Unit 5 · Computers in the World

ANSWER KEY · FOR TEACHERS

Full marks 32

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. sensor
2. actuator
3. resolution
4. Internet of Things
5. latency
6. single point of failure
7. redundancy
8. trilateration

Each carries 0.5 mark. **K · 4**

2 Label the diagram

1. Sensors soil moisture, temperature
2. The device a small computer, a radio, a battery
3. Water pump switched on and off
4. The cloud stores the readings, charts, sends alerts

Each carries 0.5 mark. **U · 2**

3 Multiple choice

i. **c.** the motor that opens a gate **K · 1**

An actuator is an output that acts on the world, such as a motor, a pump or a siren. The other three are sensors (inputs): they measure.

ii. **b.** If the network or the server fails, the pump can't be switched on or off. **U · 1**

A decision made far away needs every link between: the device's radio, the network, the server. If any of them fails, nothing happens. A device that decides for itself keeps working, and sends its data to the cloud when it can.

iii. **c.** the building loses power for longer than its generator can run **A · 1**

The load balancer sends requests round any broken server, so losing one or even two servers is covered. But all three share the building: when the building loses power, every copy goes down at once. The building is the single point of failure.

iv. **b.** The phone's clock isn't accurate enough, so the clock's error is a fourth unknown, besides the three for the position. **U · 1**

Three distances would be enough with a perfect clock. A phone's clock is far from perfect, and since its error makes every distance wrong by the same amount, one more satellite lets the receiver work out that error as well. The phone never sends anything to the satellites.

v. **b.** signing out of her Google account (or Apple ID) before the reset **A · 1**

A phone reset while still signed in to its account stays locked to that account (to stop thieves from using stolen phones), so the buyer can't set it up. She should also take out her SIM and memory card, and sign out of her wallet and bank apps.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

4 Work it out

a. ANSWER A · 4

i. 50 °C ÷ 1024 steps ≈ **0.05 °C** (0.049 °C).
ii. 300,000 km/s × 0.0675 s = **20,250 km.**
iii. 2 × 2,900 km ÷ 200,000 km/s = 0.029 s = **29 ms.**
iv. A year has 365 × 24 = 8,760 hours; 0.05% of them is 8,760 × 0.0005 = **4.38 hours** (about 4 hours 23 minutes).

MARKING SCHEME

✓ i: 50 ÷ 1024 ≈ 0.05 °C.
✓ ii: speed × time, 20,250 km.
✓ iii: there and back, twice the distance: 29 ms.
✓ iv: 0.05% of 8,760 hours, 4.38 hours.

b. MARKING SCHEME A · 3

✓ i: the whole building ÷ the computers, 1.5.
✓ ii: the whole building's 18 MW (not the computers' 12) × 8,760 hours, about 158 GWh.
✓ iii: about 7%.

5 What does it print?

a. ANSWER U · 3

```
OUTPUT
(500, 250)
(200, 100)
(1200, 400)
```

The last place is off the picture: its x, 1200, is more than the width, 1000, because its longitude, 85.52, is east of the map's right edge (85.50). The app must show another tile, or move the map.

MARKING SCHEME

✓ `(500, 250)`: halfway across and halfway down, the map's center.
✓ `(200, 100)`: y counts down from the top, so a point near the north edge has a small y.
✓ `(1200, 400)`, which is off the picture: the place is east of the map's right edge.

b. MARKING SCHEME A · 3

✓ `6 readings` and `Missing: [12]`: the hours 9 to 15 without the six that are there.
✓ `Dropped: [11] left: 5`: −127 is outside −20 to 60, so the 11:00 row goes.
✓ `Hottest: 36.1` and `Mean: 31.4`: the mean of the five good readings, 156.8 ÷ 5 (with −127 left in, the mean would have been 5.0).

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

6 Write a program

ANSWER A · 4

```
def summary(readings):
    """How many readings are good, their average, and how many are above 30."""
    good = []
    for t in readings:
        if t is not None and -20 <= t <= 60:
            good.append(t)
    hot = len([t for t in good if t > 30])
    return len(good), round(sum(good) / len(good), 1), hot

readings = [18.5, 23.1, None, -127.0, 31.0, 34.4, None, 33.0]
print(summary(readings))
```

OUTPUT

```
(5, 28.0, 3)
```

MARKING SCHEME

- ✓ A loop over the readings that skips `None` (checked first, since `None` can't be compared with a number).
- ✓ A range check keeps only readings from −20 to 60, so −127 is left out (checking for any impossible value, not only −127).
- ✓ The count and the average of the good readings only, rounded to one place.
- ✓ The good readings above 30 counted, and the three values returned (not only printed).

7 Short answer

MARKING SCHEME U · 2

- ✓ No: replication copies the deletion to the other copies too, within seconds, so the table is gone from all of them.
- ✓ It needs backups: copies from earlier times, kept apart, which a mistake made today doesn't touch.

8 Think

ANSWER HA · 2

For (any one): clean electricity instead of coal; jobs, skills and money for Nepal; Nepal's data kept inside the country; servers close to Nepali users, so lower latency; cool hills that save cooling.

Against (any one): a data center needs power all year, but in winter Nepal buys electricity, so it could compete with homes and factories; Nepal's internet reaches the world through cables across India and China, a single point of failure; earthquakes; few jobs once built; water for cooling.

Who might pay: households and industries, if winter electricity gets short or dearer; people near the site, if it takes their water or land.

MARKING SCHEME

- ✓ One sound argument for and one against.
- ✓ Who might pay, with a reason (homes and factories short of winter power, people near the site).

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

9 Activity: Copies of a service

(not marked)

WHAT STUDENTS SHOULD FIND

- 1 copy: about 14 days a year (each year differs).
- 2 or 3 copies in one building: about 4 days a year. The broken servers are covered, but on the days the building is down, every copy goes down with it.
- 2 copies in different cities: a day or none; 3: almost always none, even though some copy was down on 30 days or more.
- The building is a single point of failure: copies inside it all share its 1% chance of a bad day, so they fail together. Copies in different cities fail on different days.

Marks by level	Knowledge	Understanding	Application	Higher ability	**Total**
Marks	5	9	16	2	**32**

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking