



FUNDAMENTALS OF ENGINEERING – CIVIL EXAM WORKSHOP PROBLEMS – v2.0

CHAPTER 3 ENGINEERING

- 3.1 Time value of money (e.g., equivalence, present worth, equivalent annual worth, future worth, rate of return)
- 3.2 Cost (e.g., fixed, variable, direct and indirect labor, incremental, average, sunk)
- 3.3 Analyses (e.g., break-even, benefit-cost, life cycle, sustainability, renewable energy)
- 3.4 Uncertainty (e.g., expected value and risk)

CHAPTER 7 MATERIALS

- 7.1 Mix design of concrete and asphalt
- 7.2 Test methods and specifications of metals, concrete, aggregates, asphalt, and wood
- 7.3 Physical and mechanical properties of metals, concrete, aggregates, asphalt, and wood

CHAPTER 9 SURVEYING

- 9.1 Angles, distances, and trigonometry
- 9.2 Area computations
- 9.3 Earthwork and volume computations
- 9.4 Coordinate systems (e.g., state plane, latitude/longitude)
- 9.5 Leveling (e.g., differential, elevations, percent grades)

CHAPTER 14 CONSTRUCTION ENGINEERING

- 14.1 Project administration (e.g., documents, management, procurement, project delivery methods)
- 14.2 Construction operations and methods (e.g., safety, equipment, productivity analysis, temporary erosion control)
- 14.3 Project controls (e.g., earned value, scheduling, allocation of resources, activity relationships)
- 14.4 Construction estimating
- 14.5 Interpretation of engineering drawings



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ENGINEERING ECONOMICS

a. Time Value of Money

1. To commission a project, you require a loan in the amount of \$250,000, which will be provided at a 8% nominal annual interest rate. Assuming the payback period is over 7 years, the monthly payment amount is most nearly:
 - a. 2,355
 - b. 4,002
 - c. 12,156
 - d. 48,025

Solution:

‘Capital Recovery’ is the objective of the problem, which is (to A given P).

(A/P, i%, n)

Refer to *Interest Rate Tables* in NCEES Reference Handbook Section Titled: ‘Engineering Economics’.

Factor for (A/P, 8%, 7) = 0.1921

P = \$250,000

A = 250,000 x 0.1921 = \$48,025

Divide yearly payback by 12 to determine the monthly payback.

48,025/12 = 4,002.08

Reported Answer(s): b. 4,002



2. The cost of replacing an excavator 10 years from now will be \$96,000. Assuming I have access to a moderate-yield account which will offer a 4% interest rate. The amount I should place into the account is most nearly:
- a. 64,857
 - b. 65,568
 - c. 74,342
 - d. 142,099

Solution:

'Single Payment Present Worth' is the objective of the problem, which is (to P given F).

(P/F, i%, n)

Refer to *Interest Rate Tables* in NCEES Reference Handbook Section Titled: 'Engineering Economics'.

Factor for (P/F, 4%, 10) = 0.6756

F = \$96,000

P = 96,000 x 0.6756 = \$64,857

Reported Answer(s): a. 64,857



3. A loader required for the reconstruction of a ditch will cost \$19,000. Once its useful life of 9 years has been expended, it can be sold for \$3,400. It requires yearly maintenance of \$700 per year. Assuming the interest rate is 8%, the equivalent annual cost of ownership is most nearly:
- a. 3,469.56
 - b. 3,512.84
 - c. 3,741.90
 - d. 3,861.32

Solution:

Determine a consolidated 'Annual' for all values.

- Cost of Loader: $P = \$19,000 \rightarrow$ Capital Recovery
- Salvage Cost: $F = \$3,400 \rightarrow$ Uniform Series Sinking Fund
- Yearly Maintenance: $A = \$700$ (no conversion required!)

Refer to *Interest Rate Tables* in NCEES Reference Handbook Section Titled: 'Engineering Economics'.

- Cost of Loader: $P = \$19,000 \rightarrow$ Capital Recovery
 - $(A/P, 8\%, 9) = 0.1601$
- Salvage Cost: $F = \$3,400 \rightarrow$ Uniform Series Sinking Fund
 - $(A/F, 8\%, 9) = 0.0801$
- Yearly Maintenance: $A = \$700$ (no conversion required!)

Add all the respective 'A' values to determine an 'Equivalent Annual Cost of Ownership' (answer).

Annual Cost of Loader + (- Annual Salvage Cost) + Yearly Maintenance =
Equivalent Annual Cost of Ownership

$$\$3,041.9 + (-272.34) + \$700 = \$3,469.56$$

Reported Answer(s): a. 3,469.56



4. Which of the following best describes the time value of money?
- a. Money loses value over time due to depreciation
 - b. A dollar today is worth more than a dollar in the future due to earning potential
 - c. Interest rates have no impact on future values
 - d. The value of money remains constant over time

Solution:

Utilize process of elimination to aid in the selection of the correct answer.

Reported Answer(s): **b. A dollar today is worth more than a dollar in the future...**



5. An investment of \$10,000 grows to \$16,310 in 5 years at a constant annual interest rate. The annual interest rate is most nearly:
- a. 7%
 - b. 8%
 - c. 9%
 - d. 10%

Solution:

Given:

$$P = \$10,000$$

$$F = \$16,310$$

$$N = 5 \text{ years}$$

‘Single Payment Compound Amount’ is the relationship between the two values, which is (to F given P).

$$(F/P, i\%, n)$$

Refer to the formulas in NCEES Reference Handbook Section Titled: ‘Engineering Economics’.

$$F = P(1+i)^n$$

$$16,310 = 10,000 (1+i)^5$$

Solve for i .

$$\sqrt[5]{\frac{16,310}{10,000}} - 1 = 0.1028 = 10.28\%$$

Reported Answer(s): d. 10%



6. Which of the following best describes Net Present Value?
- a. The sum of all future cash flows of a project
 - b. The total revenue generated by an investment
 - c. The present worth of all cash flows, discounted at the required rate of return
 - d. The amount of interest earned over time

Solution:

Relevant Definitions

- Present Value (PV) or present worth means converting future cash flows into their equivalent value today.
- Cash flows refer to the series of money inflows (revenues) and outflows (expenses/costs) over time.
- Discounting is the process of adjusting future cash flows using a discount rate (often the required rate of return) to account for the time value of money.
- The required rate of return is the minimum acceptable return on investment, often set by investors or companies based on risk and opportunity cost.

Reported Answer(s): c. The present worth of all cash flows, discounted at the...



b. Cost

7. Sunk costs are synonymous with:

- a. Investment
- b. Non-recoverable Costs
- c. Capitalized Costs
- d. Bonds

Solution:

While there may be utility provided by 'Sunk Costs', they are non-recoverable.

Reported Answer(s): **b. Non-recoverable Costs**



8. Incremental cost refers to:

- a. The total cost incurred over the lifespan of a project
- b. The additional cost incurred when production volume increases
- c. The cost of labor required to manufacture a single unit
- d. The cost of obsolete equipment

Solution:

Reported Answer(s): **b. The additional cost incurred when production volume...**



9. Project costs may be comprised of all of the following except:
Select all that apply.
- a. Direct costs
 - b. Indirect costs
 - c. Maintenance costs
 - d. Program costs

Solution:

Projects are temporary endeavors that have a defined start and end to achieve certain objects.

- Direct costs
 - Such examples include: labor, materials, and equipment.
- Indirect costs
 - Such examples include: support roles such as administrative or project-based expenses, utilities, and costs to support the execution of a project.
- Maintenance costs
 - Costs that occur after the project, such as maintenance are considered operational rather than project-based.
- Program costs
 - Costs that are associated with other projects (of the program) would not fall under project costs and may be considered operational.

Reported Answer(s): c. Maintenance costs
 d. Program costs



10. Determination of Book Value of an asset using Straight-Line Depreciation requires all the following except:

- a. Purchase price
- b. Salvage value
- c. Evaluation year
- d. MACRS Factor

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Engineering Economics'
Book Value is calculated using the following:

- Purchase Price (Initial Cost)
- Salvage Price
- Useful Life
- Evaluation Year i.e., What is the book value at year 7? (7 is the 'evaluation year')

A MACRS factor is used to calculate depreciation where larger loss of value occurs earlier on in the asset life than later on (vs. Straight-Line Approach).

Reported Answer(s): d. MACRS Factor



c. Analyses

11. To justify the pursuit of the project the quantified benefit of the project should be:

- a. Less than the cost of the project
- b. Greater than the cost of the project
- c. Equal to the profitability of the project
- d. Independent from all factors

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Engineering Economics'

In a benefit-cost analysis, the benefits B of a project should exceed (or equal) the estimated costs, C .

Reported Answer(s): **b. Greater than the cost of the project**



12. An example of a breakeven analysis may be:

- a. Determining the number of products to cover total operating costs.
- b. An analysis of profits made to counteract the effects of inflation.
- c. Subtracting salvage value from purchase costs to understand the true value of ownership.
- d. The minimum acceptable rate-of-return that justifies investment.

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Engineering Economics', subsection titled: 'Breakeven Analysis'.

The variable here in this example would be associated with the minimum number of units required to capture the costs of operation. At this moment, we have reached the 'Breakeven point'. After these units are produced, profits are actualized.

Reported Answer(s): a. Determining the number of products to cover total...



13. An initial cost of \$39,000 is required to purchase machinery for a new production line. The manufacturing cost is \$2.50 per unit and there is a projected 3,125-unit output per year. Each unit can be sold for \$5.25. Neglecting interest, the minimum number of years to cover the operating costs is most nearly:
- a. 3
 - b. 4
 - c. 5
 - d. 6

Solution:

Given information:

- Initial Start-up (Machinery) Cost: \$39,000
- Manufacturing Cost per Unit: \$2.50/unit
- Gross Sale per Unit: \$5.25/unit
- Annual Output = 3,125 units

Determine the Annual Operating Cost.

- Annual Operating Cost = Manufacturing Cost per Unit $\times$ Annual Output
- Annual Operating Cost = \$2.50/unit $\times$ 3,125 units/year = \$7,812.50/year

Determine the Annual Revenue.

- Revenue = Sale Price $\times$ Annual Output
- Revenue = \$5.25/unit $\times$ 3,125 units/year = \$16,406.25/year

Determine the Annual Net Profit

- Net Profit (Delta between Revenue and Cost) = 8,593.75

Determine the number of years to cover the Initial Cost.

- Number of Years = Initial Cost / Annual Net Profit
- Number of Years = \$39,000 / 8,593.75 = 4.54 years

Reported Answer(s): c. 5 (rounding down would not suffice)



14. A loader can be purchased for \$93,000 and has a useful life of 6 years. The loader can be sold for 19,250 after its useful life. Using the Straight-Line method of depreciation, the value of the loader at year 4 is most nearly.

- a. 12,291
- b. 18,437
- c. 43,833
- d. 49,166

Solution:

$$D_j = \frac{C - S_n}{n}$$

$$C = 93,000$$

$$S_n = 19,250$$

$$n = 6$$

$$D_j = \frac{93,000 - 19,250}{6} = 12,291.67/\text{year}$$

Determine Book Value (BV)

$$BV = C - \sum D_j$$

$$BV = 93,000 - (12,291.67 \cdot 4) = \$43,833.33$$

Reported Answer(s): c. 43,833



d. Uncertainty

15. Uncertain variables may be mitigated with the following.

- a. Life-cycle cost analysis
- b. Benefit-cost analysis
- c. Cost Contingency
- d. Straight-Line Depreciation

Solution:

- Life-cycle cost analysis
 - Used to analyze the costs associated with an alternative over its entire life cycle to determine a net present value
- Benefit-cost analysis
 - Used to analyze whether the calculated benefit is higher than the cost of the alternative
- Cost Contingency
 - Risk (or uncertain) variables can be mitigated by compensating for potential cost, schedule (or other resource) overruns and exposures
- Straight-Line Depreciation
 - Used to determine book value of an asset, given its purchase price, salvage value, and useful life

Reported Answer(s): c. Cost Contingency



16. You are tasked with determining options and cost savings for insurance coverage of a newly purchase excavator. Given the following, determine the most suitable outcome and associated savings (for purchasing insurance or not).

- Purchase Price: \$86,000
 - Yearly Cost of Insurance: \$1,500
 - Insurance Deductible: \$800
 - 0.90 Probability of No Accident
 - 0.10 Probability of Small Accident (Incurring a Cost of \$650)
 - 0.02 Probability of Total Loss of the Excavator
- a. Purchase insurance and experience a cost savings of \$1,516
- b. Do not purchase insurance and experience a cost savings of \$ 1,720
- c. Purchase insurance and experience a cost savings of \$204
- d. Do not purchase insurance and experience a cost savings of \$1,654



Solution:

Refer to NCEES Reference Handbook Section Titled: 'Engineering Economics', subsection titled: 'Economic Decision Tree'.

Each event is categorized as a 'Possible Outcome' i.e., C_1 , along with its associated 'Probability' i.e., p_1

Evaluate the 'Expected Value' of Condition 1) Purchase Insurance and of Condition 2) Not Purchasing Insurance

$$EV_{\text{Insured}} = \text{Outcome}_1 \times \text{Probability}_1 + \text{Outcome}_2 \times \text{Probability}_2 + \dots$$

$$EV_{\text{Not Insured}} = \text{Outcome}_1 \times \text{Probability}_1 + \text{Outcome}_2 \times \text{Probability}_2 + \dots$$

Categorize the given scenarios (Outcomes & Probabilities) under the associated conditions.

Condition 1 – Insured

- 0.90 Probability of No Accident coupled with Outcome: Nothing
 - *No consequence of outcome, may be omitted from computation*
- 0.10 Probability of Small Accident coupled with cost of Outcome: Incurred Cost of \$650
 - *Outcome/Consequence carries a cost less than that of the Insurance Deductible*
 - *Since this scenario would be the same in both Conditions, it may be omitted as well for the purposes of comparison.*
- 0.02 Probability of Total Loss of the Excavator coupled with Outcome: Cost of Replacement of the Excavator (Deductible)

Condition 2 – Not Insured

- 0.90 Probability of No Accident coupled with Outcome: Nothing
 - *No consequence of outcome, may be omitted from computation*
- 0.10 Probability of Small Accident coupled with cost of Outcome: Incurred Cost of \$650
 - *Outcome/Consequence carries a cost less than that of the Insurance Deductible*
 - *Since this scenario would be the same in both Conditions, it may be omitted as well for the purposes of comparison.*
- 0.02 Probability of Total Loss of the Excavator coupled with Outcome: Cost of Replacement of the Excavator (Total Value of Excavator i.e., Purchase Price)

Ultimately, the delta between selecting insurance or not is limited to the following:



- Insurance Yearly Premium
- Cost Incurred by:
 - Deductible (For replacement)
 - Total Loss of Equipment

$$EV_{\text{Insured}} = \text{Outcome}_1 \times \text{Probability}_1 + \text{Outcome}_2 \times \text{Probability}_2$$

$$EV_{\text{Insured}} = \text{Purchase of Insurance (Premium)} + \text{Replacement w/Deductible}$$

$$EV_{\text{Insured}} = (\$1,500 \times 1.0) + (\$800 + 0.02) = \$1,516$$

$$EV_{\text{Not Insured}} = \text{Outcome}_1 \times \text{Probability}_1$$

$$EV_{\text{Not Insured}} = \text{Full Replacement w/o Deductible}$$

$$EV_{\text{Not Insured}} = (\$86,000 + 0.02) = \$1,720$$

$$EV_{\text{Not Insured}} < EV_{\text{Insured}}$$

\$1,720 > \$1,516, With a Delta of \$204 (of Cost Savings), when insurance is purchased

Reported Answer(s): c. Purchase insurance and experience a cost savings of \$204



MATERIALS

- a. Mix Design of Concrete and Asphalt

17. Which of the following are the primary ingredients of Portland cement concrete? Select all that apply.

- a. Asphalt
- b. Aggregates
- c. Cement
- d. Water

Solution:

Asphalt (Bitumen, aka asphalt cement) is a primary ingredient for Asphalt Concrete, not Portland cement concrete.

Portland cement concrete consists primarily of:

- Water
- Coarse and Fine Aggregates
- Cementitious Material (such as Portland Cement)

Reported Answer(s): **b. Aggregates**
 c. Cement
 d. Water



18. Which of the following factors influence the performance of a concrete mix design? Select all that apply.

- a. Water-Cement Ratio
- b. Aggregate Size and Type
- c. Atmospheric Pressure
- d. Air Entrainment

Solution:

- Water-Cement Ratio – The water-cement ratio is one of the most critical factors in mix design as it directly affects strength, durability, and workability.
- Aggregate Size and Type – The type, size, and gradation of aggregates affect the workability, strength, and durability of the mix.
- Atmospheric Pressure – While extreme pressure differences may affect concrete setting in unique situations (e.g., high altitudes or deep-sea applications), it is not a primary factor in mix design.
- Air Entrainment – Air entrainment improves the durability and workability of concrete by introducing tiny, evenly distributed air bubbles into the mix.

Reported Answer(s): **a. Water-Cement Ratio**
 b. Aggregate Size and Type
 d. Air Entrainment



19. Which of the following statements about aggregates in Portland cement concrete are true? Select all that apply.

- a. The quality and gradation of aggregates significantly affect concrete performance
- b. Coarse aggregates provide volume and strength to the concrete mix
- c. Fine aggregates (sand) fill voids between coarse aggregates
- d. Aggregates should be porous to absorb more water for better hydration

Solution:

- Good quality and well-graded aggregates improve strength, reduce shrinkage, and enhance durability.
- Coarse aggregates provide bulk and strength to concrete.
- Fine aggregates (sand) help fill voids and improve workability.
- Excessive porosity in aggregates leads to high water absorption, which can negatively impact mix consistency and durability.

Reported Answer(s):

- a. The quality and gradation of aggregates significantly affect concrete performance**
- b. Coarse aggregates provide volume and strength to the concrete mix**
- c. Fine aggregates (sand) fill voids between coarse aggregates**



20. What is the primary role of cement in a concrete mixture?

- a. It controls the slump of fresh concrete
- b. It reduces the overall cost of the mixture
- c. It binds the aggregates together by forming a paste
- d. It increases the flexibility of concrete

Solution:

Cement forms a paste when mixed with water, which binds the aggregates together as it hardens.

Other notable information:

- Flexibility is generally not a desired attribute of concrete, nor would cement contribute to that. Rather it contributes to compressive strength.
- Slump (workability) is controlled by water content and admixtures.
- Cement is often the most expensive ingredient of concrete.

Reported Answer(s): c. It binds the aggregates together by forming a paste



21. What is the primary function of water in a concrete mix?

- a. It acts as a lubricant to help mix ingredients together
- b. It initiates the hydration reaction with cement
- c. It provides long-term strength to hardened concrete
- d. It reduces the aggregate content in the mix

Solution:

Water reacts with cement in a chemical process called hydration, which forms the hardened paste that binds the aggregates together. While it does improve workability, excess water weakens the final product.

Reported Answer(s): b. It initiates the hydration reaction with cement



22. In concrete mix design, what is the primary reason for controlling the water-cement (w/c) ratio?

- a. To control the workability and strength of concrete
- b. To reduce shrinkage cracks
- c. To minimize the amount of cement used
- d. To increase the aggregate content

Solution:

- To control the workability and strength of concrete – The water-cement ratio directly influences the concrete's compressive strength and durability. A lower w/c ratio results in higher strength but may reduce workability, requiring admixtures to improve handling.
- To reduce shrinkage cracks – While a lower w/c ratio can reduce drying shrinkage cracks, it's not the primary reason for controlling it. Shrinkage is also affected by curing conditions and aggregate content.
- To minimize the amount of cement used – Reducing cement content is an economic and environmental concern, but the w/c ratio is more about balancing strength and workability.
- To increase the aggregate content – The aggregate content is controlled separately in mix design. The w/c ratio primarily affects paste properties.

Reported Answer(s): a. To control the workability and strength of concrete



23. Which of the following materials can be used to supplement or replace Portland cement as 'cementitious material' in a concrete mix design? Select all that apply.

- a. Fly Ash
- b. Silica Fume
- c. Calcium Chloride
- d. Slag

Solution:

- Fly Ash – A byproduct of coal combustion, fly ash improves workability, durability, and long-term strength while reducing cement consumption.
- Silica Fume – An ultrafine byproduct of silicon production, silica fume increases strength and durability, particularly in high-performance concrete.
- Calcium Chloride – This is a set accelerator. It is sometimes used to speed up curing in cold weather but does not contribute to cementitious properties.
- Slag, such as 'Ground Granulated Blast Furnace Slag' (GGBFS) – A byproduct of steel production, improves durability, sulfate resistance, and workability while reducing heat of hydration.

Reported Answer(s): **a. Fly Ash**
 b. Silica Fume
 d. Slag



24. Which of the following factors can help achieve a higher compressive strength? Select all that apply.

- a. Increasing the cement content
- b. Adding more water for better workability
- c. Reducing the water-cement ratio
- d. Using well-graded aggregates

Solution:

- Increasing the cement content – More cement increases the binding paste, which can help achieve higher strength. However, excessive cement can lead to shrinkage and higher costs.
- Adding more water for better workability – While water improves workability, excessive water weakens the paste, leading to lower strength and higher permeability. Instead, workability should be improved using plasticizers or optimized aggregate grading.
- Reducing the water-cement ratio – A lower w/c ratio increases strength by reducing voids and improving the paste-aggregate bond.
- Using well-graded aggregates – A well-graded aggregate distribution improves packing density, reduces voids, and enhances strength.

Reported Answer(s):

a. Increasing the cement content
c. Reducing the water-cement ratio
d. Using well-graded aggregates



25. A project requires the placement of 35 CY of high-strength concrete. The mix design specifies a cement content of 400 lb/yd³. Technical specifications require a water-cement ratio (w/c) of 0.35. The amount of water required (in pounds) for every 10-cy truck load is most nearly:

- a. 140
- b. 1,140
- c. 1,400
- d. 4,900

Solution:

$$w/c \text{ ratio} = \frac{\text{weight of water}}{\text{weight of cement}}$$

$$0.35 = \frac{\text{weight of water}}{400 \text{ lb}}$$

$$\text{weight of water} = 0.35 \times 400 \text{ lb} = 140 \text{ lb}$$

Multiply 1-CY amount of water by 10 (required per truckload) = 1,400 lb

Reported Answer(s): c. 1,400



26. A concrete mix design is provided below on a half a cubic yard basis. Assuming a sack of cement weighs 94-lb, the unit weight of the batched concrete (lb/cf) is most nearly:

- a. 123
- b. 150
- c. 2016
- d. 4030

Portland Cement	3.0 sacks
Fine aggregate	750-lb
Coarse aggregate	900-lb
Water/Cement Ratio	0.30

Solution:

Covert cement sacks to weight.

Determine water amount using cement and w/c ratio.

<i>Material</i>	<i>Quantity</i>	<i>Conversion</i>	<i>Weight</i>
Portland Cement	3.0 sacks	94-lb/sack	282-lb
Fine aggregate	-	-	750-lb
Coarse aggregate	-	-	900-lb
Water		0.30 x W _c	84.6-lb
		Total Weight	2,016.6-lb

The total calculated weight represents the amount of concrete for 0.5 cubic yards.

$$\text{unit weight} \left(\frac{\text{lb}}{\text{cy}} \right) = \frac{\text{total weight}}{\text{total volume}} = \frac{2,016.6 \text{ lb}}{0.5 \text{ cy}} = 4033.2 \text{ lb/cy} = 149.38 \text{ lb/cf}$$

Reported Answer(s): b. 150



27. Which of the following statements about the SSD condition of aggregates and its effect on water absorption in a concrete batch mix are true? Select all that apply.

- a. If aggregates are wetter than SSD, they will release excess water into the mix, increasing the effective water-cement ratio.
- b. SSD is an irrelevant concept in concrete mix design since moisture content does not affect the final mix performance.
- c. SSD aggregates have their internal pores fully saturated, but their surface is dry.
- d. If aggregates are drier than SSD, they will absorb water from the mix, reducing effective water content.

Solution:

SSD = Saturated Surface Dry is the condition of an aggregate when its internal pores are fully saturated with water, but its surface is dry. In this state, the aggregate neither absorbs nor releases water into the concrete mix, making it the reference condition for mix design calculations.

- If aggregates are wetter than SSD, they contribute extra free water, increasing the water-cement ratio, which may lead to lower strength and increased shrinkage.
- SSD is a critical concept in mix design, as incorrect moisture adjustments can significantly impact workability, strength, and durability.
- SSD condition means the aggregate's internal pores are fully saturated, but the surface is dry, preventing it from absorbing or releasing water.
- If aggregates are drier than SSD, they will absorb water from the mix, reducing the effective water-cement ratio, which may lead to reduced workability and strength issues.

Reported Answer(s): **a. If aggregates are wetter than SSD...**
c. SSD aggregates have their internal...
d. If aggregates are drier than SSD...



28. Which of the following are primary ingredients in asphalt concrete? Select all that apply.

- a. Asphalt binder
- b. Portland cement
- c. Aggregates
- d. Air voids

Solution:

Asphalt concrete consists of asphalt binder, aggregates (fine and coarse), and air voids (which are controlled for durability and performance). Portland cement is used in concrete, not asphalt mixtures.

Reported Answer(s): **a. Asphalt binder**
 c. Aggregates
 d. Air voids



29. What is the primary purpose of asphalt binder in an asphalt mix?

- a. To provide structural strength to the pavement
- b. To bind the aggregates together and provide flexibility
- c. To increase the void content in the mixture
- d. To replace the need for fine aggregates

Solution:

Asphalt binder acts as a glue that holds aggregates together while providing flexibility to resist cracking. It does not directly provide structural strength; the strength mainly comes from aggregate interlock and compaction.

Reported Answer(s): b. To bind the aggregates together and provide flexibility



- b. Test Methods and Specifications of Metals, Concrete, Aggregates, Asphalt, and Wood
- c. Physical and Mechanical Properties of Metals, Concrete, Aggregates, Asphalt, and Wood

30. Which of the following devices are commonly used to measure the density of asphalt pavement?

- a. Universal Testing Machine
- b. Frustrum Cone Apparatus
- c. Troxler Gauge
- d. Material Testing System

Solution:

- Universal Testing Machine (UTM) – Measures material properties like tensile and compressive strength, not pavement density.
- Frustum Cone Apparatus – Used in soil testing (such as sand cone density tests) but not for asphalt.
- Troxler Gauge – Uses nuclear radiation to measure in-place density and moisture content of asphalt pavement. The name is associated with the company that manufactures it.
- Material Testing System (MTS) – Used for structural and fatigue testing of materials but not typically for asphalt density.

Reported Answer(s): c. Troxler Gauge



31. Match the following terms (Column 1) with their respective definitions (Column 3) by populating Column 2. Note only (7) of the terms will be used.

Col 1: Terms	Col 2: Reported Answers	Definitions
Charpy Test		Material's ability to sustain plastic deformation before failure.
Elastic Modulus		Used to determine 'hardness' through the scale of penetration of an indent.
Cold Working		Allows for the processes of: recovery, recrystallization, and grain grown to occur simultaneously.
Yield Strain		Used to determine the energy required to fracture.
Quenching		Allow a metal to increase strength and lowers ductility (via plastic deformation).
Ductility		Describes the relationship between stress and strain during elastic loading.
Brinell Hardness Test		Rapid cooling from an elevated temperature.
Hot Working		



Solution:

Refer to NCEES Reference Handbook Sections Titled: 'Materials Science/Structure of Matter' and 'Mechanics of Materials'.

Col 1: Terms	Col 2: Reported Answers	Definitions
	Ductility	Material's ability to sustain plastic deformation before failure.
	Brinell Hardness Test	Used to determine 'hardness' through the scale of penetration of an indent.
	Hot Working	Allows for the processes of: recovery, recrystallization, and grain grown to occur simultaneously.
	Charpy Test	Used to determine the energy required to fracture.
	Cold Working	Allow a metal to increase strength and lowers ductility (via plastic deformation).
	Elastic Modulus	Describes the relationship between stress and strain during elastic loading.
	Quenching	Rapid cooling from an elevated temperature.
Yield Strain (Not Used)		



32. A 4-in-diameter × 8-in-tall plastic mold was used to cast a concrete cylinder. The specimen failed at a compressive strength of 6,250 psi at 28 days and has a Tensile Capacity of 630 psi. The axial compressive force in compression is most nearly:

- a. 7,916
- b. 19,634
- c. 78,539
- d. 314,159

Solution:

Refer to NCEES Reference Handbook Section Titled: ‘Mechanics of Materials’.
To calculate the compressive force that determined the compressive strength, use the following relationship.

$$f'_c = \frac{P}{A}$$

$$f'_c = \frac{P}{(\pi \cdot 4in^2)/4} = 6,250 \text{ psi}$$

$$P = 78,539.82 \text{ lb}$$

Reported Answer(s): **c. 78,539**



SURVEYING

a. Angles, Distances, and Trigonometry

33. A surveyor is measuring the distance across a river. Two points, A and B, are established on one side of the river, 200 ft apart. The surveyor takes angle measurements to a target C on the opposite bank and records the following:

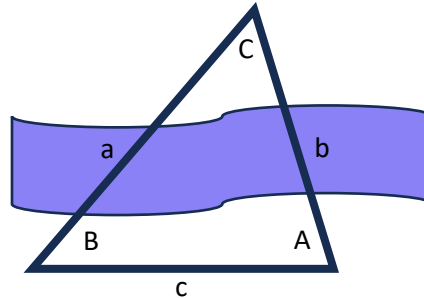
- $\angle ACB = 50^\circ$
- $\angle BAC = 75^\circ$

The distance from Point A to Point C is most nearly:

- a. 163.83
- b. 213.87
- c. 244.15
- d. 261.08

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Trigonometry'.
Sketch the setup to help situate the objective of the problem.



Where:

$$\text{Length}_{A-B} = 200 = c$$

$$\text{Objective} = \text{Length}_{A-C} = b$$

$$\angle ACB = 50^\circ = C^\circ$$

$$\angle BAC = 75^\circ = A^\circ$$

$$\text{Calculate angle } B^\circ = 180^\circ - 75^\circ - 50^\circ = 55^\circ$$

Utilize "Law of Sines" to determine the distance from Point A to Point C (side b).

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\frac{a}{\sin A} = \frac{b}{\sin 55^\circ} = \frac{200}{\sin 50^\circ}$$

Solve for b.

$$b = \frac{200 \cdot \sin 55^\circ}{\sin 50^\circ} = 213.87'$$

Reported Answer(s): **c. 213.87**



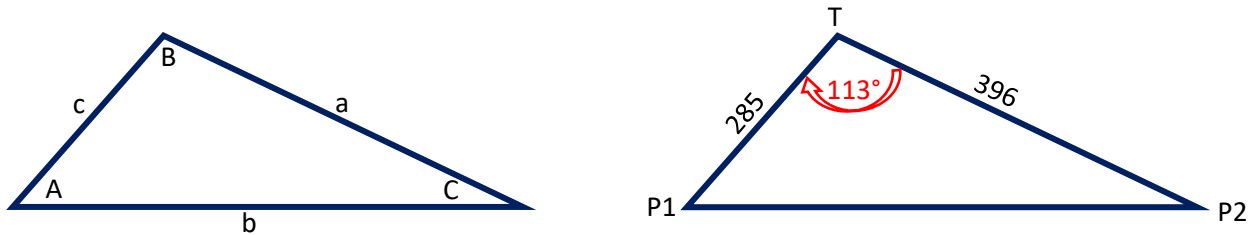
34. A construction site has two control points, P1 and P2, whose distances to a new benchmark T must be determined. Point T is north of both P1 and P2. Using the given information, the straight-line distance between P1 and P2 is most nearly:

- Distance P1 to T: 285 ft
- Distance P2 to T: 396 ft
- The intersection angle between the two lines (P1–T and P2–T) is 113°

Answer: _____

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Trigonometry'.
Sketch the setup to help situate the objective of the problem.



Employ the 'Law of Cosines' to determine the length of Side b (Distance from P1 to P2).

$$b^2 = a^2 + c^2 - 2ac \cdot \cos B$$

$$b = \sqrt{396^2 + 285^2 - 2 \cdot 396 \cdot 285 \cdot \cos 113^\circ} = 571.17'$$

Reported Answer(s): **571.17**



b. Area Computations

35. A formwork container in the shape of a cylinder will be used to cast a foundation pier. Prior to pouring, the cylinder must be coated twice in a curing compound only where the concrete will contact the formwork. Assuming a coverage rate 80 SF/gal, the amount of curing compound (gal) needed for the following formwork dimensions is most nearly:

Caisson Formwork

- Height: 65-ft
 - Diameter: 6-ft
 - Assume the formwork cylinder will be open on one side (facing up) and closed on the other side (where the concrete will be poured on to).
-
- a. 16
 - b. 32
 - c. 64
 - d. 92

Solution:

While the volume of a cylinder can be computed as:

$$V_{cylinder} = \pi r^2 \cdot h$$

We are determining the surface area. Deconstruct the formwork into (2) shapes:

- The barrel of the cylinder, which is equal to the circumference a circle multiplied by its height.
- The base of the cylinder, which is equal to a circle. (circle)

$$\begin{aligned} A_{barrel} &= 2\pi r \cdot h \\ A_{base} &= \pi r^2 \end{aligned}$$

Simplified:

$$A_{total} = \pi r^2 + 2\pi r \cdot h = \pi r (r + 2h)$$

Determine the area, then divide by the coverage rate to determine the gallon of compound and factor for 2 coats.

$$A_{total} = \pi r (r + 2h) = \pi 3 (3 + 2 \cdot 65) = 1,253.5 \text{ SF}$$

$$A_{total} = 1,253.5 \text{ SF} \times 2 \text{ coats} = 2,507.0 \text{ SF}$$

$$\text{Gallons Required} = \frac{A_{total} \text{ (SF)}}{\text{Coverage Rate } (\frac{\text{SF}}{\text{gal}})} = \frac{1,253.5 \text{ SF}}{80 \text{ SF/gal}} = 31.34 \text{ gal}$$

Reported Answer(s): **b. 32**



c. Earthwork and Volume Computations

36. The following table corresponds to projected excavations for a proposed roadway. Using a combination of the pyramid method and the average end area method, the volume of earthen material from station 8+75 to 10+50 is most nearly:

Answer: _____

Station	Area (sf)
8+75	0
9+50	115
10+50	253
11+25	374
12+00	186
13+00	150

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Earthwork Formulas'.

To determine earth quantities using cross-sectional areas and distances (between the areas), employ either:

- Average End Area Method

$$V = \frac{A_1 + A_2}{2} L$$

- Prismoidal Formula

$$V = \frac{A_1 + 4 \cdot A_m + A_2}{6} L$$

- Pyramid (or Cone) Method

$$V = \frac{A_1}{3} L$$

In this condition, we will only employ the use of Pyramid method from station 8+75 to 9+50, and the use of the Average End Area Method from station 9+50 to 10+50.

- 8+75 to 9+50:

$$L = 950 - 875 = 75'$$

$$V = \frac{A_1}{3} L = \frac{115}{3} 75 = 2875cf = 106.48cy$$

- 9+50 to 10+50:

$$L = 1050 - 950 = 100'$$

$$V = \frac{A_1 + A_2}{2} L = \frac{115 + 253}{2} 100 = 18,400cf = 681.45cy$$

Total Volume from 8+75 to 10+50 = 106.48cy + 681.45cy = 787.96

Reported Answer(s): **787.96**



37. The following table corresponds to projected excavations for a proposed roadway. Using the Prismoidal Method, the volume of earthen material from station 6+25 to 8+15 is most nearly:

Answer: _____

Station	Cut Area (sf)	Fill Area (sf)
3+55	85	0
4+00	235	25
5+25	184	50
6+25	199	75
7+00	203	54
8+15	148	25

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Earthwork Formulas'.

To determine earth quantities using cross-sectional areas and distances (between the areas), employ:

- Prismoidal Formula

$$V = \frac{A_1 + 4 \cdot A_m + A_2}{6} L$$

Prior to computing, it is important to distill/average the cut/fill sections as needed. Alternatively, if this is not completed, it will require repetitions of the Prismoidal Method i.e., one repetition for each condition (cut and fill, respectively).

- $A_1 = 199 - 75 = 124$ sf (cut)
- $A_m = 203 - 54 = 149$ sf (cut)
- $A_2 = 148 - 25 = 123$ sf (cut)
- $L = 815 - 625 = 190$ lf

$$V = \frac{A_1 + 4 \cdot A_m + A_2}{6} L$$

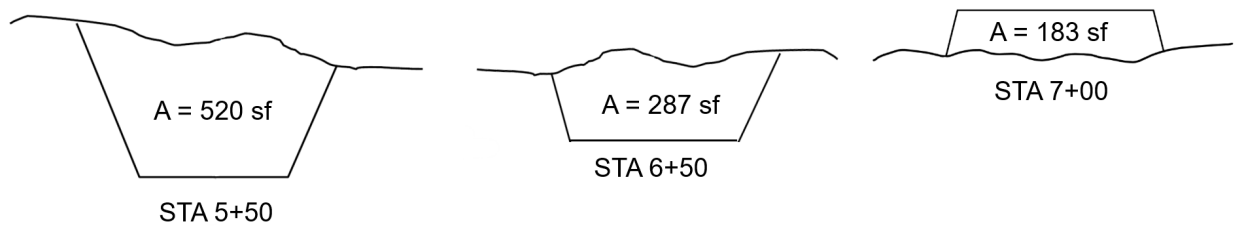
$$V = \frac{124 + 4 \cdot 149 + 123}{6} 190 = 26,726.67cf = 989.88cy$$

Reported Answer(s): **989.88**



38. The cross sections at the given stations are shown. The net material (CY) from Station 5+50 to Station 7+00 is most nearly:

- a. 169
- b. 1,593
- c. 1,760
- d. 1,929



**Solution:**

Refer to NCEES Reference Handbook Section Titled: 'Earthwork Formulas'.

To determine earth quantities using cross-sectional areas and distances (between the areas), employ:

- Average End Area Method

$$V = \frac{A_1 + A_2}{2} L$$

In this condition, it is important to combine the cut/fill sections as needed i.e., from Station 6+50 to Station 7+00.

Station	Distance (ft)	Cut (SF)	Fill (SF)	Cut Volume (CY)	Fill Volume (CY)
5+50	Start	520	0	$V = \frac{520 + 287}{2} 100$ $40,350cf = 1494cy$	0
6+50	100	287	0		
7+00	50	0	183	$V = \frac{287 + 0}{2} 50$ $7,175cf = 265.74cy$	$V = \frac{0 + 183}{2} 50$ $4,575cf = 169.44cy$
Total				1759.74	169.44

Total Net Volume = 1,759.74 – 169.44 = 1,593.30 (cut)

Reported Answer(s): **b. 1,593**



39. A highway embankment is being constructed using soil from a borrow pit. The embankment requires 15,000 cubic yards of compacted soil. The in-place dry unit weight of the embankment soil is 120 pcf, while the borrow material has a dry unit weight of 110 pcf. Determine the total volume of soil (in cubic yards) that must be excavated from the borrow pit to meet the embankment requirement.

- a. 13,750
- b. 15,000
- c. 16,363
- d. 17,121

Solution:

Refer to NCEES Reference Handbook subsection Titled: 'Geotechnical (Civil Engineering)'.

Considering the embankment (final) condition will be more densified than the source (borrow) material, we must apply a factor proportional to that relative density to determine how much material to excavate.

$$RC = \frac{\gamma_{d,emb}}{\gamma_{d,bor}}$$

To determine the overall amount of volume to be excavated:

$$Volume_{bor} = V_{emb} \cdot RC$$

$$Volume_{bor} = 15,000 \cdot \frac{120}{110} = 16,363.64 \text{ cy}$$

Reported Answer(s): **c. 16,363**



40. A contractor is constructing an embankment requiring 18,000 cubic yards of compacted soil. The in-place embankment soil has a moisture content of 12% and a dry unit weight of 125 pcf. The borrow material has a moisture content of 8% and a total unit weight of 118 pcf. Determine the total volume of soil (in cubic yards) that must be excavated from the borrow pit.

Answer: _____

Solution:

Refer to NCEES Reference Handbook subsection Titled: 'Geotechnical (Civil Engineering)'.

To determine the RC factor to be used, we must convert the Total Unit Weight to dry unit weight of the borrow material.

$$\gamma_d = \frac{\gamma}{(1 + w)} = \frac{118}{(1 + 8\%)} = 109.26 \text{ pcf}$$

$$RC = \frac{\gamma_{d,emb}}{\gamma_{d,bor}} = \frac{125}{109.26} = 1.14$$

To determine the overall amount of volume to be excavated:

$$Volume_{bor} = V_{emb} \cdot RC$$

$$Volume_{bor} = 18,000 \cdot 1.14 = 20,593.22$$

The total unit weights cannot be compared (for Relativity) because of the variable moisture content. In problems such as these, always use the dry unit weights for comparison.

Reported Answer(s): **20,595.22**



d. Coordinate Systems

41. Which of the following statements about the State Plane Coordinate System (SPCS) is correct?

- a. It uses a single projection method for all states.
- b. It is designed to minimize distortion within a specific region.
- c. It is based on a spherical Earth model without any map projection.
- d. It is used exclusively for global positioning applications.

Solution:

The SPCS is designed to minimize distortion within a specific region.

- SPCS uses different projection methods depending on the state's shape.
- SPCS is based on a projected coordinate system that accounts for the Earth's curvature.
- SPCS is meant for local and regional mapping, while global positioning relies more on latitude/longitude or UTM systems.

Reported Answer(s): **b. It is designed to minimize distortion within...**



42. What is the primary purpose of the State Plane Coordinate System (SPCS)?

- a. To provide a highly accurate coordinate system for local and regional projects
- b. To replace latitude and longitude for all global positioning applications
- c. To eliminate all distortions caused by map projections
- d. To allow all states to use the same coordinate grid

Solution:

To provide a highly accurate coordinate system for local and regional projects

- SPCS is a localized system, whereas latitude and longitude are used globally.
- SPCS minimizes distortion but does not completely eliminate it.
- Each state (or large state regions) has its own unique SPCS zones.

Reported Answer(s): **a. To provide a highly accurate coordinate system...**



43. Which of the following best describes a "coordinate system" in mapping?

- a. A system that assumes the Earth is perfectly flat
- b. A set of random numbers assigned to locations for tracking
- c. A method for uniquely identifying locations on Earth using a defined reference framework
- d. A tool used only for drawing maps by hand

Solution:

A method for uniquely identifying locations on Earth using a defined reference framework

- Coordinate systems are used in both digital and physical maps for precise location referencing.
- Coordinate systems account for the Earth's curvature using projections.
- Coordinate values are based on a structured mathematical framework, not random assignments.

Reported Answer(s): **c. A method for uniquely identifying locations...**



44. A surveyor is working on a geodetic survey. The azimuth from Point A to Point B using their geographic coordinates is most nearly:

- Point A: 35.53N, 78.25W
 - Point B: 46.89N, 137.66W
-
- a. 79.17
 - b. 82.42
 - c. 215.91
 - d. 280.83

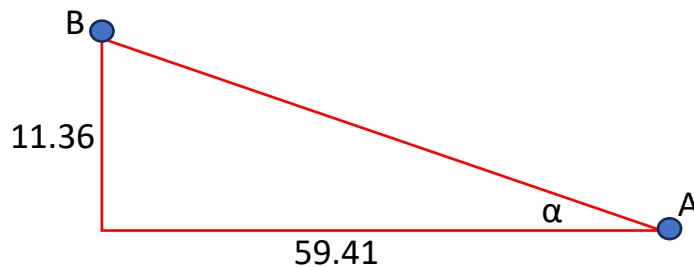


Solution:

To determine the azimuth, which is measured angle from true north, we must first calculate the difference in distance from Point A to Point B.

Northing (North-South) Delta = $46.89 - 35.53 = 11.36$

Easting (East-West) Delta = $137.66 - 78.25 = 59.41$



The next step is to determine angle α using trigonometric functions, which will then be used to determine the azimuth. Recognizing that:

$$\tan \alpha = \frac{opp}{adj} = \frac{11.36}{59.41}$$

$$\tan^{-1} \left(\frac{11.36}{59.41} \right) = \alpha = 10.83^\circ$$

Azimuth: How many degrees will it take from true north to reach the 'hypotenuse'?

Measuring from true north, the azimuth will be comprised of 3 quadrants (at 90° each) plus the remainder of angle, α

$$\text{Azimuth} = 270^\circ + 10.83^\circ = 280.83^\circ$$

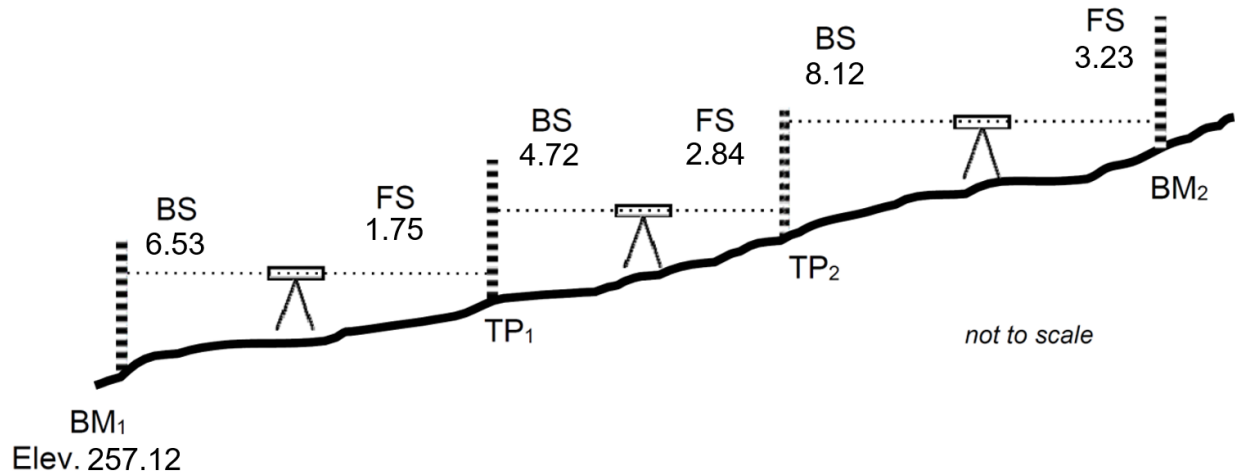
Reported Answer(s): **d. 280.83**



e. Leveling

45. Based on the information provided in the figure below, the elevation (ft) of BM₂ is most nearly:

- a. 262.01
- b. 268.67
- c. 275.13
- d. 284.31

Solution:

$$BM + BS = HI$$

$$HI - FS = TP \text{ Elevation}$$

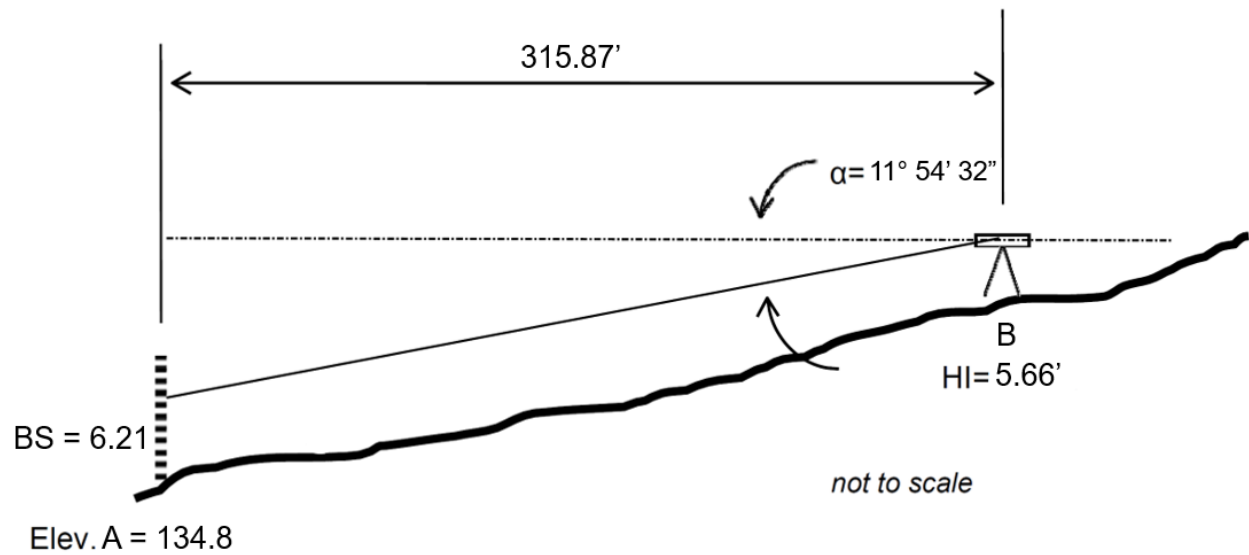
Point	BS	HI	FS	Elevation
BM ₁	6.53	263.65		257.12
TP ₁	4.72	266.62	1.75	261.90
TP ₂	8.12	271.9	2.84	263.78
BM ₂			3.23	268.67
	+19.37		-7.82	

Remember to always check the summation of the back sight and foresight with the elevation change.

Reported Answer(s): **b. 268.67**



46. The ground elevation (ft) of B is most nearly:



- a. 195.76
- b. 200.53
- c. 201.97
- d. 207.63

**Solution:**

The missing component to the determination of Elevation B is the distance from the Line of Sight (top of the BS measurement) to the Height of the Instrument Elevation. This value will be noted as 'y'. 'y' Elevation is also equal to $Elev_{HI}$ in this configuration.

The elevation of point B can be determined by:

$$\begin{aligned} Elev_B &= Elev_A + BS + y - HI \\ Elev_B &= 134.8 + 6.21 + y - HI \end{aligned}$$

Where y is equal to:

$$y = \text{Horizontal Distance} \cdot \tan\alpha = 315.87 \cdot \tan(11^\circ 54' 32'') = 66.62'$$

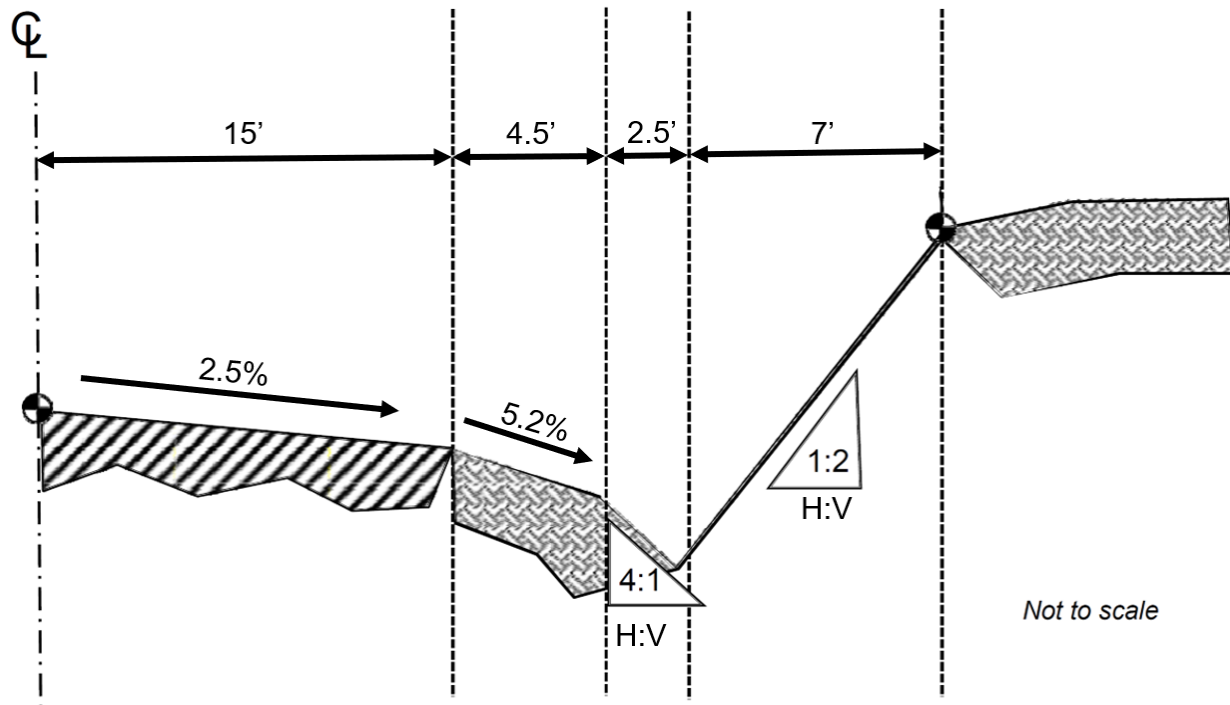
$$Elev_B = 134.8 + 6.21 + 66.62 - 5.66 = 201.97$$

Reported Answer(s): **c. 201.97**



47. The center line elevation of the roadway is 259.88-ft. The existing ground top of cut elevation (ft) is most nearly:

- a. 244.64
- b. 264.64
- c. 270.64
- d. 272.64



Solution:

Compute the top of grade elevation by computing the delta in elevation using the associated slopes.

TOC Elevation = CL Elevation + minus + minus + minus + positive

$$\text{TOC Elevation} = 259.88\text{-ft} + [(-15 \times 2.5\%) + (-4.5 \times 5.2\%) + (-2.5 \div 4) + (7 \times 2)]$$

$$\text{TOC Elevation} = 259.88\text{-ft} + (-0.38) + (-0.23) + (-0.63) + (14.0) = 272.64\text{-ft}$$

Reported Answer(s): **d. 272.64**



CONSTRUCTION ENGINEERING

a. Project Administration

48. Which of the following is not typically included in a construction contract?

- a. General conditions
- b. Construction schedule
- c. Contractor's profit statement
- d. Specifications

Solution:

A construction contract includes elements such as general conditions, specifications, drawings, and other legal documents. A contractor's profit statement is an internal financial document not included in the contract.

- General conditions outline the contractual framework, including responsibilities, rights, and procedural guidelines.
- A schedule is included as part of the contract documents to set expectations and establish milestones.
- Specifications define the quality and technical details of materials and workmanship required in the project.

Reported Answer(s): **c. Contractor's profit statement**



49. Which project delivery method provides the owner with a single point of responsibility for both design and construction?

- a. Design-Bid-Build
- b. Construction Manager at Risk
- c. Design-Build
- d. Public-Private Partnership

Solution:

In the Design-Build method, the contractor and designer work together under a single contract with the owner, ensuring streamlined communication and accountability.

- Design-Bid-Build (Traditional Delivery) is where the design and construction phases are separate, with the owner contracting the designer and contractor independently.
- In a 'Construction Manager at Risk' delivery method the construction manager helps manage risks but does not take full responsibility for both design and construction.
- Public-Private Partnerships are contractual agreements between a public agency and a private entity that allow for greater private participation in the delivery of projects, generally in the form of financing and providing capital funding.

Reported Answer(s): **c. Design-Build**



50. What is the primary purpose of a Request for Information (RFI) during construction?

- a. To request payment for completed work
- b. To seek clarification on design details or contract documents
- c. To change the scope of work
- d. To report site accidents

Solution:

An RFI is used when a contractor, subcontractor, or other project stakeholder requires clarification on ambiguous or conflicting aspects of the contract, drawings, or specifications.

- Requests for payment are typically handled through payment applications or invoices.
- Change of scope require change orders.
- Site accidents are reported through incident reports.

Reported Answer(s): **b. To seek clarification on design details or contract ...**



51. Which document typically outlines the rights and responsibilities of both the owner and the contractor?

- a. Bill of Quantities
- b. General Conditions
- c. Project Schedule
- d. Notice to Proceed

Solution:

The General Conditions define contractual rights, obligations, and procedures for handling disputes, payments, and project execution.

- Bill of Quantities lists the quantities and estimated costs of work items, not contractual rights and responsibilities.
- The Project Schedule outlines timing rather than contractual obligations.
- A Notice to Proceed is a formal document that authorizes work to begin, not a legal framework for responsibilities.

Reported Answer(s): **b. General Conditions**



52. What is the main purpose of a change order in a construction contract?

- a. To schedule inspections
- b. To modify the project scope, cost, or schedule
- c. To approve progress payments to the contractor
- d. To terminate the contract

Solution:

A change order is a formal document that adjusts the project's contract terms due to scope modifications, unforeseen conditions, or other necessary changes (post-award).

- Inspections are arranged through requests for inspections (or special forms), not change orders.
- Progress payments are managed separately through the payment application process.
- Contract termination requires a termination notice, not a change order

Reported Answer(s): **b. To modify the project scope, cost, or schedule**



53. What is the main purpose of the Substantial Completion milestone in a construction project?

- a. It marks the official project closeout
- b. It transfers ownership of the project to the contractor
- c. It signifies that the project is complete except for minor punch list items
- d. It releases the final retention payment to the contractor

Solution:

Substantial Completion means the project is mostly finished and can be used for its intended purpose, but minor corrections or finishing touches (punch list items) may still be needed.

- Project closeout happens after substantial completion and final inspections
- Ownership is always with the owner, and substantial completion usually leads to a warranty period.
- Final payment occurs only after all punch list work is completed and final acceptance is granted.

Reported Answer(s): **c. It signifies that the project is complete except...**



54. What is the main function of a performance bond in construction contracts?

- a. To ensure the contractor is paid on time
- b. To guarantee that subcontractors complete their work
- c. To protect the contractor from lawsuits
- d. To provide financial security in case the contractor fails to complete the project

Solution:

A performance bond is issued by a surety company to ensure that the contractor fulfills their obligations. If the contractor defaults, the surety compensates the owner or arranges for project completion.

- Payments are managed through progress billing and contract terms, not performance bonds.
- Subcontractors may have separate bonds or agreements, but performance bonds cover the general contractor's obligations.
- Performance bond protects the owner, not the contractor.

Reported Answer(s): **d. To provide financial security in case the...**



b. Construction Operations and Methods

55. A highway construction company is evaluating its safety performance for the past year. The company operated across three job sites and collectively recorded the following OSHA-recordable incidents and work hours respectively:

- Job Site A: 4 incidents, 180,000 hours
- Job Site B: 3 incidents, 220,000 hours
- Job Site C: 5 incidents, 150,000 hours

The highest OSHA Incidence rate is most nearly:

- a. 2.73
- b. 4.36
- c. 4.44
- d. 6.67

Solution:

Refer to NCEES Reference Handbook Subsection Titled: 'Incidence Variables Values'.

$$IR = \frac{N \times 200,000}{T}$$

Where:

N = Number of Injuries, Illnesses, and Fatalities

T = Total Hours Worked by all Employees (during the period in question)

Compute the total recordable incidents and total work hours across all sites:

Compute IR for each respective job site:

Job Site A:

$$IR_A = \frac{4 \times 200,000}{180,000} = 4.44$$

$$IR_B = \frac{3 \times 200,000}{220,000} = 2.73$$

$$IR_C = \frac{5 \times 200,000}{150,000} = 6.67$$

Job C has the highest incidence rate with a value of 6.67.

Reported Answer(s): **d. 6.67**



56. Which of the following statements about OSHA regulations is correct? Select all that apply.

- a. OSHA sets and enforces workplace safety standards to ensure a safe working environment.
- b. OSHA only applies to construction sites and does not regulate general industry workplaces.
- c. Workers have the right to refuse work if they believe there is a serious safety hazard.
- d. OSHA requires all companies, regardless of size, to keep an official record of workplace injuries and illnesses.
- e. Employers are responsible for providing Personal Protective Equipment (PPE) to workers at no cost in most cases.

Solution:

OSHA's primary role is to set and enforce safety standards across various industries.

Employers must provide PPE, such as hard hats, gloves, and safety glasses, at no cost when required for job safety.

Workers have the right to refuse unsafe work if they reasonably believe it poses a serious hazard.

- OSHA applies to all workplaces, including construction, general industry, maritime, and agriculture—not just construction.
- While OSHA requires many companies to record workplace injuries, small businesses (with 10 or fewer employees) may be exempt from this requirement.

Reported Answer(s):

a. OSHA sets and enforces workplace safety...
c. Workers have the right to refuse work if...
e. Employers are responsible for providing...



57. What is the primary objective of soil erosion and sediment control measures on a construction site?

- a. To minimize pollutants from affecting protected wetlands
- b. To minimize displacement of soil and prevent sediment from entering navigable waters
- c. To accelerate water runoff and reduce ponding on-site
- d. To improve soil fertility for future landscaping

Solution:

To minimize displacement of soil (erosion) and prevent sediment from entering navigable waters.

- Soil erosion and sediment best management practices generally do not offer protection from pollutants affecting wetlands
- Increasing runoff can worsen erosion and sediment transport.
- Some erosion controls may help with vegetation growth, their main purpose is sediment containment.

Reported Answer(s): **b. To minimize displacement of soil and prevent...**



58. What is the primary purpose of a silt fence in erosion and sediment control?

- a. To provide structural stability to slopes
- b. To control groundwater movement
- c. To prevent sediment from leaving the construction site
- d. To increase infiltration of rainwater into the soil

Solution:

Silt fences are temporary barriers used to trap sediment-laden runoff, preventing erosion and protecting nearby water bodies.

Silt Fences:

- are not designed for slope stabilization; they only filter sediment from runoff.
- Manage surface water runoff, not groundwater, which requires drainage systems.
- Trap sediment (and slow runoff) but do not significantly improve water infiltration.

Reported Answer(s): **c. To prevent sediment from leaving the construction...**



59. When should temporary erosion control measures be installed on a construction site?

- a. After heavy rain to minimize water damage
- b. After major grading activities are completed
- c. Before land-disturbing activities begin
- d. Only when required by regulatory agencies

Solution:

Control measures and best management practices should be in place prior to construction activities begin.

- Erosion controls should be installed proactively, not reactively.
- Best management practices (BMPs) should be used regardless of enforcement to protect the environment.

Reported Answer(s): **c. Before land-disturbing activities begin**



60. A clamshell bucket attachment is used to move clean fill from the barge on to trucks to be transported to the embankment site. The bucket attachment has a capacity of 5 CY and takes 55 seconds to transfer every load into the truck. Each transport truck has a capacity of 15 CY. After loading, the trucks depart to the point of placement, then return to refill in 14 minutes. Assuming, there is 6700 CY of fill that needs to be hauled using 3 trucks, the total time (in hours) for the operation is most nearly:

- a. 21
- b. 42
- c. 84
- d. 125

Solution:

Refer to NCEES Reference Handbook Subsection Titled: 'Material Handling'.

Determine the amount it takes for 1 truck to complete a trip.

- $\text{Truck Trip Time} = \text{Cycle Time} + \text{Load Time}$

How many 5-CY loads will each truck-load require?

$$\text{Loads} = \frac{\text{Truck Capacity}}{\text{Bucket Load}} = \frac{15\text{CY}}{5\text{CY/Load}} = 3 \text{ Loads}$$

$$\text{Time}_{\text{Load}} = \text{Loads} \times \text{Cycle Time} = 3 \text{ Loads} \times 55 \frac{\text{s}}{\text{Load}} = 165\text{s} = 2.75\text{min}$$

$$\text{Truck Trip Time} = 14 \text{ min} + 2.75 \text{ min} = 16.75\text{min}$$

- Each truck can process 15 CY every 16.75min.
- To calculate the total trips required, divide the total scope by the truck load.

$$\frac{\text{Total Scope}}{\text{Truck Capacity}} = \frac{6700 \text{ CY}}{15 \text{ CY}} = 446.67 \text{ Trips will be required.}$$

$$\text{Time per trip} \times \text{Total Trips} = \text{Total Time per Scope}$$

$$16.75\text{min} \times 446.67 = \text{Total Time per Scope} = 7,481.67 \text{ mins}$$

- Each Trip will take 16.75 min, which equals: 7,481.67 mins to process the entire scope (using 1 truck).
- Factor for additional resources (divide by 3 trucks): 2493.89 min = 41.56 hours

Reported Answer(s): **b. 42**



61. The construction of a 300 traffic signal controllers in an upgrade program will require the installation of 5-circuit boards and 8-breakers per controller. Each circuit board and breaker can be installed by a laborer in 3 minutes and 5 minutes, respectively. There are 10 laborers commissioned to this program. Assuming the workday is 9.5 hours with a half-hour lunch break, the duration of this activity (days, hours) is most nearly:

- a. 3, 1
- b. 5, 1
- c. 10, 3
- d. 30, 5

Solution:

Refer to NCEES Reference Handbook Subsection Titled: 'Material Handling'.

Circuit Boards	Breakers
5 units per controller	8 units per controller
1500 units for total activity	2400 units for total activity
3 min/unit	5 min/unit
4500 min/total activity (1 laborer)	12,000 min/total activity (1 laborer)
450 min/total activity (10 laborer)	1,200 min/total activity (10 laborer)
Total Time = Total Circuit Board Time + Total Breaker Time Total Time = 450 + 1,200 = 1,650 min/total activity Corrected Workday (for worktime) = 9.5 hr – 0.5 hr = 9 hr/workday $\text{Work Time} = \frac{\text{Total Work Time (min)}}{\text{Time per Workday} \left(\frac{\text{min}}{\text{day}}\right)} = \frac{1,650 \text{ min}}{\frac{9 \text{ hr}}{\text{wday}} \times 60 \frac{\text{min}}{\text{hr}}} = 3.06 \text{ wdays}$ 3.06 = 3 days and 0.06 days 0.06 days x 9hr/day = 0.5 hrs <u>Reported Answer(s):</u> <u>a. 3, 1</u>	



c. Project Controls

62. In Earned Value Management, what is the metric used to determine the cost of a project at completion?

- a. Cost Performance Index
- b. Budget at Completion
- c. Estimate at Completion
- d. Variance at Completion

Solution:

Estimate at Completion is defined as the project estimate at completion.

- Cost Performance Index measures cost efficiency but does not predict the total cost at project completion.
- Budget at Completion is the original project estimate (prior to commencement).
- Variance at Completion represents the difference between the budgeted and estimated final cost, but EAC provides the actual estimated completion cost.

Reported Answer(s): **c. Estimate at Completion**



63. What happens if an activity that is not on the critical path is delayed by five days?

- a. The project will be delayed by five days unless corrective action is taken.
- b. The delay can be ignored as long as costs are controlled.
- c. The project completion date remains the same if there is enough float to absorb the delay.
- d. The delay will only affect activities with zero float.

Solution:

The project completion date remains the same if there is enough float to absorb the delay.

- Only activities on the critical path directly affect the project completion date.
- Even if the project completion date is unaffected, delays can impact resource availability and workflow efficiency.
- Activities not on the critical path have positive float, meaning they can be delayed without delaying the project—but only up to a certain limit.

Reported Answer(s): **c. The project completion date remains the same...**



64. Which of the following are true about Total Float in project scheduling? Select all that apply.

- a. It applies only to the critical path.
- b. It represents the amount of time an activity can be delayed without delaying project completion.
- c. It is always negative.
- d. It can be shared among parallel activities that are not on the critical path.

Solution:

Total Float is equal to the difference between the Late (Start or Finish) minus the Early (Start or Finish) of an Activity. It can be consumed without affecting the delivery of the project and is shared with other activities along its path (not on the Critical Path)

- Total float applies to non-critical activities; the Critical Path has zero float.
- Float is generally positive or zero. May be negative when the logic/sequencing is forcing activities to be completed earlier than baselined.

Reported Answer(s):

b. It represents the amount of time an activity can be...
d. It can be shared among parallel activities that are...



65. A project scope is assessed for completion and the auditor has valued the completed scope at \$50,000. Project invoices reveal that it cost \$60,000 and at the point in the project \$56,000 worth of scope should have been completed. Which of the following statements are correct? Select all that apply.

- a. The project is over budget, with a CPI of 0.83.
- b. The project is ahead of schedule, with a SPI of 0.89.
- c. The project has a CV of -10,000.
- d. The project has a SV of 6,000.

Solution:

Refer to NCEES Reference Handbook Section Titled: 'Earned-Value Analysis'.

Given:

- Earned Value (BCWP): \$50,000
- Actual Cost (ACWP): \$60,000
- Planned Value (BCWS): \$56,000

$$CPI = \frac{BCWP}{ACWP} = \frac{50,000}{60,000} = 0.83 \quad \therefore \text{(Over Budget)}$$

$$SPI = \frac{BCWP}{BCWS} = \frac{50,000}{56,000} = 0.89 \quad \therefore \text{(Behind Schedule)}$$

$$CV = EV - ACWP = 50,000 - 60,000 = -10,000 \quad \therefore \text{(Over Budget)}$$

$$SV = BCWP - BCWS = 50,000 - 56,000 = -6,000 \quad \therefore \text{(Behind Schedule)}$$

Reported Answer(s): **a. The project is over budget, with a CPI of 0.83.**
 c. The project has a CV of -10,000.



66. Which type of schedule diagram should be used to recompute a change in activity duration?

- a. Gantt Chart
- b. Activity-on-Node
- c. Precedence Diagram
- d. Critical Path

Solution:

Activity-on-Node is the only appropriate choice.

- Gantt Charts are static mediums to present project status for the purposes of briefing not planning/control.
- 'Precedence Diagram' is not a classified term/diagramming medium or method.
- Critical path method is a methodology of used to evaluate the baseline duration of a schedule, but is not a diagram in it of itself.

Reported Answer(s): **b. Activity-on-Node**



67. A civil engineering firm is managing a roadway expansion project with a total budget of \$500,000. At the 40% completion mark, an audit of progress completion and finances are conducted. The team determines that they have only completed \$200,000 worth of work, even though they have already spent \$250,000. The program manager now calls to request a forecast for the total expected cost at completion with the assumption there will be no change in the performance for the rest of the project. The projected cost of the roadway expansion is mostly nearly:

- a. 125,000
- b. 500,000
- c. 600,000
- d. 625,000

Solution:

Refer to NCEES Reference Handbook Subsection Titled: '**Earned-Value Analysis**'.

Strategy: With a CPI and BAC, we can calculate EAC.

Given:

- Budget at Completion (BAC): \$500,000
- Earned Value (BCWP): \$200,000
- Actual Cost (ACWP): \$250,000

Calculate CPI:

$$CPI = \frac{BCWP}{ACWP} = \frac{200,000}{250,000} = 0.80 \quad \therefore \text{(Over Budget)}$$

Calculate EAC:

$$EAC = \frac{BAC}{CPI} = \frac{500,000}{0.80} = 625,000$$

Reported Answer(s): **d. 625,000**



68. A contractor is overseeing a bridge construction project with a total duration of 12 months. At the 6-month mark, the project team evaluates their progress and gathers the following data.

- The milestone reports projected that they should have completed \$425,200 worth of work.
- The owner's inspector values the work at \$455,250.
- All processed invoices to date reveal that the contractor was paid \$535,000.

The project manager wants to analyze the project's performance in terms of cost and schedule efficiency. The following performance metrics are most nearly:

- Schedule Performance Index (SPI) _____
- Cost Performance Index (CPI) _____
- Cost Variance (CV) _____
- Schedule Variance (SV) _____

Solution:

Refer to NCEES Reference Handbook Subsection Titled: '**Earned-Value Analysis**'.

Given:

- Planned Value (BCWS): \$425,200
- Earned Value (BCWP): \$455,250
- Actual Cost (ACWP): \$535,000

Calculate SPI:

$$SPI = \frac{BCWP}{BCWS} = \frac{455,250}{425,200} = 1.07 \therefore \text{(Ahead Schedule)}$$

Calculate CPI:

$$CPI = \frac{BCWP}{ACWP} = \frac{455,250}{535,000} = 0.85 \therefore \text{(Over Budget)}$$

Calculate CV:

$$CV = BCWP - ACWP = 455,250 - 535,000 = -79,750 \therefore \text{(Over Budget)}$$

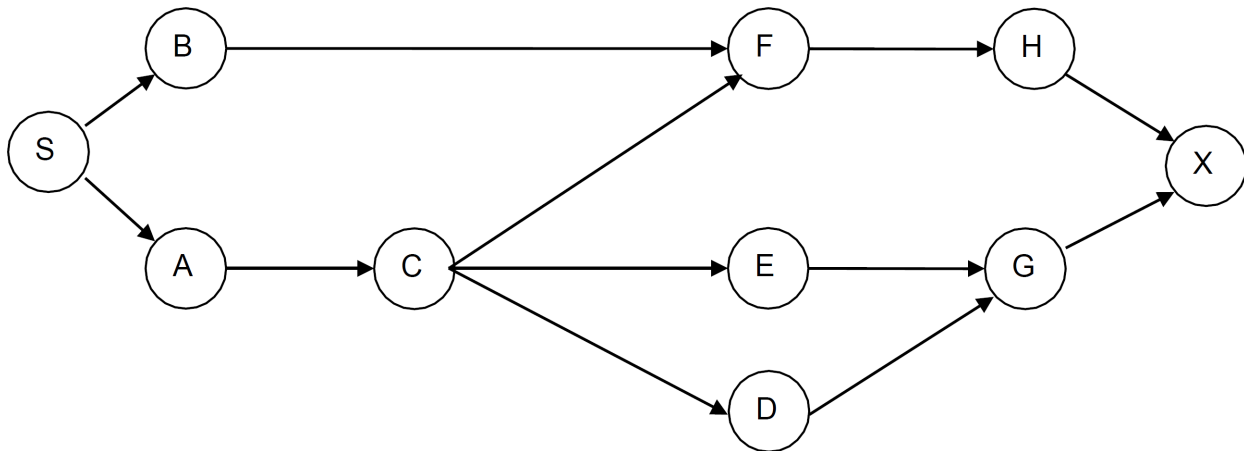
Calculate SV:

$$SV = BCWP - BCWS = 455,250 - 425,200 = 30,050 \therefore \text{(Ahead Schedule)}$$

<u>Reported Answer(s):</u>	Schedule Performance Index (SPI)	<u>1.07</u>
	Cost Performance Index (CPI)	<u>0.85</u>
	Cost Variance (CV)	<u>-79,750</u>
	Schedule Variance (SV)	<u>30,050</u>



69. An activity and relationship table are provided for the network diagram. The minimum amount of days required for project completion is most nearly:



Answer: _____

Activity	Successor	Duration
S	A,B	0
A	C	4
B	F	3
C	F,E,D	1
D	G	2
E	G	3
F	H	5
G	X	1
H	X	2
X	Finish	0

Solution:

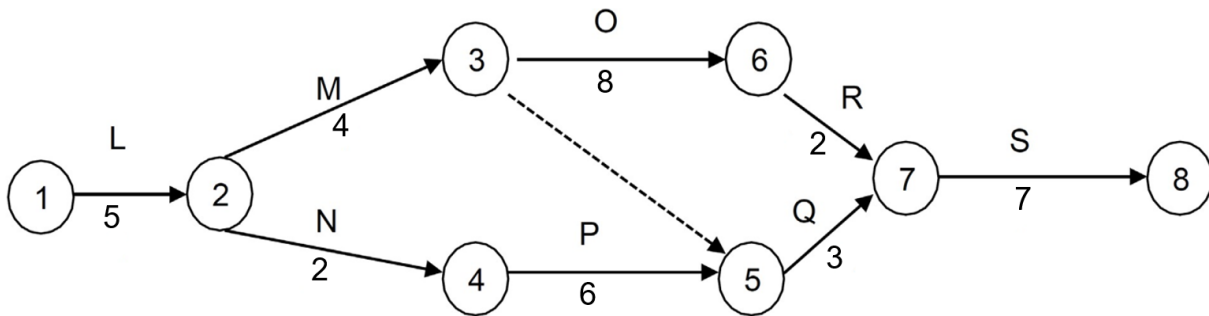
Copy relevant information from the table to the diagram and perform a Forward Pass to determine the Critical Path.

$$sACFH_x = 4 + 1 + 5 + 2 = 12$$

Reported Answer(s): **12**



70. The Duration of the critical path is most nearly:



- a. 16
- b. 19
- c. 23
- d. 26

Solution:

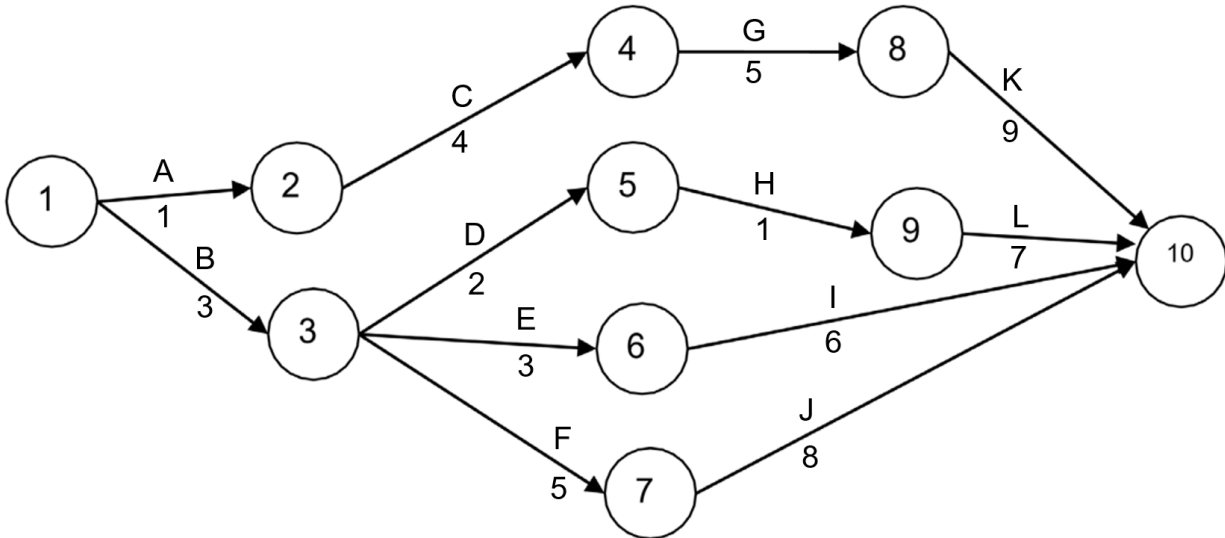
Perform the 'Forward Pass' and determine the sequence of critical activities is as follows:

L-M-O-R-S (Nodes: 1-2-3-6-7-8) = 5 + 4 + 8 + 2 + 7 = 26

Reported Answer(s): **d. 26**



71. Use the following network diagram and associated durations to determine the minimum amount of time for project completion.



Answer: _____

Solution:

The Critical Path can be defined as 'the shortest amount of time for project completion', which must include a duration that allows for the completion of all activities and as 'the longest numerical path through the diagram'.

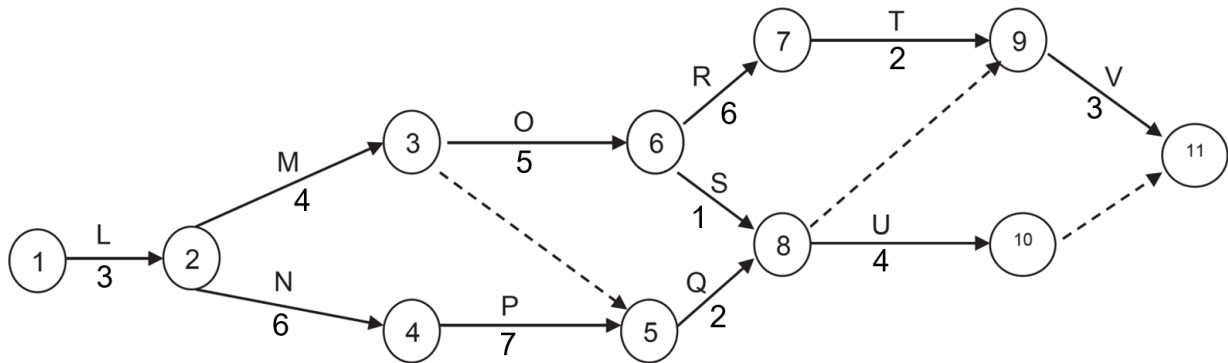
Perform the 'Forward Pass' and determine the sequence of critical activities is as follows:

$$A-C-G-K \text{ (Nodes: 1-2-4-8-10)} = 1 + 4 + 5 + 9 = 19$$

Reported Answer(s): **19**



72. Using the following network diagram, determine all the Early Finishes for all the activities. The largest EF is most nearly:



- a. 20
- b. 22
- c. 23
- d. 24

Solution:

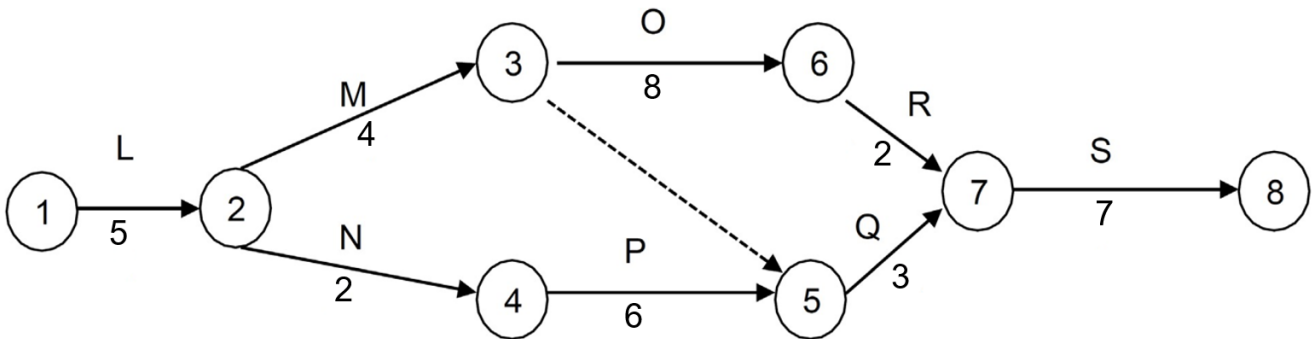
The Early Finishes are determined by performing the 'Forward Pass'. The largest value will be associated with the last (critical) activity.

$$L-M-O-R-T-V \text{ (Nodes: 1-2-3-6-7-9-11)} = 3 + 4 + 5 + 6 + 2 + 3 = 23$$

Reported Answer(s): **c. 23**



73. The following diagram below represents the baseline schedule. You have just been notified that activity Q is now delayed by 4 days. Which of the following statements are true regarding the updated schedule? Select all that apply.



- a. There are 4 critical activities
- b. Schedule now takes 1 days longer
- c. Activity R has 1 day of Total Float
- d. Schedule now takes 4 days longer
- e. Activity P has 0 days of Total Float
- f. Schedule is unaffected (due to available float)
- g. There are 3 non-critical activities
- h. Activity O has 1 day of Total Float

Solution:

Baseline schedule must be completed first, which is achieved using the Forward Pass.

Baseline Schedule: L-M-O-R-S (Nodes: 1-2-3-6-7-8) = 5 + 4 + 8 + 2 + 7 = 26

Updated Schedule: L-N-P-Q-S (Nodes: 1-2-4-5-7-8) = 5 + 2 + 6 + (3+4) + 7 = 27

Reported Answer(s):

- b. Schedule now takes 1 days longer**
- c. Activity R has 1 day of Total Float**
- e. Activity P has 0 days of Total Float**
- g. There are 3 non-critical activities**
- h. Activity O has 1 day of Total Float**



d. Construction Estimating

74. A contractor is preparing a circular foundation footing for a new storage tank. The footing has an outer diameter of 28-ft. The inside of the cylinder will remain unpoured for utility access and has an inside diameter 20-ft. Assuming the footing has a height of 12-ft and will be cast on existing subgrade, the amount of concrete (cy) to cast-in-place is most nearly:

- a. 134
- b. 140
- c. 273
- d. 3,619

Solution:

Recognize to determine the volume, we must compute the net area (footprint) of the footing that will be poured. This is determined by taking the difference between the outer diameter and the inner diameter. Then multiply that net area (sf) by the height (lf) to determine the total net volume.

$$\text{Area Net Circle} = \text{Area}_{\text{outer}} - \text{Area}_{\text{inner}}$$

$$\text{Area Net Circle} = \frac{\pi D_{28}^2}{4} - \frac{\pi D_{20}^2}{4}$$

$$\text{Area Net Circle} = 615.75 - 314.16 = 301.59 \text{sf}$$

$$\text{Volume of Concrete Footing (Barrel)} = \text{Area Net Circle} \times \text{Height}$$

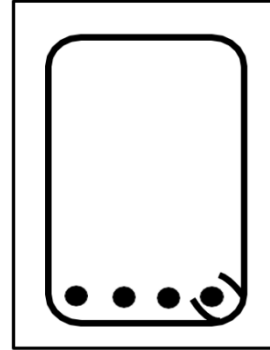
$$\text{Volume} = 301.59 \times 12 = 3618.84 \text{ cf} = 134.03 \text{cy}$$

Reported Answer(s): **a. 134**



75. The cross-section view of a reinforced concrete beam, which will be cast on grade, is as shown with the given design parameters. The SFCA using the available steel forms 2-ft wide x 4-ft long is most nearly:

- Type: Pre-cast
- Beam Length: 24-ft
- Beam Height: 36-in.
- Beam Width: 24-in
- Longitudinal Reinforcement: 4 - #10
- Transverse Reinforcement: #5 @ 12" OC



- a. 108
- b. 156
- c. 204
- d. 252

Solution:

SFCA = Square Foot of Contact Area (Where the poured concrete surface will make contact with the Formwork Panels)

Considering the beam will be cast on grade, it will not require formwork on the bottom.

The formwork will consist of (2) sides and (2) faces, with no formwork on top.

Side 1 + Side 2 + Face 1 + Face 2 = Total SFCA (Formwork Area)

$$2 \times (3' \times 24') + 2 \times (2 \times 3) = 156 \text{ SF}$$

Reported Answer(s): **b. 156**



76. A contractor is constructing a utility duct bank that will be encased in concrete. The duct bank measures 4-ft wide by 3-ft tall, which will run from station 3+15 to station 4+23. The duct bank is protecting 4 ducts, each measuring 5-inches OD and carrying 2 communication service lines per duct. Using the information given, the amount of concrete (cy) to be ordered is most nearly.

- a. 44
- b. 46
- c. 48
- d. 266
- e. 1237
- f. 1296

Solution:

Determine the net cross-sectional area multiplied by the length between the stations.

$$V_{net} = A_{net} \times L$$

$$L = sta\ 4 + 23 - sta\ 3 + 15 = 423 - 315 = 108$$

$$A_{gross} = 4ft \times 3ft = 12sf$$

Multiply the cross-sectional area of the duct by 4, which is the total number of ducts.

$$A_{deduct} = 4 \times \frac{\pi D^2}{4}$$

$$A_{deduct} = 4 \times \frac{\pi(0.4167)^2}{4} = 0.5454\ sf$$

$$A_{net} = A_{gross} - A_{deduct}$$

$$A_{net} = 12 - 0.5454 = 11.45sf$$

$$V_{net} = A_{net} \times L = 11.45sf \times 108lf = 1237.1\ cf = 45.82cy$$

Reported Answer(s): **b. 46**



77. A W14 × 82 steel column will be used in the construction for a multi-story structure. The column extends from elevation 12.5-ft to elevation 44.75-ft, where it will be bolted to an adjacent existing W14 × 88 column with a starting elevation of 10.3-ft to elevation 46-ft. The amount of steel the contractor will be required to order for the new scope is most nearly:

- a. 2,645
- b. 2,838
- c. 2,927
- d. 5,786

Solution:

W: Corresponds to the shape of the steel member, in this case, it is a Wide-Flanged Beam

14: The number of inches from flange to flange

82: The amount of pounds per linear ft of member

$$W_{total} = \text{Linear Mass Density} \times \text{Total Length of Member}$$

Only consider the new steel column for consideration. The existing member is omitted from inclusion.

$$W_{total} = 82 \frac{lb}{lf} \times (44.75 - 12.5) = 2,644.5 \text{ lb}$$

Reported Answer(s): **a. 2,645**



e. Interpretation of Engineering Drawings

78. The difference between a solid line and screened line on a drawing is the difference between:

- a. Proposed scope and existing conditions
- b. Various underground utilities types
- c. Roadway centerline and shoulder edge
- d. Existing grades and limits of work

Solution:

Proposed scope is typically represented by darker/heavier line weights whereas existing scope is screened/greyed.

Reported Answer(s): **a. Proposed scope and existing conditions**



79. In an engineering drawing, what does the symbol " $\varnothing$ " indicate?

- a. Radius
- b. Diameter
- c. Square shape
- d. Centerline

Solution:

- Radius is represented by "R" instead of " $\varnothing$ ".
- Square shape is indicated by a box or dimension notes.
- Centerline are represented by dashed lines and " CL ".

Reported Answer(s): **b. Diameter**



80. What is the purpose of a title block in an engineering drawing?

- a. To provide information on materials and finishes
- b. To show detailed section views of components
- c. To provide essential information like project name, date, and scale
- d. To list all dimensions of the drawing

Solution:

To provide essential information like project details, engineering license information, revision number (or modifications), date, and scale.

- Information on materials and finishes are usually listed in a separate "Bill of Materials" or "Notes" section.
- Detailed section views of components are part of the drawing itself, not the title block.
- Dimensions are placed within the drawing, not in the title block.

Reported Answer(s): **c. To provide essential information like project name...**



81. On a civil site plan, a contour interval of 2 feet means what?

- a. The difference in elevation between two contour lines is 2 feet.
- b. Each contour line represents a total elevation of 2 feet.
- c. Contour lines are spaced exactly 2 feet apart.
- d. The site has a uniform slope of 2 feet per horizontal unit.

Solution:

The difference in elevation between contour to counter is 2 feet+/-.

- Each line represents an elevation, but the contour interval is the difference between two consecutive lines.
- The horizontal spacing depends on the terrain slope—closer lines indicate steeper slopes.
- Contour intervals describe vertical elevation differences, not horizontal slope values.

Reported Answer(s): **a. The difference in elevation between two contour...**



82. In a roadway plan and profile sheet, what does the "profile" portion typically represent?

- a. A top-down view of the road alignment
- b. A cross-section of the roadway at a specific station
- c. A longitudinal vertical section showing existing and proposed grades
- d. A perspective rendering of the roadway

Solution:

A longitudinal vertical section showing existing and proposed grades

- A top-down view of the road alignment describes the plan view, not the profile view.
- A cross-section of the roadway at a specific station illustrates a segment at one station, while the profile extends along the length/centerline the road.
- A perspective rendering of the roadway is an aesthetic/artistic illustration that does not capture engineering features or functions.

Reported Answer(s): c. A longitudinal vertical section showing existing and...



83. Which of the following details can typically be found in the "Plan View" of a civil site drawing? Select all that apply.

- a. Property boundaries and easements
- b. Locations of roads, utilities, and structures
- c. Profile of the roadway centerline
- d. North arrow and scale

Solution:

Plan views are 'top down' drawings that can capture an array of information and intent. Design intents which are conveyed in this format such as: grading plans, paving plans, utility plans, etc.

- Profile views are captured only in profile drawings, not in plan views.

Reported Answer(s):

- a. Property boundaries and easements**
- b. Locations of roads, utilities, and structures**
- d. North arrow and scale**



84. In a typical stormwater drainage plan, which symbols or notations are commonly used? Select all that apply.

- a. "RCP" to indicate Reinforced Concrete Pipe
- b. Arrows to show direction of water flow
- c. Contour lines to indicate topography
- d. Hatching to represent water depth in pipes

Solution:

RCP is a common material used for drainage systems.

Arrows or slopes may be presented to demonstrate flow path or drainage patterns.

Drainage utility plans are often combined with grading plans to highlight the design intent along with grading/drainage patterns.

- Hatching is generally used for material sectioning or illustration, not to show water depth inside pipes.

Reported Answer(s):

- a. "RCP" to indicate Reinforced Concrete Pipe**
- b. Arrows to show direction of water flow**
- c. Contour lines to indicate topography**



85. Which of the following are key characteristics of an engineering drawing?
Select all that apply.

- a. Uses industry-standard line types, symbols, and notations
- b. Always drawn to full scale for accuracy
- c. Represents objects using orthographic, isometric, or section views
- d. Allows for subjective interpretation based on the viewer's understanding
- e. Includes dimensions, tolerances, and scale for accuracy
- f. Conveys design intent and construction details to stakeholders
- g. Biddable

Solution:

Drawings must convey design intent, be accurate, employ a scale system, be constructable, and biddable/quantifiable to highlight a few primary characteristics.

- Engineering drawings employ different scales for different sheet sets which also vary from project to project.
- Engineering drawings must be precise and unambiguous, following strict conventions to ensure consistent interpretation from stakeholder to stakeholder.

Reported Answer(s):

a. Uses industry-standard line types, symbols...
c. Represents objects using orthographic, isometric...
e. Includes dimensions, tolerances, and scale for...
f. Conveys design intent and construction details to...
g. Biddable



86. Assuming a drawing was originally plotted using a 1-30 scale. 0.75" measured on a half-size drawing is most nearly how many feet in the project site:

Answer: _____

Solution:

Note: Scales that are used were intended for reference on drawings are plotted at full-size.

$$0.75'' \times 30' = 22.5'$$

However, this measured distance of 0.75" was taken from a half-sized sheet, it must be multiplied by a factor of two. Alternatively, the scale may be multiplied by 2 prior to the conversion as well.

$$22.5' \times 2 = 45'$$

Reported Answer(s): **45**