2}}{-R^{-2}}$$

$$\frac{\mathbf{dR}}{dt}=\frac{dR_1}{dt}\cdot\frac{R_1^{-2}}{R^{-2}}+\frac{dR_2}{dt}\cdot\frac{R_2^{-2}}{R^{-2}}$$

$$\frac{\mathbf{dR}}{dt}=\frac{dR_1}{dt}\cdot\frac{R^2}{R_1^2}+\frac{dR_2}{dt}\cdot\frac{R^2}{R_2^2}$$

$$\frac{dR}{dt}=\frac{R^2}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{R^2}{R_2{}^2}\cdot\frac{dR_2}{dt}$$

$$\frac{1}{R}=\frac{1}{225}+\frac{1}{350}=\frac{23}{3150}$$

R $=\frac{3150}{23}$ (total resistance)

$$R_1=225$$

$$R_1=350$$

$$\frac{dR_1}{dt}=0.4=\frac{2}{5}$$

$$\frac{dR_2}{dt}=0.6=\frac{3}{5}$$

$$\frac{\mathbf{dR}}{dt}=\frac{127}{529}\approx 0.2401$$

$$\frac{dR}{dt}=\frac{R^2}{R_1{}^2}\cdot\frac{dR_1}{dt}+\frac{R^2}{R_2{}^2}\cdot\frac{dR_2}{dt}$$

$$=\frac{\left(\frac{1600}{13}\right)^2}{(225)^2}\cdot(0.4)+\frac{\left(\frac{1600}{13}\right)^2}{(350)^2}\cdot(0.6)$$

$$=\frac{\frac{9922500}{529}}{50625}(0.4)+\frac{\frac{9922500}{529}}{122500}(0.6)$$

$$=\frac{196}{529}(0.4)+\frac{81}{529}(0.6)$$

$$=\frac{196}{529}\left(\frac{2}{5}\right)+\frac{81}{529}\left(\frac{3}{5}\right)$$

$$=\frac{127}{529}\approx 0.240075614367$$

Problem 2

	A	B	C	D
=				
1	mass	m	**2500**	
2	velocity or speed	v	**60**	
3	acceleration	dv/dt	**15**	
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

A1 *mass*

10. If a 2500 kg car is accelerating at a rate of 15 m/sec^2, then how fast is its kinetic energy changing when the speed is 60 m/sec.

Recall kinetic energy formula $E_k = \frac{1}{2} m v^2$

$E = \frac{1}{2} m v^2$ note: m is constant

$E = \frac{1}{2}(2500)v^2 \rightarrow E = 1250\, v^2$

$\frac{d}{dt}(E = 1250\, v^2)$

$\frac{dE}{dt} = \frac{1}{2} \cdot 2(2500)v\frac{\mathbf{dv}}{dt} \rightarrow \frac{dE}{dt} = 2500\, v\frac{\mathbf{dv}}{dt}$

$\rightarrow \frac{dE}{dt} = 2500(60)(15) = 2250000 \frac{kg\ m^2}{\sec^3}$

$= 2250000 \frac{1\ Joule}{\sec}$ NOTE: 1J = $\frac{1\ kg\ m^2}{\sec^2}$

(I had to look up this so no pts off for not knowing what a Joule was)

	A	B	C
=			
1	p	1	
2	v	500	
3	k	?	
4	dv/dt	-4000	
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
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21			

8

An internal combustion engine uses a piston to compress combustible air in a cylinder before igniting it to generate energy in the form of mechanical work. Suppose the volume of such a cylinder is 500 cm3 at 1 atm of pressure. Suddenly, the piston begins to compress the volume of the air−fuel mixture at a rate of -4000 cm3/second.

11. What is the corresponding rate of change of pressure in the cylinder? Because we'll assume the temperature doesn't change in this scenario, use Boyle's law, PV = k which says that k is a constant.

$$PV=k \rightarrow \frac{d}{dt}(PV=k) \rightarrow \frac{dP}{dt}\cdot V+\frac{\mathbf{dV}}{dt}\cdot P=0$$

$$\frac{dP}{dt}(500)+(-4000)(1)=0$$

$$500\frac{dP}{dt}-4000=0$$

$$500\frac{dP}{dt}=4000$$

$$\frac{dP}{dt}=4000/500=8 \text{ atm/s}$$