EOC Review Answer Key

1.1 Levers

12) 2nd class lever since the resistance in the middle

13)

Equation(s)	Substitution / Calculations	Solution with units
$\Sigma M = 0$	**ΣM = - (11 N) (.381 m) + (25.3 N)(d m)** **ΣM = - 4.191 Nm + 25.3d Nm** **4.191 = 25.3d** **** Note: centimeters were converted to meters since meter is the base unit. This was not necessary in this problem, but is typically a good method when calculating****	**d = .17 m** **or** **d = 17 cm**

14) 3rd class lever

15)

Equation(s)	Substitution / Calculations	Solution with units
$IMA = \frac{D_E}{D_R}$	**IMA = 1.3 in/16.1 in**	**IMA = 0.08** **or** **1 : 12**

1.1 Wheel & Axle

3) B – 6 revolutions

4)

Equation(s)	Substitution / Calculations	Solution with units
$IMA = \frac{r_W}{r_A}$	**Radius of the wheel is 18 inches** **Radius of axle is 6 inches since the diameter is one foot** **IMA = 18 in/6 in**	**IMA = 3** **or** **3 : 1**

5)

Equation(s)	Substitution / Calculations	Solution with units
$AMA = \frac{F_R}{F_E}$	**AMA = 1005 lbs / 102 lbs**	**AMA = 9.85** **Or** **9.85 : 1**

1.1 Pulleys

5)

Equation(s)	Substitution / Calculations	Solution with units
$AMA = \frac{F_R}{F_E}$	$6 = \frac{60}{F_E}$	$F_E = 10$ lb.

6)

Equation(s)	Substitution / Calculations	Solution with units
$AMA = \frac{F_R}{F_E}$	$AMA = \frac{60.}{13.4}$	4.5
$Efficiency = \frac{AMA}{IMA}$	$Efficiency = \frac{4.47761194}{6}$	Efficiency = .7 or 70%

1.1 Gears

7) Compound gear train

8)

Equation(s)	Substitution / Calculations	Solution with units
$GR = \frac{n_{out}}{n_{in}}$	$GR = \frac{30 \text{ teeth}}{15 \text{ teeth}}$	GR = 2

9)

Equation(s)	Substitution / Calculations	Solution with units
$GR = \frac{n_{out}}{n_{in}}$	$GR = \frac{40 \text{ teeth}}{20 \text{ teeth}}$	GR = 2

10)

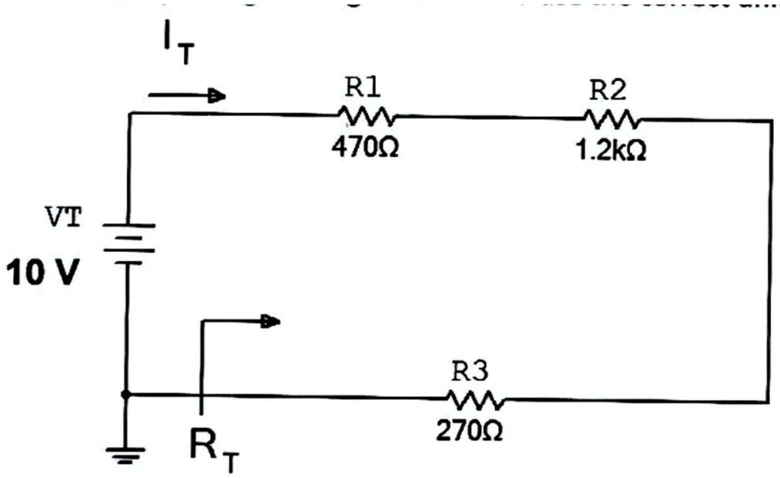
Equation(s)	Substitution / Calculations	Solution with units
Multiply all gear ratios in gear train	$GR = \frac{2}{1} \times \frac{2}{1}$	GR = 4

1.1 Inclined Plane/Wedge

Equation(s)	Substitution / Calculations	Solution with units
$AMA = \frac{F_R}{F_E}$	AMA = 81 N / 47 N	AMA = 1.7
$IMA = \frac{D_E}{D_R}$ or $IMA = \frac{L}{H}$	IMA = 20 cm / 7.1 cm	IMA = 2.8
$Efficiency = \frac{AMA}{IMA}$	Efficiency = 1.723404255 / 2.816901408	Efficiency = .61 or 61%

1.1 Series Circuit

4)



R_T = 1940 Ω

I_T=.00515 A or 5.15 mA

I_{R1}=.00515 A or 5.15 mA

I_{R2}=.00515 A or 5.15 mA

I_{R3}=.00515 A or 5.15 mA

V_{R1}= 2.42 V

V_{R2}= 6.18 V

V_{R3}= 1.39 V

$R_T = 470\Omega + 1200\Omega + 270\Omega = 1940\Omega$

$I_T = \frac{V_T}{R_T} = \frac{10V}{1940\Omega} = .00515\ A$

$I_T = I_{R1} = I_{R2} = I_{R3}$

$V_{R1} = IR = (.00515\ A)(470\Omega) = 2.42\ V$

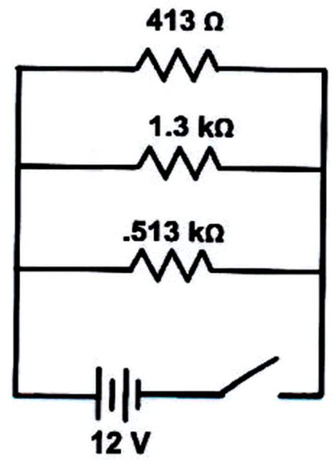
$V_{R1} = IR = (.00515\ A)(1200\Omega) = 6.18\ V$

$V_{R1} = IR = (.00515\ A)(270\Omega) = 1.39\ V$

KIRCHHOFF: 2.42 V + 6.18 V + 1.39 V ≈ 10 V

1.2 Parallel Circuits

5)



$$R_T = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}} = \frac{1}{\frac{1}{413\Omega}+\frac{1}{1300\Omega}+\frac{1}{513\Omega}} = 194.6\ \Omega$$

$$I_T = \frac{V_T}{R_T} = \frac{12\ V}{194.6\ \Omega} = .062\ A$$

6) Total Voltage – Stay the same; Total Current – Decrease; Total Resistance – Decrease; Voltage drop at 0.513 Ohm resistor – Stay the same; Current at 1.3 Ohm resistor – Stay the same

5)

$$R_T = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}} = \frac{1}{\frac{1}{450\Omega}+\frac{1}{390\Omega}+\frac{1}{620\Omega}} = 156.2\ \Omega$$

$$V_T = 12V$$

$$I_T = \frac{V_T}{R_T} = \frac{12\ V}{156.2\ \Omega} = .077\ A$$

$$V_{R1} = 12\ V$$

$$V_{R2} = 12\ V$$

$$V_{R3} = 12\ V$$

$$I_{R1} = \frac{V_{R1}}{R_{R1}} = \frac{12\ V}{450\ \Omega} = .027\ A$$

$$I_{R2} = \frac{V_{R2}}{R_{R2}} = \frac{12\ V}{390\ \Omega} = .031\ A$$

$$I_{R3} = \frac{V_{R3}}{R_{R3}} = \frac{12\ V}{620\ V} = .019\ A$$

Krichhoff: $I_T = I_{R1} + I_{R2} + I_{R3}$

.077A = .027 A + .031A + .019A

R_T=______________

V_T = ____________

I_T=______________

V_{R1}=______________

V_{R2}=______________

V_{R3}=______________

I_{R1}=______________

I_{R2}=______________

I_{R3}=______________

KIRCHHOFF=________________

1.2 Energy Sources

Biomass is renewable while the other three are inexhaustible.

Hydrogen can be inexhaustible, renewable or non-renewable depending on what is used to generate it. The other three are always non-renewable.

4)

Equation(s)	Solution with units
$W = F \cdot d$	2730 N·m
$P = \frac{W}{t}$	$160 \frac{N \cdot m}{s}$ = 160 Watts
$P = I \cdot V$	360 Watts
Efficiency = $\frac{\text{Energy Output}}{\text{Energy Input}}$ X 100%	44.4%

1.1 Intro to Thermodynamics

Zeroth Law of Thermodynamics – If two bodies are each in thermal equilibrium with some third body, then they are also in equilibrium with each other.

First Law of Thermodynamics - Matter and energy can be transformed, and energy can be converted from one form into another, but the total of the equivalent amounts of both must always remain constant.

Second Law of Thermodynamics - Whenever energy is transformed from one form to another form, entropy increases and the amount of useful energy decreases. – Thermal energy also flows from hot to cold.

Complete the following table:

Scale	Freezing point of water	Boiling point of water	Absolute zero
Celsius	**0°C**	**100°C**	**-273.15°C**
Kelvin	**273.15 K**	**373.15 K**	**0 K**
Fahrenheit	**32°F**	**212°F**	**-459.67°F**
Rankine	**491.67 R**	**671.67 R**	**0 R**

Is the following radiation, convection, or conduction?

Radiation The heat you feel from a fireplace
Convection warm air rises to the ceiling
Convection water pumped in an auto cooling system
Conduction Frying a pancake
Conduction particles colliding with other particles
Convection air travels this way
Conduction transfer through solid

Radiation transfer through space
Radiation moves as a wave
Convection moves as a current
Radiation sun rays reaching earth
Convection occurs only within fluids
Conduction a coil on an electric stove
Radiation this type of transfer is affected by color

Covert 58 °F to degrees Kelvin.

Equation(s)	Substitution / Calculations	Solution with units
C = 5/9(F – 32) **K = C + 273.15**	**C = 5/9 (58 – 32) = 14.4** **K = 14.4 + 273.15**	**K = 287.59**

The U-value of a material measures the ability of the material to _____________ heat. The _________ the value the better the material will conduct heat.

A) conduct, lower
B) resist, higher
C) conduct, higher
D) resist, lower

The R-Value of a material measures the ability of a material to ________________ heat. The ________ the R-value the more resistance to heat the material has.

A) conduct, lower
B) resist, higher
C) conduct, higher
D) resist, lower

The U-value of a material is $0.37 \frac{Btu}{ft^2 * {}^\circ F * hr}$. Calculate the R-value of the material with correct units.

Equation(s)	Substitution / Calculations	Solution with units
R = 1/U	$R = 1/ (0.37 \frac{Btu}{ft^2 * {}^\circ F * hr})$	$R = 2.70 \frac{ft^2 \cdot {}^\circ F \cdot hr}{Btu}$

_____________ is the measure of how evenly heat is distributed within a system.

A)entropy
B)enthalpy
C) Q - value
D) T - value

1)

Calculations	Solution with units
$R_{Total} = .45 + 5.5(3.142) + 4 + 1.5(.17) + .80$	$R_{Total} = 22.786 \frac{ft^2 \cdot {}^\circ F \cdot hr}{Btu}$

2)

Calculations	Solution with units
$R_{Total} = .45 + 6.88 + 4 + 1.5(.17) + .80$	$R_{Total} = 12.385 \frac{ft^2 \cdot {}^\circ F \cdot hr}{Btu}$

3)

Calculations	Solution with units
Difference of $R_{Total} = 24.201 - 12.385$	Difference = $10.401 \frac{ft^2 \cdot {}^\circ F \cdot hr}{Btu}$

4)

4) A side wall in a refrigerated semi-trailer has a R-value of 13.0 $\frac{ft^2 \cdot °F \cdot hr}{Btu}$. The temperature outside the trailer is 84°F, and the inside of the trailer is 45°F. Calculate the energy transfer over 2 hours, through a single side wall on the trailer. The dimensions of the wall are 50 ft. by 13 ft. Ensure to use all correct units.

Equation(s)	Substitution / Calculations	Solution with units
$U = \frac{1}{R}$	$U = \frac{1}{13.0 \frac{ft^2 \cdot °F \cdot hr}{Btu}}$	U = .0769 $\frac{Btu}{ft^2 \cdot °F \cdot hr}$
$U = \frac{P}{A\Delta T}$	P = UAΔT P = (.0769 $\frac{Btu}{ft^2 \cdot °F \cdot hr}$)(650 ft^2)(39°F)	P = 1949.4 $\frac{Btu}{hr}$
$P = \frac{Q}{\Delta t}$	Q = PΔt Q = (1949.4 $\frac{Btu}{hr}$)(2 hr)	Q = 3898.8 Btu

5)

Equation(s)	Substitution / Calculations	Solution with units
$Q = m \cdot C_p \cdot \Delta T$	Q = (2kg)(4184 $\frac{J}{kg \cdot °C}$)(22°C)	Q = 184096 J

6)

Equation(s)	Substitution / Calculations	Solution with units
$Q = m \cdot C_p \cdot \Delta T$	$m = \frac{Q}{C_p \cdot \Delta T}$ $m = \frac{184096\ J}{\left(900 \frac{J}{kg \cdot °C}\right)(53°C)}$	m = 3.86 kg

2.1 Centroids

$\bar{x}$ = 2.5 in
$\bar{y}$ = 3 in

2)

$\bar{x}$ = 3 m
$\bar{y}$ = 11.5 m

3)

2.1 Beam Deflection

1) Calculate the moment of inertia of the given beam.

Equation(s)	Substitution / Calculations	Solution with units
$I_{xx} = \frac{bh^3}{12}$		I_{xx} = 20.8 in^4

2) Calculate the modulus of elasticity of the beam.

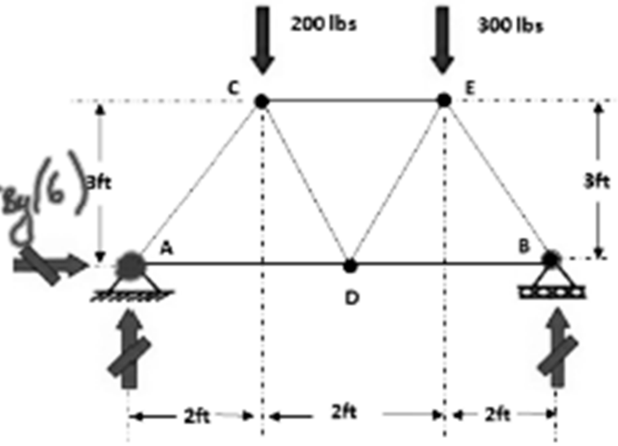
Equation(s)	Substitution / Calculations	Solution with units
$\Delta MAX = \frac{FL^3}{48EI}$		E = 593,653.84 lbs/in^2

3) How much force would need to be applied in order to deflect the beam exactly 1.00 inch?

Equation(s)	Substitution / Calculations	Solution with units
$\Delta MAX = \frac{FL^3}{48EI}$		F = 1000 lbs

Truss Calculations

1) Calculate the magnitude of R_{fAY}



$\Sigma M_A = 0$

$\Sigma M_A = -200lb(2ft) - 300lb(4ft) + R_{FBy}(6)$

$0 = -400ft\cdot lbs - 1200ft\cdot lbs + 6R_{FBy}$

$1600ft\cdot lbs = 6R_{FBy}$

$6R_{FBy} = 1600ft\cdot lbs$

$R_{FBy} = 266.67\ lbs$

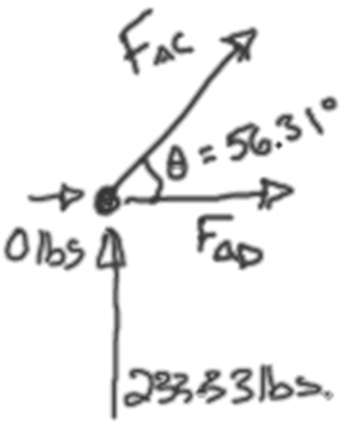
$\Sigma F_y = 0$

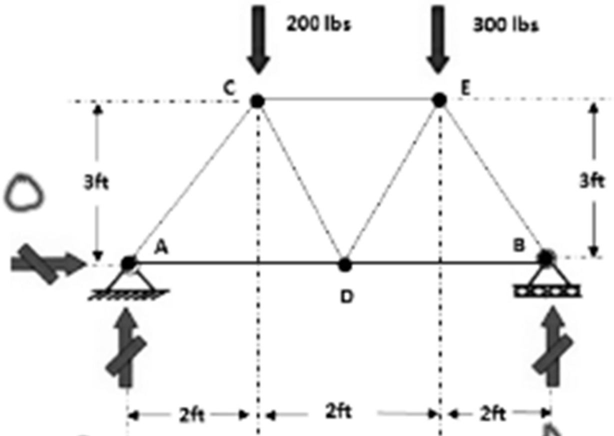
$\Sigma F_y = R_{FAy} - 200 - 300 + 266.67$

$0 = R_{FAy} - 233.33$

$R_{FAy} = 233.33\ lbs.$

2) Draw the free body diagram of joint A

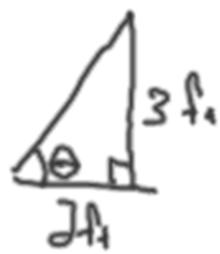




$R_{FAx} = 0$

$R_{FAy} = 233.33$ lbs

$R_{FBy} = 266.67$ lbs



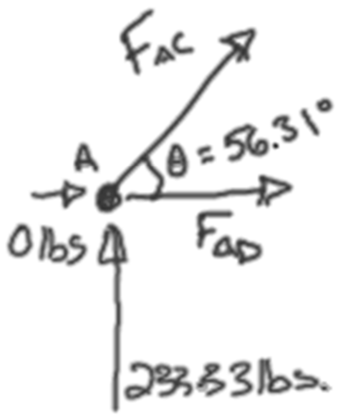
$$\tan\theta = \frac{OPP}{ADJ}$$

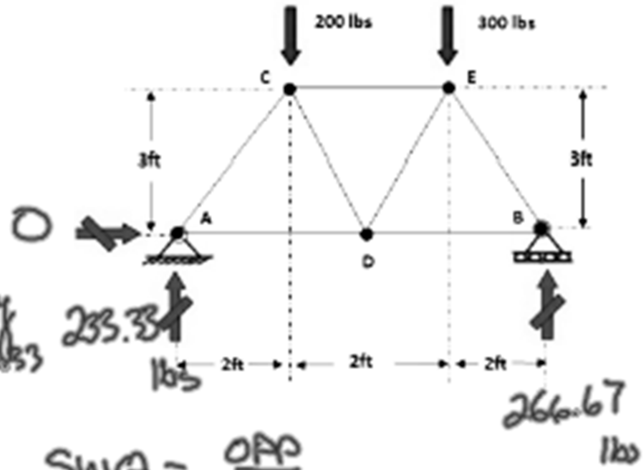
$$\tan\theta = \frac{3}{2}$$

$$\theta = \tan^{-1}\left(\frac{3}{2}\right)$$

$$\theta = 56.31°$$

3) Calculate the force in member AC. Determine whether it is in tension or compression.





$\Sigma F_y = 0$

$\Sigma F_y = 233.33\text{ lbs} + F_{ACy}$

$0 \quad F_{ACy} = -233.33\text{ lbs}$

0

$\sin\theta = \frac{OPP}{HYP}$

$\sin(56.31) = \frac{233.33}{F_{AC}}$

$F_{AC} = \frac{233.33}{\sin(56.31)}$

$F_{AC} = 280.43\text{ lbs}$

2.1 Force Vectors

8)

Equation(s)	Substitution / Calculations	Solution with units
$sin\theta = \frac{opp}{hyp}$ $cos\theta = \frac{adj}{hyp}$		F_{Ax} = 43.30 lbs F_{Ay} = 25 lbs
$sin\theta = \frac{opp}{hyp}$ $cos\theta = \frac{adj}{hyp}$		F_{Bx} = 51.96 lbs F_{By} = -30 lbs
$\sum F_x$ $\sum F_y$		ΣF_x = 95.26 lbs ΣF_y = -5 lbs
$a^2 + b^2 = c^2$		Magnitude: 95.39 lbs
$tan\theta = \frac{opp}{adj}$		Direction: 3° CW to + X axis Sense: Right and Down

2.3 Material Strength Testing

1) Calculate the stress at the point that would correspond to the proportional limit of a stress strain curve.

Equation(s)	Substitution / Calculations	Solution with units
$\sigma = \frac{F}{A}$	$\sigma = \frac{60,000\ lbs}{.0125\ in^2}$	$4,800,000 \frac{\text{lbs}}{\text{in}^2}$

2) Calculate the ultimate stress of the material

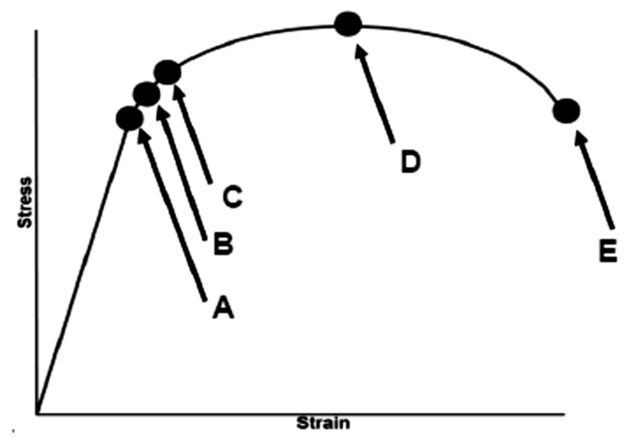
Equation(s)	Substitution / Calculations	Solution with units
$\sigma = \frac{F}{A}$	$\sigma = \frac{79,000\ lbs}{.0125\ in^2}$	$6,320,000 \frac{\text{lbs}}{\text{in}^2}$

3) Calculate the modulus of elasticity of the material.

Equation(s)	Substitution / Calculations	Solution with units
$E = \frac{PL_0}{A_0\delta}$	$E = \frac{(60,000\ lbs)(.554\ in)}{(.0125\ in^2)(.01\ in)}$	$265,920,000 \frac{\text{lbs}}{\text{in}^2}$

4) Using the internet, look up the given modulus of elasticity (often referred to as Young's Modulus) to determine the material. What material does it appear to be?

Carbon Fiber



9) Given the Stress Strain graph to the side identify each point.

B Yield point / Elastic limit

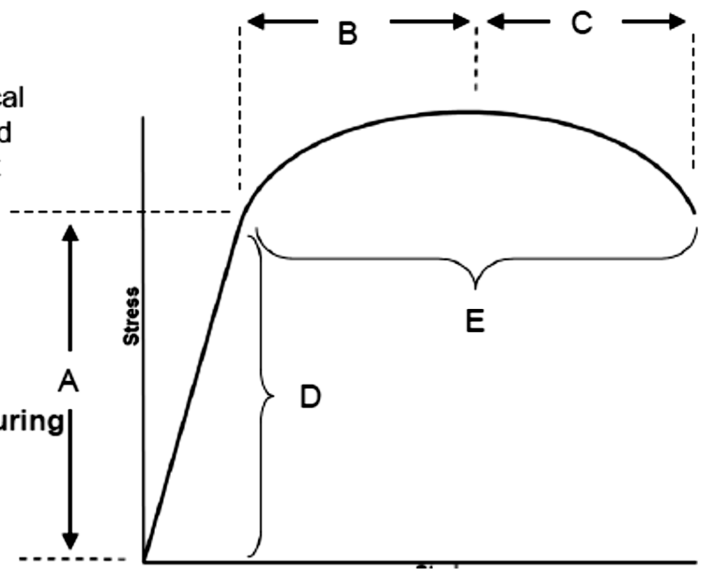
A Proportional limit

E Failure

D Ultimate Strength / Ultimate Stress

C Offset Yield Strength

10) For sections A, B, and C describe how the physical aspect of the material is changing and how stress and strain are behaving (increasing, decreasing, constant change, etc.).



A: **The stress and strain increase proportionally In a linear relationship.**

B: **The stress and strain increase similar to a Logarithmic function. Strength hardening is occuring**

C: **As strain increases the stress the sample can Withstand decreases.**

11) For D, and E name the regions of the graph being illustrated.

D: **Elastic Region**

E: **Plastic Region**

12) A testing sample has a diameter of .25" and has a 2500 lb tensile load applied to it. Calculate the amount of stress the sample is under.

Equation(s)	Substitution / Calculations	Solution with units
$A = \pi r^2$ $\sigma = \frac{F}{A}$	$A = (3.14)(.125")^2$ $\quad \sigma = \frac{2500 lb}{.049\ in^2}$	$\sigma = 51020.40 \frac{lb}{in^2}$

13) A sample portion of a dog bone had an original length of 1.125". After a load was applied to the sample the final length was 1.197". Calculate the amount of strain endured by the sample.

Equation(s)	Substitution / Calculations	Solution with units
$\epsilon = \frac{\delta}{L_0}$	$\delta = 1.197 in - 1.125 in = .072\ in$ $\quad \epsilon = \frac{.072\ in}{1.125\ in}$	$\epsilon = .064 \frac{in}{in}$ or 6.4%

Fluid Power

The use of a *gas* flowing under pressure to transmit power from one location to another is Pneumatics. The use of a *liquid* flowing under pressure to transmit power from one location to another is Hydraulics.

Gauge Pressure + Atmospheric Pressure = Absolute Pressure

Atmospheric pressure equals 14.7 psi (lb/in^2)

1)

a) Absolute pressure before = gauge pressure + atmosphere pressure

= 5 psi + 14.7 psi = 19.7 psi

• Absolute pressure after = 11 psi + 14.7 psi = 25.7 psi

b) $P_1(V_1) = P_2(V_2)$

$19.7\ psi(3\ in^3) = 25.7\ psi(V_2)$

$V_2 = 2.3\ in^3$

2) Q = v(A)

flow rate = flow velocity X cross section area of the line

$$v = \frac{1400\,\frac{cubic\ inch}{minute}}{\pi(2in)^2} = 111\,\frac{in}{min}$$

Statistics

1)

Name	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Mean	Median	Mode	Range
John	79	81	89	81	78	82	84	82	81	81	11
Mary	63	83	69	82	86	92	92	81	83	92	29

Jose	68	78	71	81	84	78	79	77	78	78	16
Martha	88	70	82	64	85	70	87	78	82	70	24
Jacob	72	62	73	69	73	68	73	70	72	73	11

2) 8.7; 5.54; The data points for Test 2 are much more spread out than that of Test 5.

3) 1/6

4) 1/5 + 1/5 = 2/5

5) 1/6 + 1/6 + 0/6 = 1/3

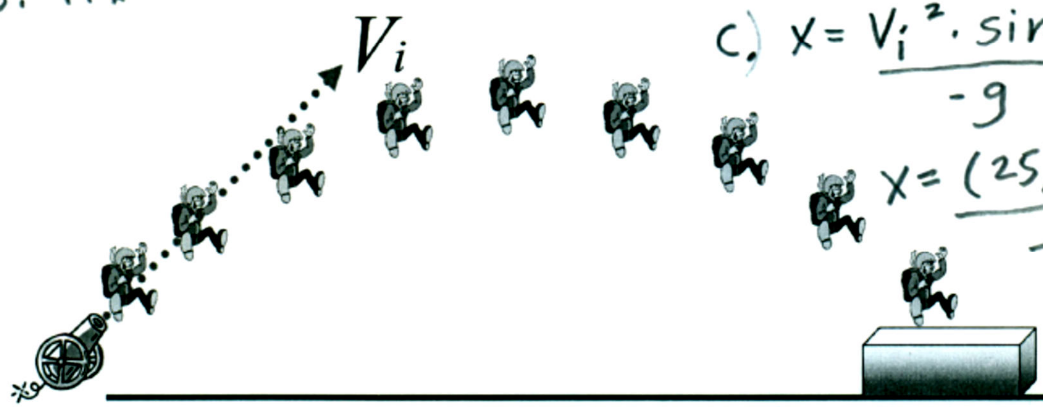
6) 2/6 X 2/6 = 4/36 = 1/9

Kinematics

1)

a. $V_{iy} = V_i \sin\theta = 25\,ft/s \sin 30° = 12.5\,ft/s$

b. $V_{ix} = V_i \cos\theta = 25\,ft/s \cos 30° = 21.7\,ft/s$



c) $x = \dfrac{V_i^2 \cdot \sin 2\theta}{-g}$

$x = \dfrac{(25)^2 \cdot \sin(2 \cdot 30)}{-(-32.15)}$

$x = 16.8\,ft$

2) 29.7°

RobotC Programming

1) A

2)

```
task main()
{
while (1=1)
   {
      if(SensorValue[bumper] == 1)
      {
         stopMotor(rightMotor);
         stopMotor(leftMotor);
      }
      else if(SensorValue[sonarSensor] < 10)
      {
         stopMotor(rightMotor);
         stopMotor(leftMotor);
         wait(1);
         startMotor(leftMotor,63);
         wait(1);
         startMotor(rightMotor,63);
      }
      else
      {
         startMotor(leftMotor,63);
         startMotor(rightMotor,63);
      }
   }
}
```