Battle Drill
Answers

1.0 Battle Drills:
Basic Math Review

1. What is the value of the following?

$$\frac{\frac{15}{14}}{\frac{23}{16}}$$

a. 0.98
b. 0.54
c. 2.4
(d) 0.75

2. Solve the following x:

$(23)(15+x) = 157$

$\frac{23(15+x)}{23} = \frac{157}{23}$

$15 + x = 6.83$

$x = 6.83 - 15$

$= -8.17$

a. –11.7
b. 11.17
c. -8.17
d. 1.23

3. $\log\left[\frac{(10+x)^2}{243}\right] = 2$

$\log(10+x)^2 - \log 243 = 2$

$\log(10+x)^2 = 4.39$

$(10+x)^2 = 10^{4.39}$

$\sqrt{(10+x)^2} = \sqrt{24547}$

$10 + x = 156.7$

$x = 146.7$

a. –32.4
b. 2433.22
c. –12.3
d. ~~155.7~~ 146.7

4. $\left[\sqrt{(12-x)^{2.5}}\right]\left[(\ln(12-3)^3\right] = 32$

$(\sqrt{(12-x)^{2.5}})(6.59) = 32$

$\left(\sqrt{(12-x)^{2.5}}\right)^2 = (4.86)^2$

$\sqrt[2.5]{(12-x)^{2.5}} = \sqrt[2.5]{23.6}$

$12 - x = 3.54$

$x = 8.46$

(a) 8.46
b. 8.20
c. 9.34
d. 10.2

5. $\left[\frac{\sqrt{(45-x)^5}}{75}\right] = 17$

$\sqrt{(45-x)^5} = (17)(75)$

$\left(\sqrt{(45-x)^5}\right)^2 = (1275)^2$

$\sqrt[5]{(45-x)^5} = \sqrt[5]{1625625}$

$45 - x = 17.5$

$x = 27.5$

a. 12.4
b. 32.2
(c) 27.5
d. 11.0

Battle Drills: Conversions

1. Convert 32.5 inches into meters.
   - a. 1.23 meters
   - b. 3.22 meters
   - (c) 0.83 meters
   - d. 2.42 meters

$$32.5\,in \times \frac{2.54\,cm}{1\,in} \times \frac{1\,m}{100\,cm} = 0.83\,m$$

2. 2300 milligrams per liter of liquid is equivalent to how many pounds per gallon?
   - a. 1.2 lbs/gal
   - (b) 0.02 lbs/gal
   - c. 0.05 lbs/gal
   - d. 1.4 lbs/gal

$$\frac{2300\,mg}{l} \times \frac{1\,l}{1.06\,qt} \times \frac{4\,qts}{1\,gal} \times \frac{1\,g}{1000\,mg} \times \frac{1\,kg}{1000\,g} \times \frac{2.2\,lbs}{1\,kg} = \frac{0.02\,lbs}{gal}$$

3. 42,000 pounds per square inch is equivalent to how many kilograms per square foot?
   - a. 34582 kg/square foot
   - b. 325291 kg/square foot
   - (c) 2749091 kg/square foot
   - d. 438103 kg/square foot

$$\frac{42000\,lbs}{in^2} \times \frac{144\,in^2}{1\,ft^2} \times \frac{1\,kg}{2.2\,lbs} = 2749091\,kg/ft^2$$

4. Floor is load tested to be 45 lbs per square foot. If the floor total square footage is 320 square feet, how many total kilograms of weight is allowed on this floor?
   - (a) 6545 kg
   - b. 4530 kg
   - c. 2348 kg
   - d. 2341 kg

$$320\,ft^2 \times \frac{45\,lbs}{ft^2} \times \frac{1\,kg}{2.2\,lbs} = 6545\,kg$$

5. If a cement mixing bag requires 2 gallons of water for every 5 lbs of cement, how many liters of water do you need for 230 pounds of cement?
   - a. 234 liters
   - (b) 347.2 liters
   - c. 231.2 liters
   - d. 23 liters

$$230\,lbs \times \frac{2\,gal}{5\,lbs} \times \frac{4\,qts}{1\,gal} \times \frac{1\,l}{1.06\,qts} = 347.2\,l$$

Battle Drills
Geometry & Trigonometry

1. A cylindrical water storage tank must hold a volumetric capacity of 300,000 gallons to serve a population of 150 people. The commercial property where this tank must be built can only fit a tank with a diameter of 50 feet. Assuming that 50 feet diameter base will be used, how high in feet should the tank be constructed to meet the volumetric capacity?

a. 110 feet
b. 153 feet
c. ~~210~~ feet
d. 113 feet

$V = \frac{\pi d^2 h}{4}$

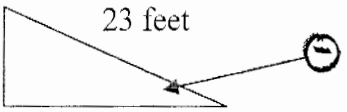
$42372\ ft^3 = \frac{\pi (50)^2 h}{4}$

$21.6' = h$

$= 300{,}000\ gal \times \frac{4\ qt}{1\ gal} \times \frac{0.035\ ft^3}{1\ qt}$

$= 42{,}372\ ft^3$

2. Given the following values, calculate the angle indicated by the arrow.



12 feet

$\cos\Theta = \frac{12}{23}$

$\Theta = 59^\circ$

a. 22 degrees
(b) 59 degrees
c. 12 degrees
d. 23 degrees

3. If a room requires 55 m^3 of clean air per person and the ~~room volume is 25,000~~ cubic feet, how many people maximum is allowed to safely be in this room ~~to work for an 8 hour day~~?

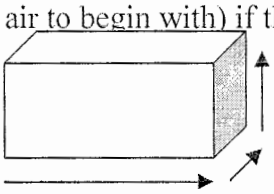
room has 25,000 of air until the air runs out?

a. 13 persons
b. 14 persons
c. 11 person
(d) 12 persons

$55\ m^3 \times \frac{35.3\ ft^3}{1\ m^3} = 1941.5\ ft^3$

$25{,}000\ ft^3 \times \frac{1\ person}{1941.5\ ft^3} = 12.8 \approx 12\ people$

4. Given the following figure, how long would it take to fill the room with air (assuming it had no air to begin with) if the air compressor can only produce 23 cubic feet of air per minute?



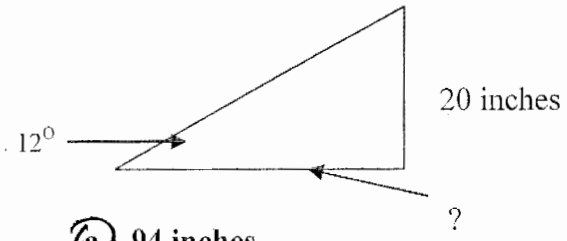
$V = 120 \times 24 \times 74 = 213120\ in^3$

$213120\ in^3 \times \frac{1\ ft^3}{1728\ in^3} = 123.33\ ft^3$

$123.33\ ft^3 \times \frac{1\ min}{23\ ft^3} = 5.4\ min$

(a) 5.4 minutes
b. 7 minutes
c. 2 minutes
d. 10 minutes

5. Given the following right triangle, determine the length as indicated with the arrow.



$\tan(12^\circ) = \frac{20\text{ in}}{x}$

$94.1\text{ in} = x$

a. **94 inches**
b. **23 inches**
c. **45 inches**
d. **22 inches**

Battle Drills
Engineering and Physics Part I

1. A tower crane must lift a load weighing 1500 lbs. Its counterweight is located 60 feet from the mast. If the load is lifted about 100 feet from the mast, how much counterweight in pounds is required?

a. 450 lbs
(b) 2500 lbs
c. 2200 lbs
d. 1200 lbs

$F_1D_1 = F_2D_2$
$(1500)(100) = F_2(60)$
$2500 = F_2$
2500 lbs

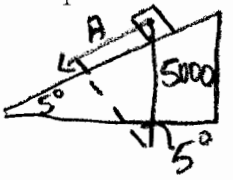
2. During an accident investigation, an engineer, reviewing the damaged structure, estimated that approximately 150,000 ft-lbs/sec^2 of force had impacted into a store's structure. If the car had a mass of 2200 lbs, how fast in miles per hour must the car have traveled when it crashed?

a. 5.5 mph
b. 2.3 mph
(c) 8.0 mph
d. 5.0 mph

$KE = \frac{mv^2}{2}$
$150{,}000 = \frac{(2200\text{lbs})(v)^2}{2}$
$11.7\text{fps} = v \Rightarrow \frac{11.7\text{ft}}{\text{sec}} \times \frac{3600\text{sec}}{1\text{hr}} \times \frac{1\text{mile}}{5280\text{ft}} = 7.9 \approx$ 8.0mph

3. There is a 5000 lb object that must be kept on the ramp for the evening. There is a 5 degree ramp. Assuming a negligible friction, what is the required force needed against the object to keep it from slipping off this ramp?

(a) 435.8 lbs
b. 1,000 lbs
c. 235 lbs
d. 456.2 lbs



$\sin 5° = \frac{A}{5000}$
$435.8 = A$
435.8 lbs

4. A tower crane has a standard counterweight of 345,000 lbs with a distance of 20 feet from the tower's mast. Is it sufficient to lift a 55,000 lb load at a reach of 140 feet from the mast as requested by the job foreman?

a. Yes
(b) No

$F_1D_1 = F_2D_2$
$(345000)(20) = F_2(140)$
$49286\text{lbs} = F_2 < 55{,}000\text{lbs}$ reqd.
MAX

5. During an accident investigation, a vehicle created 220 feet of braking skids on asphalt having a coefficient of friction of 0.45, and 66 feet of skid on grass having a coefficient of friction of 0.67 before hitting a tree. What was the vehicle's estimated speed?

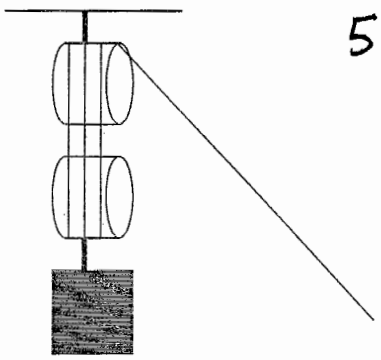
a. 45.5 mph
(b) 65.6 mph
c. 76.5 mph
d. 89.3 mph

$V_A = \sqrt{30 \times 220 \times .45} = 54.5$ mph
$V_G = \sqrt{30 \times 66 \times .67} = 36.4$ mph

$V = \sqrt{(54.5)^2 + (36.4)^2}$
$= 65.6$ mph

Battle Drills
Engineering & Physics Part II

1. How much downward force is required to lift the object weighing 230 lbs using this pulley?

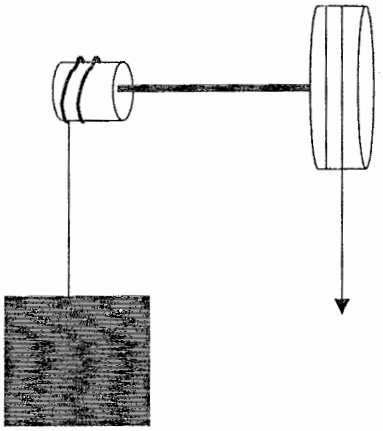


$5 - 1 = 4$

$\frac{1}{4}(230) = 57.5$ lbs

a. 45 lbs
b. ~~27 lbs~~ 57.5 lbs
c. 20 lbs
d. 34 lbs

2. How much downward force is required to lift this object weighing 550 lbs using this pulley design where the small pulley has a 6-inch diameter, and the large pulley has a 14 inch diameter?



$F_1 D_1 = F_2 D_2$

$(550)(6) = F_2(14)$

$235.7 = F_2$

a. 123 lbs
b. 435 lbs
c. 236 lbs
d. 250 lbs

3. Suppose a mobile crane wanted to lift a 235,000 lbs container. The mobile crane uses a 6-part cable that is 2.0 inch in diameter and a pulley that has a frictional coefficient of 3.8%. However, the cable is fairly used so you determine a 25% safety factor of the SWL. Can the crane pick up this load safely?

a. Yes
(b.) No

$L_1 = \frac{235000}{6}(1 + .038)^6$

$= 48989 \text{ lbs} > SWL$

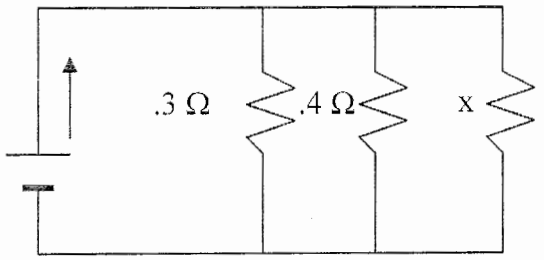
NO

$SWL = D^2 \times 8 = (2)^2 \times 8 = 32 \text{ tons}$

$\times .25$

$16{,}000 \text{ lbs} = 8 \text{ tons}$

4. What is the resistance at x given the following diagram?



$\frac{1}{R} = \sum \frac{1}{R_i}$

$\frac{1}{6.25} = \frac{1}{.3} + \frac{1}{.4} + \frac{1}{x}$

$0.18 = x$ ignore (−)

a. 1.20 ohms
(b.) 0.18 ohms
c. 2.3 ohms
d. 5.0 ohms

$V = IR$

$\frac{25V}{4 \text{ AMPS}} = R = 6.25 \Omega$

5. A tower crane uses a 8 line pulley system. If the load weight is 230,000 lbs, what is the actual upward force required?

a. 14,520 lbs
b. 33,283 lbs
(c.) 28,750 lbs
d. 54,929 lbs

$\frac{1}{8}(230{,}000) = 28{,}750 \text{ lbs}$

Battle Drills
Basic Industrial Hygiene

1. You receive an Industrial Hygiene report of a painting process. The laboratory reported the Formaldehyde levels at 2.1 mg/m^3, 1.5 mg/m^3, and 0.7 mg/m^3. If the OSHA Permissible Exposure Limit is 0.75 parts per million (ppm), what are these levels in ppm? The molecular weight of Formaldehyde is 30 grams/mole.

$$ppm = \frac{mg/m^3}{mw} \times 24.45$$

1.71 ppm, 1.2 ppm, .57 ppm

a. **1.7 ppm, 1.2 ppm, 0.57 ppm**
b. **2.1 ppm, 1.5 ppm, 0.7 ppm**
c. **1.7 ppm, 2.5 ppm, 0.57 ppm**
d. **1.7 ppm, 0.23 ppm, 0.57 ppm**

2. Recent air sampling results from your staff Industrial Hygienists show an average time-weighted average exposure to respirable Crystalline Silica at 150 mg/m^3 during a sanding operation of HMMVs at the base in order to fit new armor plating. If the Threshold Limit Value is 3 mg/m^3, and there is no local exhaust ventilation in the shop during the sanding operation, what respirator type would you recommend using the TWA above? Note: OSHA Assigned Protection Factors: 10 for Half-Face Respirators, 10 for Filtering Facepiece, 50 for Full-Face Respirators, 250 for Powered Air Purifying Respirators.

$$FF = \frac{150}{3} = 50$$

a. **Filtering Facepiece**
b. **Half-Face Respirators**
c. **Full-Face Respirator**
d. **Powered Air Purifying Respirators**

3. Seamen assigned to collateral duty at the Auto Hobby Shop were measured for noise exposures. Part of job is standing watch while other uniformed members work on their cars. On average, while standing watch in the garage area during auto work, the time-weighted average was 102 decibels (A-weighted) during an 8-hour work shift. Based on this information, what is the maximum amount of time allowed to stand watch using a 5 dB exchange rate? Assume the member does not wear hearing protection and the seamen rotate constantly from different units to this position.

a. **30 minutes**
b. **40 minutes**
c. **8 hours is fine.**
d. **1.5 hours**

$$T = \frac{8}{2^{(L-90)/5}}$$

$$= \frac{8}{2^{(102-90)/5}}$$

$$= 1.5 \text{ hrs}$$

4. If a painting process releases 5 pints of solvent per hour, each pint creating 50 cubic feet of vapor per the Material Safety Data Sheet, using a Safety Factor of 2, what is the required amount of ventilation to reduce the concentration to below 1.6% LEL?

a. 430 cfm
b. 120 cfm
c. ~~525~~ cfm 1313
d. 200 cfm

$Q = \frac{G}{C}$

$= \frac{G}{LEL} \times 100$

$= \frac{21 \text{ cfm}}{1.6} \times 100 = 1313 \text{ cfm}$

$\frac{5 \text{ pts}}{60 \text{ min}} \times \frac{50 \text{ cf}}{1 \text{ pt}} = 4.2 \text{ cfm}$

$4.2 \text{ cfm} \times 5 = 21 \text{ cfm}$

5. A GS-7 working with fuel tanks is doubling duty with administrative work. Your Industrial Hygienist conducts air monitoring for benzene. She discovers that the GS-7 was exposed to his first 3 hours to 3.5 ppm benzene in the morning, goes to work in the admin office and then, return for 2 hours of fuel tank work in the afternoon and exposed to 0.9 ppm. The other 3 hours involved the administrative work. What is his time weighted average exposure to benzene?

a. 2.3 ppm
b. 1.5 ppm
c. 0.9 ppm
d. 2.0 ppm

$\frac{(3)(3.5) + (2 \times .9) + 0}{8} = 1.5 \text{ ppm}$

Battle Drills
Statistics & Probabilities

1. Data was collected of sound level measurements in a indoor firing range: 110 dB, 103 dB, 120 dB, 111 dB, 105 dB, 117 dB. What is the mean of these measurements?

a. 120 dB
b. 111 dB
c. 105 dB
d. 103 dB

2. Using the data set in problem#1 above, calculate the standard deviation.

a. 5.46
b. 6.60
c. 2.22
d. 1.34

$= \sqrt{\frac{(110-111)^2+(103-111)^2+(120-111)^2+(111-111)^2+(105-111)^2+(117-111)^2}{6-1}}$

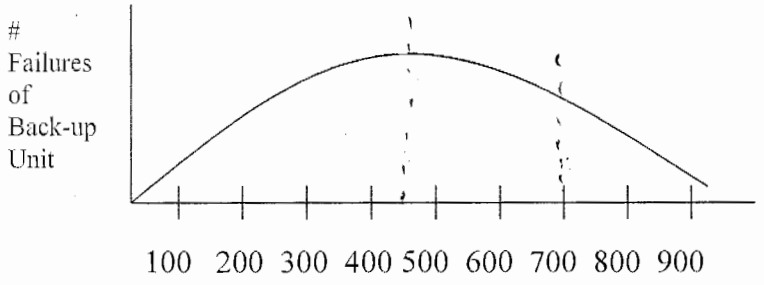
$= \sqrt{\frac{1+64+81+0+36+36}{5}} = 6.60$

3. Your safety office was asked to evaluate two light meters. Evaluating different office and warehouse spaces, you listed 2 sets of data with 20 data points. Light Meter A had a mean of 153 foot-candles for all of the spaces measured with standard deviation of 3.43. Light Meter B had a standard deviation of 5.32 with a mean of 176 foot-candles for all of the same spaces. Which light meter would you recommend for your superiors?

a. Light Meter A
b. Light Meter B

$CV_A = 100\left(\frac{3.43}{153}\right) = 2.24$; $CV_B = 100\left(\frac{5.32}{176}\right) = 3.02$

4. As a safety officer for Ace Forklifts, Inc, you have been tracking the failure rates of the back-up units for your 1-K forklifts. Based upon the graph below, a mean failure rate at 450 hours of use, and a Standard Deviation of 175, what is the probability that the back-up unit will fail at 700 hours of service?



$z = \frac{700-450}{175} = 1.43$

Ck z table

$z = 0.4192$

$0.50 + .4192 = .9192$

$\approx 92\%$

a. 75%
b. 78%
c. 88%
d. 92%

5. As the base safety officer, you read an annual service-wide report that the active duty death rate due to private motor vehicle accidents is 5.5 per 100,000. For this year, then, what is the probability that you will have exactly 1 active duty death due to a private motor vehicle accident this year if you have an active duty population of 2500?

(a) 12%
b. 23%
c. 7 %
d. 5 %

λ

$$2500 \times \frac{5.5}{100{,}000} = 0.1375 = \lambda$$

$$P = \frac{\lambda^x e^{-\lambda}}{x!}$$

$$= \frac{(.1375)^1 e^{-.1375}}{1!}$$

$$= 0.119 \approx \underline{12\%}$$