EWEEK SOLUTIONS

FEB. 18-24 • SOLUTIONS TO EWEEK PROBLEM SETS

TUESDAY, FEB. 18: ELECTRICAL ENGINEERING

1.1 In a series circuit, the total resistance is the sum of the individual resistances. Using the given resistances, we have 150 + 250 + 75 = 475 Ω. So, the total resistance of the circuit is **475** Ω.

1.2 In a parallel circuit, the total reciprocal resistance of the system is equal to the sum of the reciprocals of the individual resistances. We have $1/R_{total}$ = 1/150 + 1/250 + 1/75 = 5/750 + 3/750 + 10/750 = 18/750 = 0.024. That means R_{total} = 1/0.024 ≈ **41.67** Ω.

1.3 This circuit combines parallel and series configurations. We can start by calculating the resistance of the two 100 Ω resistors in parallel. We have $1/R_{parallel}$ = 1/100 + 1/100 = 2/100 = 1/50, so $R_{parallel}$ = 50 Ω. Next, we can add the parallel combination to the series resistor (200 Ω), giving us 50 + 200 = 250 Ω. So, the total resistance of this circuit is **250** Ω.

WEDNESDAY, FEB. 19: AEROSPACE ENGINEERING

2.1 The formula for the volume of a right cylinder is $V = \pi r^2 h$. We are given that the radius (r) is 13.8 feet and the height (h) is 154 feet, so $V = \pi(13.8)^2(154)$ cubic feet. We are also given that 1 cubic foot is 7.48 gallons, so the volume of the fuel tank is $V = \pi(13.8)^2(154) \times 7.48 \approx$ **689,176.35** gallons.

2.2 Knowing the fuel tank holds 689,176.35 gallons, 90% capacity is 0.90 × 689,176.35 = 620,258.715 gallons. At $2 per gallon, the cost to fill the tank is 620,258.715 × 2 = $**1,240,517.43**.

2.3 The fuel is being consumed at a rate of 1492.5 gallons per second during launch. So, to consume the 620,258.715 gallons in the tank, it will take 620,258.715 ÷ 1492.5 ≈ **416** seconds.

THURSDAY, FEB. 20: BIOMEDICAL ENGINEERING

3.1 Marina's workday lasts from 7:30 a.m. to 3:30 p.m., which is a total of 8 hours. The time spent assisting with surgeries includes the scheduled surgery from 8:00 a.m. to 9:00 a.m. (1 hour) and another scheduled surgery from 1:00 p.m. to 2:30 p.m. (1.5 hours), totaling 2.5 hours. To find the fraction of her workday spent assisting surgeries, divide the time spent assisting surgeries by the total workday time, so 2.5 hours/8 hours = 5/16. That means Marina spends **5/16** of her workday assisting surgeries.

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3.2 To find the new failure rate for rotator cuff repairs, calculate 50% of the original rate and subtract it from the initial failure rate. Fifty percent of the original rate, 20%, is 10%. Subtracting that from the initial failure rate, we have 20% – 10% = 10%. Therefore, the new failure rate for younger patients is **10**%.

3.3 The device reduces the failure rate by 50%, so the 47% failure rate after using the device represents 50% of the original failure rate. To find the original failure rate, we can double the new failure rate, giving us 47% × 2 = 94%. That means the original failure rate for rotator cuff repairs for elderly patients before using the device was **94**%.

FRIDAY, FEB. 21: SOFTWARE ENGINEERING

4.1 The first digit of the 6-digit code lock must be 1, leaving 5 remaining positions that can each be one of the 2 digits, 0 or 1. Since each of these 5 positions has 2 choices, there are 2^5 = **32** unique combinations for the 6-digit code lock.

4.2 Since there are 4 positions, each of which must be either 0 or 1, there are 2^4 = 16 possible combinations for the 4-digit code. Guessing 1 of the 16 possibilities correctly on the first try gives a probability of **1/16**. Alternatively, since each position has a 1/2 chance of being guessed correctly, the probability of guessing all four positions correctly is 1/2 × 1/2 × 1/2 × 1/2 = **1/16**.

4.3 To form an 8-digit authentication code with exactly three 1s and five 0s, we choose 3 positions out of 8 for the 1s. The number of ways to do this is $C(8, 3) = 8!/(3!(8-3)!) = 8!/(3! \times 5!) = (8 \times 7 \times 6)/(3 \times 2 \times 1) = 56$. So, there are **56** different 8-digit codes that meet this requirement.

4.4 We are given the conditions that *x*, *y* and *z* each represent either 0 or 1, the total sum of *all* numbers within Columns B and D equals 5, and two unidentified rows *each* have a sum of 4. First, let's add up the numbers in Columns B and D. Without including *x* and *z*, the current sum is 4. Since we know that the sum of these two columns must equal 5 exactly, only *x* or *z* can be 1, but not both. We are also told that the independent sums of the digits in two separate rows must equal 4. Looking at the rows, there are only two possible rows that could add to 4 (ones that do not already contain a zero), Rows A and B. To meet this logical constraint, *x* and *y* must both be 1. Since we know that *x* and *y* are both equal to 1, it follows that *z* = **0**.

MONDAY, FEB. 24: MECHANICAL ENGINEERING

5.1 The kinetic energy, *K*, is calculated using the formula $K = 1/2 \times m \times v^2$, where m = 7.5 kg and v = 8 m/s. Substituting the mass (m) and velocity (v) of the model train, $K = 1/2 \times 7.5 \times 8^2 = 240$ J. So, the kinetic energy of the train is **240** J.

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5.2 We can calculate the potential energy at the top of the hill using the formula $U = m \times g \times h$. We know the mass (m) of the train is 7.5 kg, the acceleration due to gravity (g) on earth is 9.8 m/s^2 and the height of the hill (h) is 1.3 m. Substituting these values into the formula for potential energy, we have $U = 7.5 \times 9.8 \times 1.3 = 95.55$ J. That means the potential energy of the train at the top of the hill is **95.55** J.

5.3 The total mechanical energy of the train is the sum of its kinetic energy (K) and its potential energy (U) at any given point. We calculated in #5.1 that the kinetic energy of the train before going up the hill is 240 J, and we are given here that the potential energy of the train before going up the hill is 0 J. Thus, the total mechanical energy at the bottom of the hill is 240 + 0 = 240 J. We know that the total mechanical energy is conserved, so at the top of the hill, it will also be 240 J. Now, we know from #5.2 that the potential energy at the top of the hill is 95.55 J. Substituting this into the equation for total mechanical energy, we have $240 = K + 95.55 \rightarrow K = 240 - 95.55 = 144.45$ J. This means the kinetic energy at the top of the hill is **144.45** J.