

**Question 1: A mobile robot uses wheel encoders and a gyroscope for navigation. After moving 10 m forward and turning 90°, the robot's odometry shows 10.6 m. Which is the most likely cause?**

- a) Perfect sensor fusion — no issue
- b) Wheel slip or encoder miscalibration causing distance error
- c) Gyroscope battery is low (only affects angle)
- d) The floor temperature changed

**Question 2: In a design brief, which element is most important to state clearly before prototyping?**

- a) Colour of the prototype
- b) Measurable success criteria and constraints (size, cost, function)
- c) The designer's favourite materials
- d) Number of meetings to schedule

**Question 3: A circuit contains a resistor and an LED in series with a 9 V battery. The LED does not light. Which troubleshooting step is best first?**

- a) Replace the resistor with a short circuit immediately
- b) Check LED polarity and battery voltage with a multimeter
- c) Increase battery voltage to 20 V without checking LED rating
- d) Replace LED with a random component

**Question 4: Which programming construct best fits “repeat until condition is true”?**

- a) for-loop with fixed iterations only
- b) while-loop or do-while loop (loop with condition check)
- c) if-else block only
- d) switch-case

**Question 5: In experimental design, what is the purpose of a control group?**

- a) To receive double the treatment as test group
- b) To provide a baseline to compare effects of the independent variable
- c) To confuse participants intentionally
- d) To ensure every subject gets identical treatment as test group

**Question 6: Which material property is most important when designing a load-bearing beam for a prototype?**

- a) Electrical conductivity
- b) Tensile strength and stiffness (Young's modulus)
- c) Colour fastness
- d) Magnetic permeability

**Question 7: Which technology most directly supports precision agriculture (monitoring soil moisture and optimizing irrigation)?**

- a) Virtual reality headsets
- b) IoT sensors with data analytics for soil moisture and automated valves
- c) Analog radios for farmers
- d) Paper logbooks only

**Question 8: A student writes this Python-looking pseudocode to sort two numbers:**

```
if a > b:
    swap a and b
print a, b
```

**What is the intended outcome and why might it fail when expanded to sorting three numbers?**

- a) It prints numbers but swapping is illegal in pseudocode
- b) It sorts two numbers ascending; it fails for three because pairwise swap must be extended (additional comparisons needed)
- c) It will sort any number of elements automatically
- d) Swap always reverses order permanently

**Question 9: A DC motor's speed controller uses PWM (pulse-width modulation). Increasing the duty cycle will:**

- a) Increase average voltage delivered to motor and generally increase speed
- b) Decrease motor torque only
- c) Convert DC to AC automatically
- d) Make motor change direction

**Question 10: Which statement correctly describes hypothesis in a scientific study?**

- a) A proven fact that needs no testing
- b) A testable prediction that can be supported or refuted by data
- c) The final conclusion of the experiment
- d) A list of materials for the experiment

**Question 11: Which innovation most directly reduces embodied carbon in buildings?**

- a) Using imported heavy concrete with high cement content
- b) Designing for reuse and using low-carbon materials like cross-laminated timber and recycled steel
- c) Adding more air-conditioning units per room
- d) Using more single-use plastics in construction

**Question 12: Which circuit element stores energy in a magnetic field?**

- a) Capacitor
- b) Resistor
- c) Inductor (coil)
- d) Diode

**Question 13: In a block diagram of a feedback control system, which block measures the output and sends information back to the controller?**

- a) Actuator
- b) Sensor (feedback element)
- c) Power supply
- d) Load only

**Question 14: A prototype solar-powered water pump works during tests but fails in the field at noon. Which is the most useful data to collect next?**

- a) Operator's lunch menu
- b) Measured solar panel voltage/current and ambient temperature during failure
- c) Prototype designer's favourite colour
- d) Brand of bolts used

**Question 15: Which is an example of an open-source tool commonly used for collaborative engineering design?**

- a) Proprietary CAD only available offline
- b) Free CAD (open-source CAD software)
- c) A private paper notebook
- d) A single laptop with no sharing

**Question 16: In digital logic, what is the output of an AND gate when inputs are 1 and 0?**

- a) 1
- b) 0
- c) Depends on gate voltage only
- d) Cannot determine

**Question 17: Which metric describes how often a hypothesis test would reject a true null hypothesis (Type I error)?**

- a) Power ( $1 - \beta$ )
- b) Significance level ( $\alpha$ )
- c) Confidence interval width
- d) Test statistic only

**Question 18: Which sensor is most appropriate for detecting obstacles regardless of colour or light:**

- a) Light sensor (photocell)
- b) Ultrasonic sensor (uses reflected sound)
- c) Colour sensor
- d) Thermistor

**Question 19: A flowchart diamond symbol typically represents:**

- a) Input/output step
- b) Decision/branch point (yes/no)
- c) Start/Stop
- d) Process step

**Question 20: Which one is a renewable energy storage solution suitable for grid-scale seasonal storage?**

- a) Pumped hydro storage (using reservoirs at different elevations)
- b) Single-use alkaline batteries only
- c) Burning coal and storing heat in landfill
- d) Disposing surplus electricity

**Question 21: A student working on human-subject research collects identifying data without consent. What must the student do?**

- a) Continue and publish — results are first priority
- b) Immediately stop, inform supervisor, anonymize data where possible, and seek ethical review/consent remedy
- c) Delete the project entirely without informing anyone
- d) Sell the data

**Question 22: Which programming paradigm focuses on objects that contain data and methods?**

- a) Functional programming
- b) Object-oriented programming (OOP)
- c) Procedural programming only
- d) Declarative programming only

**Question 23: In PCB design, why is it important to include ground planes?**

- a) To make the board heavier
- b) To provide low impedance return paths, reduce noise, and improve heat dissipation
- c) To hide copper from view
- d) To prevent mounting screws

**Question 24: Which approach helps reduce electromagnetic interference (EMI) in sensitive circuits?**

- a) Use very long unshielded wires for signals
- b) Use twisted pair wiring, shielding, and proper grounding
- c) Place noisy and sensitive circuits together without separation
- d) Multiply switching frequency without filtering

**Question 25: Which term describes a device that converts digital signals to analog signals (useful in robotics for motors)?**

- a) ADC (analog-to-digital converter)
- b) DAC (digital-to-analog converter)
- c) MCU (microcontroller)
- d) FPGA

**Question 26: In a well-designed experiment, randomization of subjects to groups primarily reduces:**

- a) Random measurement error only
- b) Systematic bias by evenly distributing confounding variables across groups
- c) Cost of experiment
- d) Need for data collection

**Question 27: A line-following robot overshoots corners due to too much integral action in controller. Which tuning change would help reduce overshoot?**

- a) Increase integral gain further
- b) Reduce integral gain or increase derivative action to add damping
- c) Remove proportional control entirely
- d) Increase battery voltage

**Question 28: Which fabrication technique is best when detailed plastic prototype parts with internal cavities are required?**

- a) Laser cutting only
- b) Fused deposition 3D printing (FDM) or stereolithography (SLA) depending on resolution — 3D printing allows complex internal features
- c) Hand carving from solid wood only
- d) Using only sheet metal bending

**Question 29: Which gas is a major contributor to urban photochemical smog?**

- a) Methane only
- b) Nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds reacting in sunlight to form ozone
- c) Argon
- d) Water vapour only

**Question 30: Which algorithmic problem is best solved with breadth-first search (BFS)?**

- a) Finding the shortest path in an unweighted graph
- b) Multiplying matrices fastest
- c) Solving linear equations only
- d) Sorting numbers

**Question 31: Which of the following is a measurement of electrical power?**

- a) Ohm
- b) Watt (Volts × Amps)
- c) Ampere
- d) Farad

**Question 32: When testing a hypothesis, increasing sample size generally:**

- a) Decreases statistical power always
- b) Increases power to detect small effects (if they exist) and narrows confidence intervals
- c) Has no effect on p-values or variance
- d) Always makes effect sizes larger

**Question 33: A company wants to make a low-cost water filter for remote villages. Which design choice best balances cost and effectiveness?**

- a) Use high-grade industrial membranes regardless of cost
- b) Use locally available ceramic filters with silver coating and a rapid test kit to monitor performance
- c) Make a complex multi-stage system requiring specialized maintenance only available in cities
- d) Ship bottled water to each village indefinitely

**Question 34: Which principle explains why high-voltage transmission reduces power loss?**

- a) Higher voltage reduces current for same power, and resistive losses drop strongly with lower current
- b) Higher voltage increases current and losses
- c) Voltage changes have no effect on losses
- d) Only frequency affects losses

**Question 35: Which engineering drawing shows cross-sectional internal features?**

- a) Elevation view only
- b) Sectional view (cut-away)
- c) Isometric pictorial only
- d) Title block

**Question 36: What is the main environmental benefit of green roofs on buildings?**

- a) Increase building weight for stability
- b) Reduce urban heat island effect, absorb rainwater, and provide insulation
- c) Attract insects only
- d) Make roofs slippery

**Question 37: In robotics, PWM frequency selection is important because:**

- a) Higher frequency always increases torque without any trade-offs
- b) It affects motor heating, audible noise, and control resolution; choose frequency that balances switching losses and motor response
- c) Frequency is irrelevant — only duty cycle matters
- d) PWM is only for LEDs

**Question 38: Which software tool is typically used to write, compile, and upload code to microcontrollers like Arduino?**

- a) Word processor
- b) Arduino IDE or similar embedded development environment
- c) Spreadsheet software
- d) Image editor

**Question 39: Which statement about lead-acid v/s lithium-ion batteries is true for portable robotics?**

- a) Lead-acid has higher energy density than lithium-ion
- b) Lithium-ion offers higher energy density and lighter weight, but requires careful charging management
- c) Both are identical in safety characteristics
- d) Lead-acid is lighter and safer always

**Question 40: A plant growth experiment tests fertilizer A v/s B. Sunlight varies across benches. What should the experimenter do?**

- a) Randomly assign pots from each treatment across benches or rotate pots regularly to control light as a confounding variable
- b) Place all A on sunny bench and B on shady bench to emphasize difference
- c) Ignore light variation and proceed
- d) Move plants only at night

**Question 41: Which sensor measures temperature by change in electrical resistance of a material?**

- a) Light sensor
- b) Thermistor (resistance changes with temperature)
- c) Ultrasonic sensor
- d) GPS

**Question 42: What does the term “iterative design” mean?**

- a) Single attempt then final product
- b) Repeated cycles of prototyping, testing, analysing, and refining a design
- c) Random changes with no testing
- d) Avoiding feedback

**Question 43: Which renewable energy technology produces electricity using ocean tides?**

- a) Tidal turbines (kinetic energy from tides)
- b) Rooftop solar panels
- c) Onshore wind turbines only
- d) Coal gasification

**Question 44: Which safety precaution is most important when soldering PCBs?**

- a) Solder with no ventilation to save time
- b) Use fume extraction, wear eye protection, and avoid skin contact with molten solder
- c) Touch the hot tip regularly to transfer heat quickly
- d) Solder near flammable liquids

**Question 45: Which type of diagram best illustrates the step-by-step logic of an algorithm including decisions and loops?**

- a) Pie chart
- b) Flowchart
- c) Bar graph
- d) Gantt chart

**Question 46: When designing an experiment, which is an advantage of blinding (participants or assessors unaware of group assignment)?**

- a) It increases observer bias
- b) It reduces placebo effects and measurement bias, improving credibility of results
- c) It hides data from researchers permanently
- d) It automatically increases sample size

**Question 47: In electric circuits, Kirchhoff’s Voltage Law (KVL) states that:**

- a) Sum of currents at a junction equals zero
- b) Sum of voltage drops around a closed loop equals the supplied EMF (zero net change)
- c) Voltage always increases in a loop
- d) Resistance is constant always

**Question 48: A city wants to reduce storm, water flooding and improve water quality. Which combined solution is most effective?**

- a) Increase impervious surfaces and remove vegetation
- b) Implement green infrastructure: bioswales, permeable pavements, rain gardens and retention basins
- c) Build only taller buildings with no drainage
- d) Channel all water into sewers without treatment

**Question 49: Which prototyping method is quickest to test the user flow of a handheld device (form and ergonomics)?**

- a) CNC machining of final metal parts only
- b) Foam-core or 3D-printed shell mock-up to test size, grip, and button placement
- c) Full production tooling immediately
- d) No mock-up — wait for final product

**Question 50: Which law relates electric current flowing through a conductor to voltage and resistance?**

- a) Newton's law
- b) Ohm's Law ( $V = IR$ )
- c) Hooke's Law
- d) Boyle's Law

**Question 51: In experimental reporting, which element increases reproducibility most?**

- a) Detailed methods and exact parameters (materials, timings, instrument settings)
- b) Hiding the exact steps to prevent copying
- c) Only reporting conclusions without data
- d) Using informal descriptions like “a while later”

**Question 52: Which energy concept does “capacity factor” describe?**

- a) The fraction of actual energy produced over a period divided by the energy if unit operated at full nameplate capacity continuously
- b) The volume of a battery only
- c) The speed of wind turbines only
- d) The physical size of a solar panel

**Question 53: Which component protects circuits from reverse polarity and only allows current to flow one way?**

- a) Resistor
- b) Diode (e.g., rectifier or protection diode)
- c) Capacitor
- d) Transformer

**Question 54: A start-up proposes using algae bioreactors to capture CO<sub>2</sub> and produce biofuel. Which evaluation question is most important before pilot deployment?**

- a) Is the company's logo attractive?
- b) What is the lifecycle CO<sub>2</sub> balance and land/water/resource requirements compared to alternatives?
- c) How many investors liked the idea instantly?
- d) Can it be done with no capital?

**Question 55: Which measurement unit quantifies electric charge?**

- a) Volt
- b) Coulomb
- c) Watt
- d) Ohm

**Question 56: In prototyping, “DFM” stands for:**

- a) Design for Manufacture — designing parts so they are easy and cost-effective to produce
- b) Design for Marketing
- c) Data for Models
- d) Design for Magic

**Question 57: Which is an example of biomimicry in engineering?**

- a) Designing faster cars randomly
- b) Velcro inspired by burrs that stick to fabric
- c) Using only metals for everything
- d) Painting structures green

**Question 58: In a resistive divider with  $R_1 = R_2$ , the midpoint voltage equals:**

- a) The full supply voltage
- b) Half supply voltage
- c) Zero always
- d) Twice the supply voltage

**Question 59: Which environmental engineering practice reduces nutrient runoff from farms into rivers?**

- a) Installing riparian buffer strips, cover crops, and controlled fertilizer application timing
- b) Applying fertilizers heavily right before rain storms
- c) Removing wetlands nearby
- d) Channelizing rivers without vegetation

**Question 60: A student designs an experiment to compare LED brightness using different currents. Which safety/ethical consideration must be included?**

- a) Ensure currents are within LED and wiring ratings to prevent overheating, include protective eyewear for bright light tests, and document disposal of components
- b) Ignore wiring ratings — more current is better
- c) Use unknown batteries without testing
- d) Publish photos of experiments without consent only