



# Solar PV NABCEP

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## Practice Questions

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**1. Before energizing a newly installed PV system, which document should the installer review to confirm all components meet the design specifications?**

- A. The approved construction drawings and equipment submittals
- B. The utility interconnection tariff schedule
- C. The property survey and title report
- D. The original equipment manufacturer warranty cards

**2. What is the basic building block of a photovoltaic module?**

- A. A PV cell
- B. A bypass diode
- C. An inverter
- D. A charge controller

**3. Which tool is used to measure the sun path and identify shading obstructions at a potential PV installation site?**

- A. Solar pathfinder or equivalent shading analysis tool
- B. Multimeter
- C. Clamp ammeter
- D. Tilt-and-orientation meter only

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**4. What is the photovoltaic effect?**

- A. The generation of an electric current when light strikes a semiconductor material
- B. The conversion of electrical energy into heat by a resistive element
- C. The storage of charge in a capacitor when exposed to light
- D. The phenomenon of electrons being reflected by a metallic surface



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**5. Which tool is used to measure the sun hours available at a specific site for solar PV system sizing?**

- A. Solar pathfinder or shade analysis tool
- B. Clamp meter
- C. Multimeter
- D. Infrared thermometer

**6. Which NEC article specifically covers solar photovoltaic (PV) systems?**

- A. Article 690
- B. Article 705
- C. Article 702
- D. Article 680

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**7. Which class of hard hat provides the highest level of electrical protection for solar PV installers working near energized conductors?**

- A. Class E (Electrical)
- B. Class G (General)
- C. Class C (Conductive)
- D. Class F (Forestry)

**8. Which tool is most commonly used to determine the annual solar resource at a specific location before designing a PV system?**

- A. A digital multimeter
- B. A pyranometer calibration certificate
- C. NREL's PVWatts Calculator
- D. A load calculation spreadsheet

**9. During a visual pre-commissioning inspection, which condition would be an immediate reason to halt energization?**

- A. A slightly dusty module surface
- B. Conduit with a single 90-degree bend
- C. Exposed, unprotected DC conductors
- D. Modules installed at a 20-degree tilt



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**10. Which type of silicon PV cell technology typically has the highest efficiency among commercially available flat-plate modules?**

- A. Amorphous silicon (a-Si)
- B. Cadmium telluride (CdTe)
- C. Monocrystalline silicon (mono-Si)
- D. Polycrystalline silicon (poly-Si)

**11. What does a roof load assessment determine before installing a PV system?**

- A. The optimal tilt angle for modules
- B. The inverter sizing ratio
- C. Whether the roof structure can support the added weight of PV equipment
- D. The number of string combiners required

**12. What minimum energy must a photon possess to free an electron in a semiconductor and contribute to photocurrent?**

- A. Any amount of energy, because all photons can dislodge electrons
- B. Energy equal to the work function of copper
- C. Energy equal to or greater than the band-gap energy of the semiconductor
- D. Energy equal to the thermal voltage of the p-n junction

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**13. What is the primary purpose of conducting a roof load analysis before installing a solar PV array?**

- A. To determine the optimal tilt angle for maximum energy production
- B. To identify the best conduit routing path
- C. To ensure the roof structure can support the added weight of the array
- D. To calculate the number of panels that fit aesthetically



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**14. In NEC Article 690, what term is used to describe the maximum voltage a PV system is designed to produce under open-circuit conditions?**

- A. Rated voltage
- B. Operating voltage
- C. Open-circuit voltage (Voc)
- D. Maximum power voltage (Vmp)

**15. When working on a rooftop PV installation, which PPE is required to prevent falls when the work area is 6 feet or more above the lower level?**

- A. Safety glasses only
- B. Hard hat only
- C. Fall arrest or fall restraint system
- D. Steel-toed boots only

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**16. What unit is used to express peak sun hours (PSH) when evaluating a site's solar resource?**

- A. kWh/m<sup>2</sup>/day
- B. W/m<sup>2</sup>
- C. kW/hr
- D. BTU/ft<sup>2</sup>

**17. When inspecting module-level power electronics (MLPEs) during pre-commissioning, the technician should verify that each device is:**

- A. Rated for 600 V AC output
- B. Properly grounded or bonded per the manufacturer's instructions
- C. Installed with at least 6 inches of clearance from adjacent modules
- D. Configured to operate at a fixed power set point

**18. Standard test conditions (STC) for rating PV modules specify an irradiance of 1000 W/m<sup>2</sup>. What cell temperature does STC also specify?**

- A. 0 °C
- B. 25 °C
- C. 47 °C
- D. 60 °C



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**19. A site in the northern hemisphere has a roof pitch of 4:12 facing due south. Which factor most directly determines the optimal fixed tilt angle for maximum annual energy yield?**

- A. The local utility interconnection voltage
- B. The site's latitude
- C. The roof's azimuth angle
- D. The inverter clipping ratio

**20. Silicon is classified as which type of material?**

- A. Conductor
- B. Semiconductor
- C. Insulator
- D. Superconductor

**21. A residential roof faces due west. Compared to a south-facing roof at the same tilt in the northern hemisphere, annual energy production will be approximately:**

- A. Equal, because total solar radiation reaching Earth is the same in all directions
- B. Lower by roughly 10–20%, due to the mismatch between peak insolation and afternoon sun
- C. Higher, because afternoon electricity prices are often greater
- D. Lower by more than 50%, making the site unsuitable for solar

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**22. NEC 690.8(A) requires PV source circuit conductors to be sized at a minimum of what percentage of the PV source circuit short-circuit current (Isc)?**

- A. 100%
- B. 125%
- C. 150%
- D. 175%



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**23. Arc flash PPE for DC electrical work on a PV system should be selected based on which document?**

- A. The inverter installation manual
- B. An arc flash hazard analysis per NFPA 70E
- C. The module manufacturer's datasheet
- D. OSHA 1910.303 alone

**24. A site assessment in a northern hemisphere location shows the sun's azimuth at solar noon is 180°. What does this indicate?**

- A. The site is in the southern hemisphere
- B. The sun is due south at solar noon, which is typical for northern hemisphere sites
- C. The sun is due north at solar noon
- D. The azimuth reading is erroneous and must be recalibrated

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**25. What is the primary purpose of a continuity test performed on equipment grounding conductors (EGC) before commissioning?**

- A. To measure the open-circuit voltage of each string
- B. To verify the insulation resistance of PV conductors
- C. To confirm the inverter firmware version is current
- D. To verify a low-resistance fault-current path exists from all metallic parts to ground

**26. A module's temperature coefficient of Pmax is  $-0.40\%/^{\circ}\text{C}$ . If STC Pmax is 300 W and the operating cell temperature is 65 °C, approximately how much power does the module produce?**

- A. 312 W
- B. 305 W
- C. 288 W
- D. 252 W

**27. During a site assessment, you calculate a shading loss of 15% using a solar path analysis tool. How should this factor be applied in a production estimate?**

- A. Ignored if the shading occurs only in winter months
- B. Added as a gain to the system output
- C. Subtracted from the inverter efficiency rating
- D. Applied as a derate factor reducing the estimated annual energy output by 15%



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**28. What type of doping creates an n-type silicon semiconductor?**

- A. Adding a trivalent element such as boron
- B. Adding a divalent element such as magnesium
- C. Removing electrons by exposing silicon to UV radiation
- D. Adding a pentavalent element such as phosphorus

**29. When using a solar resource database to estimate annual output, which factor must be applied to translate global horizontal irradiance (GHI) into plane-of-array (POA) irradiance?**

- A. The panel's temperature coefficient
- B. The inverter efficiency
- C. The system voltage
- D. The tilt and azimuth transposition model

**30. A PV array string has a short-circuit current ( $I_{sc}$ ) of 10 A. What is the minimum ampacity of the PV source circuit conductor required by NEC 690.8?**

- A. 10 A
- B. 12 A
- C. 13 A
- D. 12.5 A



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## Answer Key & Explanations

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### 1. A — The approved construction drawings and equipment submittals

Approved construction drawings and equipment submittals establish what was engineered and what was approved by the AHJ. Comparing as-built conditions to these documents catches substitutions or omissions before the system is energized.

### 2. A — A PV cell

A PV module is constructed from individual PV cells (typically silicon wafers) connected in series and/or parallel. Bypass diodes, inverters, and charge controllers are separate components added to the circuit.

### 3. A — Solar pathfinder or equivalent shading analysis tool

A solar pathfinder or equivalent tool (e.g., SunEye, HelioScope shade analysis) plots the sun's path across the sky and reveals obstructions that cast shadows on the array. A multimeter measures electrical values, not shading.

### 4. A — The generation of an electric current when light strikes a semiconductor material

The photovoltaic effect occurs when photons with sufficient energy dislodge electrons in a semiconductor, creating an electron-hole pair and a resulting electric current. It was first observed by Edmond Becquerel in 1839.

### 5. A — Solar pathfinder or shade analysis tool

A solar pathfinder or equivalent shade analysis tool maps obstructions across the sky dome and translates them into peak sun hours lost, which is essential for accurate system sizing. Clamp meters and multimeters measure electrical quantities, not solar availability.

### 6. A — Article 690

NEC Article 690 is dedicated to solar photovoltaic systems. Article 705 covers interconnected electric power production sources, Article 702 covers optional standby systems, and Article 680 covers swimming pools.

### 7. A — Class E (Electrical)

Class E hard hats are rated to protect against electrical hazards up to 20,000 volts. Class G offers lower voltage protection (2,200 V), Class C provides no electrical protection, and Class F is not an ANSI designation for electrical protection.

### 8. C — NREL's PVWatts Calculator

NREL's PVWatts Calculator uses satellite-derived irradiance data to estimate annual energy production for a given location, tilt, and azimuth, making it the industry-standard tool for initial solar resource evaluation.

### 9. C — Exposed, unprotected DC conductors

Exposed, unprotected DC conductors present a shock and arc-flash hazard. NEC and OSHA requirements mandate all conductors be properly insulated and protected before any circuit is energized.



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**10. C — Monocrystalline silicon (mono-Si)**

Monocrystalline silicon cells are made from a single continuous crystal lattice, which allows electrons to move more freely and results in higher efficiencies (typically 18–24%) compared to polycrystalline or thin-film technologies.

**11. C — Whether the roof structure can support the added weight of PV equipment**

PV arrays add dead load to the roof. A structural assessment verifies the roof framing, sheathing, and rafters can safely bear the added weight, preventing structural failure.

**12. C — Energy equal to or greater than the band-gap energy of the semiconductor**

A photon must have energy at least equal to the semiconductor's band gap ( $E_g$ ) to excite an electron from the valence band to the conduction band. Photons with less energy pass through or are converted to heat, not electricity.

**13. C — To ensure the roof structure can support the added weight of the array**

A roof load analysis confirms the structural adequacy of the roof to bear the dead load of the PV modules, racking hardware, and any live loads such as snow or maintenance workers. Neglecting this can lead to structural failure.

**14. C — Open-circuit voltage ( $V_{oc}$ )**

Open-circuit voltage ( $V_{oc}$ ) is the maximum voltage a PV source produces when no current is flowing. It is the benchmark used for conductor and equipment voltage ratings in NEC 690.

**15. C — Fall arrest or fall restraint system**

OSHA 29 CFR 1926.502 requires fall protection at 6 feet above the lower level in construction. A personal fall arrest system (PFAS) or fall restraint system is required to prevent falls from rooftop edges.

**16. A — kWh/m<sup>2</sup>/day**

Peak sun hours are expressed as kWh/m<sup>2</sup>/day, representing the equivalent number of hours of sunlight at 1,000 W/m<sup>2</sup> irradiance that would deliver the same daily energy as the actual variable irradiance at the site.

**17. B — Properly grounded or bonded per the manufacturer's instructions**

MLPEs such as microinverters and DC optimizers must be grounded or bonded per the manufacturer's instructions and the NEC to prevent shock hazards and ensure proper fault current paths.

**18. B — 25 °C**

STC uses 1000 W/m<sup>2</sup> irradiance, a cell temperature of 25 °C, and an air mass of 1.5 (AM1.5). These conditions allow consistent comparison of module ratings across manufacturers.

**19. B — The site's latitude**

For fixed-tilt systems in the northern hemisphere, a tilt angle approximately equal to the site's latitude maximizes annual energy production by balancing winter and summer irradiance. Azimuth matters but latitude drives the optimal tilt.

**20. B — Semiconductor**

Silicon has four valence electrons and an intermediate band-gap (~1.12 eV), making it a semiconductor. Its conductivity can be precisely controlled through doping, which is why it dominates PV cell manufacturing.

**21. B — Lower by roughly 10–20%, due to the mismatch between peak insolation and afternoon sun**

A due-west orientation in the northern hemisphere typically yields about 10–20% less annual energy than a



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due-south orientation at optimal tilt, because the roof collects predominantly afternoon sun and misses the high-angle midday insolation. The financial offset from time-of-use rates is a billing consideration, not an energy production fact.

**22. B — 125%**

NEC 690.8(A) requires that PV source circuit conductors be sized for not less than 125% of the rated short-circuit current. This accounts for continuous loading conditions in solar installations.

**23. B — An arc flash hazard analysis per NFPA 70E**

NFPA 70E requires an arc flash hazard analysis to determine incident energy and the appropriate PPE category. The analysis result drives the selection of arc-rated clothing, face shields, and gloves.

**24. B — The sun is due south at solar noon, which is typical for northern hemisphere sites**

In the northern hemisphere, the sun transits due south ( $180^\circ$  azimuth) at solar noon year-round, which is why south-facing arrays capture the most annual solar energy at those latitudes.

**25. D — To verify a low-resistance fault-current path exists from all metallic parts to ground**

A continuity test on EGCs confirms that a low-impedance path exists for fault current to travel to ground, allowing overcurrent protection to operate quickly and safely in the event of a ground fault.

**26. D — 252 W**

$\Delta T = 65 - 25 = 40^\circ\text{C}$ . Derating =  $40 \times 0.40\% = 16\%$ .  $P = 300 \times (1 - 0.16) = 300 \times 0.84 = 252\text{ W}$ . High cell temperatures reduce output significantly because increased thermal energy disrupts electron mobility.

**27. D — Applied as a derate factor reducing the estimated annual energy output by 15%**

Shading losses directly reduce the energy that reaches and is converted by modules. A 15% shading derate multiplied through the production model yields the realistic annual output.

**28. D — Adding a pentavalent element such as phosphorus**

Pentavalent dopants like phosphorus contribute an extra (free) electron, creating excess negative charge carriers. This n-type material is one side of the p-n junction in a solar cell.

**29. D — The tilt and azimuth transposition model**

GHI measures irradiance on a horizontal surface. A transposition model (such as Perez or isotropic) converts GHI to POA irradiance by accounting for the direct, diffuse, and ground-reflected components hitting the tilted and oriented array surface. Temperature coefficients and inverter efficiency are applied afterward.

**30. D — 12.5 A**

NEC 690.8(A) requires 125% of  $I_{sc}$ :  $10\text{ A} \times 1.25 = 12.5\text{ A}$ . The conductor must have a minimum ampacity of 12.5 A before any derating for temperature or conduit fill.



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