Worksheet 04: Main Energy Levels, Sublevels and Orbital Capacity

Focus: 2n^2 rule, s p d f sublevels, orbital numbers, energy ordering | Suggested time: 50 minutes | Total: 40 marks

Student name	_____	Class	_____
Instructions	Answer all questions. Show working for calculations. Use the data booklet values where needed.	Calculator	Permitted where appropriate

Section A: Multiple choice

Choose the best answer for each question. Each question is worth 1 mark.

1. The maximum number of electrons in the n = 3 main energy level is:

A. 6	B. 8
C. 18	D. 32

2. How many orbitals are in a p sublevel?

A. 1	B. 3
C. 5	D. 7

3. Which sublevel does not exist?

A. 2p	B. 3d
C. 3f	D. 4f

4. The maximum number of electrons in a d sublevel is:

A. 2	B. 6
C. 10	D. 14

5. Which set lists sublevels in the usual filling order around potassium and calcium?

A. 3p, 3d, 4s	B. 3p, 4s, 3d
C. 4s, 3p, 3d	D. 3d, 4s, 4p

6. Degenerate orbitals are orbitals that:

A. contain no electrons	B. have the same energy
C. have no shape	D. are found only in metals

Section B: Short-answer questions

1. Use the 2n^2 rule to calculate the maximum number of electrons in n = 4. [2 marks]

Answer: _____

_____

_____

2. State the number of orbitals and maximum electrons in the 4f sublevel. [2 marks]

Answer: _____

_____

_____

3. Explain why the second main energy level can hold eight electrons. [3 marks]

Answer: _____

_____

_____

4. List 4s, 4p, 4d and 4f in order of increasing energy within the same main level. [2 marks]

Answer: _____

Section C: Data response / case study

The table is an incomplete summary of sublevels in the first four main energy levels.

Main level	Sublevels present	Total orbitals	Maximum electrons
n = 1	1s	1	2
n = 2	2s, 2p	?	8
n = 3	3s, 3p, 3d	9	?
n = 4	4s, 4p, 4d, 4f	?	32

1. Complete the missing total orbitals for n = 2 and n = 4. [2 marks]

2. Complete the missing maximum number of electrons for n = 3. [1 marks]

3. Explain the relationship between n and the number of sublevels in a main energy level. [2 marks]

4. A student claims that a 1p orbital exists because p orbitals are common in atoms. Explain why this claim is incorrect. [3 marks]

Section D: Extended response

Explain how the main energy level and sublevel model helps account for electron capacity and electron configurations. [8 marks]

Write a structured response. Use relevant scientific terminology and support your points with examples where possible.

Answer key and marking guidance

Award marks for scientifically correct alternative wording. Penalize only once for the same repeated error unless it causes a new error in reasoning.

Section A: Multiple choice

Q	Answer	Brief marking guidance
1	C	2n^2 = 2 x 3^2 = 18.
2	B	A p sublevel contains three p orbitals.
3	C	For n = 3, possible sublevels are 3s, 3p and 3d only.
4	C	Five d orbitals can hold two electrons each, so 10 electrons.
5	B	The 4s sublevel fills after 3p and before 3d.
6	B	Degenerate means equal in energy within the same sublevel.

Section B: Short-answer mark scheme

Q	Marks	Expected answer / marking points
1	2	Substitute n = 4 into 2n^2 (1); answer = 32 electrons (1).
2	2	Seven orbitals (1); maximum 14 electrons (1).
3	3	n = 2 contains 2s and 2p sublevels (1); 2s holds 2 electrons and 2p holds 6 (1); total = 8 (1).
4	2	4s < 4p < 4d < 4f (2); award 1 for mostly correct order with one adjacent error.

Section C: Data response / case study mark scheme

Q	Marks	Expected answer / marking points
1	2	n = 2 has 4 orbitals (1); n = 4 has 16 orbitals (1).
2	1	18 electrons (1).
3	2	The nth main level contains n sublevels (1); example such as n = 4 has four sublevels 4s, 4p, 4d, 4f (1).
4	3	n = 1 has only one sublevel (1); that sublevel is 1s (1); p sublevels begin at n = 2 (1).

Section D: Extended response mark scheme

Award up to 8 marks: main levels are labelled by n (1); nth level contains n sublevels (1); sublevels consist of fixed numbers of orbitals: s 1, p 3, d 5, f 7 (1); each orbital holds two electrons of opposite spin (1); gives capacities s2, p6, d10, f14 (1); total maximum electrons per level follows 2n^2 (1); Aufbau order fills lower energy orbitals first (1); the model helps explain periodic patterns/blocks or examples of configurations (1).