

# Invertebrates

## (LA 6)



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## A Learning Arrangement: Invertebrates (Theme Box: Equations and Functions – LA 6/LA)

Ben and Mira are in the woods with their class. They are looking at invertebrates for science. Because of their size, these creatures are easiest to look at with a cup magnifier.

They find dung beetles and garden spiders.

Dung beetles are found on the ground.

Garden spiders spin their webs in low shrubs just above the ground.



1. How many legs do multiple beetles or spiders have?  
Calculate the number of legs of one to twenty invertebrates and make a table to organize your information.



2. Each pupil observes one square meter of the forest floor.

My 18  
invertebrates have  
a total of 120 legs!



How many beetles and spiders are in Ben's area? Present your ideas in writing!



3. A common trait of all centipedes is that they have an odd number of pairs of legs. Centipedes can have between 15 and 177 pairs of legs depending on the species with the average being 35 pairs.



Consider this: Can a centipede have 100 legs? Justify your answer!



4. Mira finds different species of millipedes.  
Upon closer observation, she discovers that they either have 8 or 12 pairs of legs.

All my millipedes  
together have a total  
of 384 legs!



There is a species of  
millipede with more  
than 650 pairs of legs,  
but most millipedes  
have far fewer, for  
example 12, 23 or 49.

How many of each species could she have found?  
Figure out at least one possible solution.

## 1 The Idea

This learning arrangement provides pupils the opportunity to explore functional contexts with the help of proportional relationships: If I change the number of animals, the number of legs changes, too.<sup>1</sup> Both quantities are proportionally related.

The topic of invertebrates from science instruction has been integrated into this learning arrangement to investigate one of their traits, specifically the number of legs.

More than 90% of all living animal species lack a backbone. Included in this category are sea stars, earthworms, sponges, jellyfish, crabs, snails, insects and spiders.<sup>2</sup>

This learning arrangement focuses on dung beetles, garden spiders, centipedes and millipedes. Dung beetles can fly, but also have six legs for walking on the ground.<sup>3</sup>

Garden spiders can be found in sunny areas with plants on which they can anchor their webs.<sup>4</sup> Here the eight-legged creatures wait for their prey. Centipede and millipedes belong to the arthropods.

The number of pairs of legs in centipedes is always an odd number.<sup>5</sup> During embryonic development, two pairs of legs develop from a body segment, i.e. four individual legs. However, the first pair of legs is transformed into a poison claw, so that the first segment has only one pair of legs. All other leg segments each have two pairs of legs.

The nickname „thousand-leggers“ for millipedes and the fact that the name centipede literally means 100 legs is quite misleading. Normally neither creature has near this number of legs, but recently a „true“ millipede species was discovered in Australia with 1306 legs.<sup>6</sup>

In Task 1, the math strategy of organizing information in a logical format by making a table is the focus. Pupils practice functional thinking as they analyse how the change in one variable (the number of animals) affects a dependent variable (number of legs).<sup>7</sup>

In order to solve Task 2, pupils have to set up a complex equation. Through skilful adding of the numbers from the table in Task 1, the pupils are able to come close to an answer. The solution becomes clear by specifying the number of animals.<sup>8</sup>

The third task requires careful reading and the exact application of information. Pupils are required to support their answers. This is one way in which the learning arrangement promotes the development of language skills.

The fourth task can be solved using trained heuristic strategies and tools. The pupils make a table but have to read precisely in order to be able to exclude some of the answers. This task does not have a clear solution.<sup>9</sup>

This learning arrangement teaches and supports the main concepts of [L1] *Numbers and Operations* and [L4] *Equations and Functions*.

<sup>1</sup> Karpinski-Siebold, Nadja, Fritzlar, Torsten: Sechs Augen und acht Beine. In: Praxis Grundschule (2015) 2, S. 16

<sup>2</sup> [www.britannica.com/animal/invertebrate](https://www.britannica.com/animal/invertebrate) [08.06.2024, 21:30 Uhr]

<sup>3</sup> [www.natgeokids.com/uk/discover/animals/insects/dung-beetle-facts](https://www.natgeokids.com/uk/discover/animals/insects/dung-beetle-facts) [08.06.2024, 21:30 Uhr]

<sup>4</sup> [www.wildlifetrusts.org/wildlife-explorer/invertebrates/spiders/garden-spider](https://www.wildlifetrusts.org/wildlife-explorer/invertebrates/spiders/garden-spider) [08.06.2024, 21:30 Uhr]

<sup>5</sup> [www.australian.museum/learn/animals/centipedes](https://www.australian.museum/learn/animals/centipedes) [08.06.2024, 21:30 Uhr]

<sup>6</sup> [www.nature.com/articles/s41598-021-02447-0](https://www.nature.com/articles/s41598-021-02447-0) [08.06.2024, 21:30 Uhr]

<sup>7</sup> Karpinski-Siebold, Nadja, Fritzlar, Torsten: (2015) 2, S.16 ff., M2

<sup>8</sup> Karpinski-Siebold, Nadja, Fritzlar, Torsten: (2015) 2, M4

<sup>9</sup> Karpinski-Siebold, Nadja, Fritzlar, Torsten: (2015) 2, M4

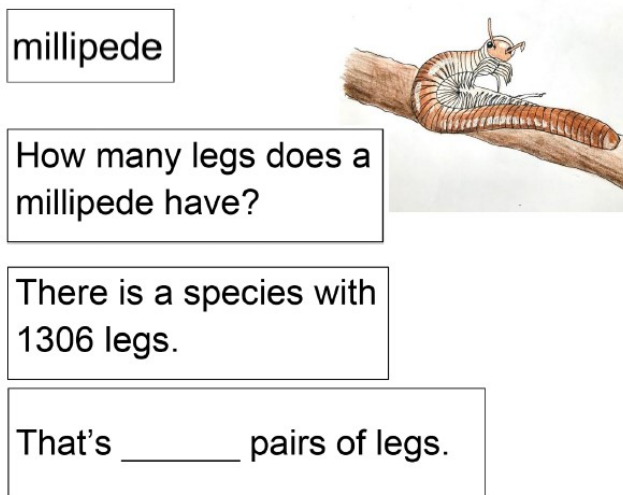
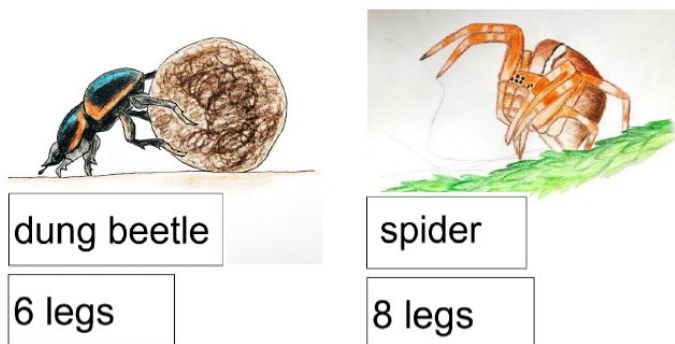
**Class 5/6**

## 2 Didactics and Teaching Methods (practical tips for teachers)

**Duration:** 2-3 lessons (45 minutes each)

### Introduction:

The pupils look at the drawings of a dung beetle, a garden spider and a centipede. The vocabulary cards ([M2](#)) are added to the presentation on the board (see below). During a class discussion, the pupils are asked to share what they already know about invertebrates. It is important to call attention to the number of legs as this information is required to solve the tasks. Use the millipede as an example to highlight the difference between number of legs and pairs of legs.



### Nr 1.:

The pupils make a table and put in the data related to the number of invertebrates and the number of legs. Experience has shown that pupils have difficulties making a table.<sup>10</sup> There are tip cards

<sup>10</sup> vgl. Hoffmann, Antje: „Ein Huhn und ein Schwein haben zusammen sechs Beine“ Viertklässler entwickeln, nutzen und wählen Darstellungen aus für die Bearbeitung eines mathematischen Problems. In: Grundschulunterricht Mathematik (2011) 2, S. 11-14

(M1) provided should they be necessary. Pupils who are struggling the most can use the fourth tip card (M1) and fill in the table. Pupils can check to see if they have filled in their table correctly by comparing it to the answer key (AK). Alternatively, the tables can be compared at the beginning of the following phase of partner work.

**Nr 2.:**

In primary school, functional relationships are described in a variety of ways: verbally as a description, numerically as tables, visually as diagrams or graphs and purely as digits and terms.<sup>11</sup>

The pupils work in pairs and use their tables from Task 1 to search for possible solutions.

The solution (AK) can be reached using various methods:

- find „married pairs“ (numbers that add up to 10)
- adding to
- crossing out numbers that cannot work
- working systematically
- breaking down 18
- breaking down 120
- other heuristic strategies

The tip cards (M1) can be used if necessary. In order to support the formation of a hypothesis, the worksheet (WS 1) with vocabulary and phrases can be used. As a wrap up to this activity, the pupils share their methods of finding a solution during a class discussion. Questions such as „How did you start?“, „What did you decide next?“, „Which way was the best way to solve this problem?“ can be helpful in directing the discussion.

**Nr 3.:**

This task is to be completed independently. The pupils read a statement. There are two factors that complicate comprehension: first, we are now talking about pairs of legs and secondly, the pupils must be familiar with the term „odd number“. A simple yes or no is not enough to answer this question (AK). The pupils also have to justify their answer. There are also tip cards (M1) provided for this task as well as a worksheet (WS 2) with vocabulary and phrases that can be helpful in formulating an answer. The pupil's reasoning should be presented at the conclusion of the activity.

**Nr 4.:**

Working with a partner, the pupils can solve this task with the help of table by systematically trying out different combinations or solving numerically with equations. Pupils can choose whether to calculate with the number of individual legs or the number of pairs of legs. If they use the pairs of legs, then the numbers are not as big. Due to the fact that the number of invertebrates is not specified, this task does not have a clear solution. There are seven possible solutions (AK), each requiring at least one millipede. If necessary, the tip cards (M1) can be used. At the end of the lesson, the pupils present their answers and describe how they came to these conclusions.

<sup>11</sup> Leuders, Timo, Prediger, Susanne: Funktioniert's?- Denken in Funktionen. In: PM (2005) 2, S. 4

### 3 References to the Berlin State Curriculum

#### 3.1 Process oriented mathematical standards of this learning arrangement<sup>12</sup>

Process oriented mathematical competencies	The pupils can
<b>argue mathematically</b>	<ul style="list-style-type: none"> <li>ask questions that are typical for mathematics (Are there...? How does it change...? Is this always true...?)</li> <li>recognize correlations and structures and pose hypotheses to mathematical situations</li> <li>question mathematical statements and check their correctness</li> </ul>
<b>solve problems mathematically</b>	<ul style="list-style-type: none"> <li>tackle problems for which they have not yet learned a formal solution routine (use alternate strategies to help themselves)</li> <li>develop and use solution strategies (for example from guessing to systematical trial and error)</li> <li>use heuristic aids to solve problems</li> </ul>
<b>model mathematically</b>	<ul style="list-style-type: none"> <li>translate real world situations/problems into the language of mathematics and solve them using mathematical reasoning and operations</li> </ul>
<b>use mathematical representations</b>	<ul style="list-style-type: none"> <li>choose, use and develop appropriate representations for working mathematically on real world situations and problems</li> </ul>
<b>use symbols, formal and technical elements</b>	<ul style="list-style-type: none"> <li>use tables, terms, equations and diagrams to describe facts and situations</li> </ul>
<b>communicate mathematically</b>	<ul style="list-style-type: none"> <li>describe their approach, understand the approaches of others and reflect on common approaches</li> <li>work on tasks in a group</li> </ul>

#### 3.2 Content-related mathematical competencies of this learning arrangement<sup>13</sup>

Theme	Competency	Level
<b>Numbers and Operations</b>	The pupils can <ul style="list-style-type: none"> <li>use strategies, methods and rules of calculations and the laws of the basic operations</li> </ul>	C/D
<b>Equations and Functions</b>	<ul style="list-style-type: none"> <li>solve simple equations</li> <li>represent mapping and patterns in various ways</li> </ul>	C/D
<b>Data and Probability</b>	<ul style="list-style-type: none"> <li>systematically present solutions to combination questions</li> </ul>	C

<sup>12</sup> vgl. Rahmenlehrplan Jahrgangsstufen 1-10, Teil C Mathematik, S. 19-21, Berlin, Potsdam 2015

<sup>13</sup> vgl. Rahmenlehrplan Jahrgangsstufen 1-10, Teil C Mathematik, S. 22-31, Berlin, Potsdam 2015

3.3 Themes and Content of this learning arrangement <sup>14</sup>

Theme	Content	Niveau
<b>Numbers and Operations</b>	The pupils <ul style="list-style-type: none"> <li>use situation-appropriate, learned calculating methods and strategies</li> <li>automatically solve the multiplication facts of the 1-10 times tables</li> </ul>	C
<b>Equations and Functions</b>	<ul style="list-style-type: none"> <li>guess, estimate, and check calculations</li> <li>use rules of arithmetic and geometric<sup>15</sup> patterns to find further elements</li> <li>represent mapping (using tables)</li> <li>represent real world situations using terms and equations (including those with several mathematical operations)</li> <li>describe a strategy for solving an equation</li> <li>independently check the correctness of an answer both mathematically and based on on factual content</li> </ul>	C
<b>Data and Probability</b>	<ul style="list-style-type: none"> <li>systematically work through possibilities and evaluate combination questions</li> </ul>	C

3.4 References to the general curriculum for language development <sup>16</sup>

<b>Standards of language development</b>	The pupils can
<b>Awareness/ Reading Comprehension</b>	<ul style="list-style-type: none"> <li>identify specific information in texts (facts, events, themes)</li> </ul>
<b>Production/ Speaking</b>	<ul style="list-style-type: none"> <li>express their own thoughts on a situation or text</li> <li>articulate and justify hypotheses</li> <li>present results of individual, partner and group work</li> </ul>
<b>Interaction</b>	<ul style="list-style-type: none"> <li>differentiate between speech acts such as assertion, declaration and criticism</li> </ul>

<sup>14</sup> vgl. Rahmenlehrplan Jahrgangsstufen 1-10, Teil C Mathematik, S. 31ff, Berlin, Potsdam 2015

<sup>15</sup> Die inhaltsbezogenen mathematischen Standards sind unverändert aus dem Rahmenlehrplan übernommen worden. Kompetenzen, die mit dieser Lernumgebung nicht gefördert werden, sind grau gedruckt.

<sup>16</sup> vgl. Rahmenlehrplan Jahrgangsstufen 1-10, Teil B Fachübergreifende Kompetenzentwicklung, S. 6-10, Berlin, Potsdam 2015

3.5 References to the general curriculum for media education <sup>17</sup>

<b>Standards of the media education</b>	The pupils can
<b>Presentation</b>	<ul style="list-style-type: none"> <li>design a subject and situation appropriate presentation of learning and work results</li> </ul>

3.6 Connections to other Subject Areas

<ul style="list-style-type: none"> <li>science</li> <li>German (language)</li> </ul>
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**4 Language Development**

4.1 Possible language difficulties in task directions

Task	Original Text	Alternatives
	Because of their size, these creatures are easiest to look at with a cup magnifier.	These small animals are easiest to look at with a cup magnifier.
1	Calculate the number of legs of one to twenty invertebrates and make a table to organize your information.	How many legs do the animals have? Make a table for one to twenty invertebrates.
3	A common trait of all centipedes is ...	All centipedes have ...
	pairs of legs	two legs
	Consider this:	Think about this:
4	She discovers...	She sees ...
	Upon closer observation....	She looks closely...

*Pupils must understand the following vocabulary:*

number, cup magnifier, legs, pairs of legs, observation, centipede, trait, millipede, write down, justify, observe, transfer, all together, species, invertebrates, depending on, consider

<sup>17</sup> vgl. Rahmenlehrplan Jahrgangsstufen 1-10, Teil B Fachübergreifende Kompetenzentwicklung, S. 15-22, Berlin, Potsdam 2015

## 4.2 Vocabulary List for Comprehension

*The teacher must be sure that the pupils understand the following mathematical vocabulary.*

Nouns	Verbs	Adjectives/Adverbs
number	Calculate	between
area	observe	odd
square meter (m <sup>2</sup> )		together
table		either...or
column		
line		

## 4.3 Subject relevant vocabulary and theme specific phrases

During the course of this learning arrangement, the pupils will actively use the following vocabulary and phrases. These will be the foundation for establishing a relevant word list to use when presenting their results.

... beetles have ... legs.  
... spiders have ... legs.  
Together they have ... legs.  
One pair of legs has two legs, so...  
I think that...  
There are many possible solutions...

## 4.4 Language Support

For pupils with language deficits or difficulties, or simply pupils needing extra support to verbalise their thinking, [vocabulary aides](#) for tasks 2 and 3 are provided.

**5 Materials needed for this learning arrangement**

Phase / Task	Amount	Material	Preparation / Notes
entire learning arrangement	per pupil	Learning Arrangement ( <a href="#">LA</a> )	copy
	1 set	Vocabulary Cards for a Word Wall ( <a href="#">M2</a> )	print vocabulary cards, enlarging the pages, if desired, and cut out
Introduction			Vocabulary Development, <a href="#">Example presentation on the board</a>
Task 1	as needed	tip cards ( <a href="#">M1</a> )	copy, cut out
		answer key ( <a href="#">AK</a> )	print out if needed
Task 2	as needed	tip cards ( <a href="#">M1</a> )	copy, cut out
		answer key ( <a href="#">AK</a> )	print out if needed
	per pair	worksheet ( <a href="#">WS 1</a> )	Copy
Task 3	as needed	tip cards ( <a href="#">M1</a> )	copy, cut out
		answer key ( <a href="#">AK</a> )	print out if needed
	per pupil	worksheet ( <a href="#">WS 2</a> )	Copy
Task 4	as needed	tip cards ( <a href="#">M1</a> )	copy, cut out
		answer key ( <a href="#">AK</a> )	print out if needed

**Tip Cards Task 1**

**Tip 1 for Task 1:**



How many legs does one spider/ one beetle have?  
 How many legs do two spiders/ two beetles have?  
 ...  
 How many legs do nineteen spiders/ nineteen beetles have?  
 How many legs do twenty spiders/ twenty beetles have?

LA 6 / Task 1

**Tip 2 for Task 1:**



Write down the number of legs in a table.  
 Draw a table with a pencil and ruler. The table should have 3 columns and 21 lines.

LA 6 / Task 1

**Tip 3 for Task 1:**



Make a table:

Amount	Legs (beetle)	Legs (spider)
1	6	8
2	12	
3		
4		
...		

Calculate the number of legs of 1-20 invertebrates.

LA 6 / Task 1

**Tip 4 for Task 1:**



Fill in the table.

Amount	Legs (beetle)	Legs (spider)
1	6	8
2	12	
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

LA 6 / Task 1

### Tip Cards

#### Tip 1 for Task 2:



There are 18 invertebrates.

Start with whatever number of beetles you'd like. Find the number of legs they'd have in the table.

Now think about how many spiders you'd have to have.

How many legs do they have?

Does this add up to 120?

LA 6 / Task 2

#### Tip 2 for Task 2:



18 invertebrates:

\_\_\_ beetles and \_\_\_ spiders

\_\_\_ legs + \_\_\_ legs = \_\_\_ legs

LA 6 / Task 2

#### Tip 3 for Task 2:



18 invertebrates:

17 beetles and 1 spider

102 legs + 8 legs = 110 legs

16 beetles and 2 spiders

96 legs + 16 legs = 116 legs

15 beetles and 3 spiders

\_\_\_ legs + \_\_\_ legs = \_\_\_ legs

...

LA 6 / Task 2

#### Tip 1 for Task 3:



A pair is always two things that are the same or belong together.

LA 6 / Task 3

#### Tip 2 for Task 3:



A centipede has 49 pairs of legs.

How many legs is that?

LA 6 / That 3

**Tip 3 for Task 3:**



Double the number of pairs of legs to get the number of legs.

LA 6 / Task 3

**Tip 1 for Task 4:**



384 legs are \_\_\_\_\_ pairs of legs.

LA 6 / Task 4

**Tip 2 for Task 4:**



Try it out: What happens to your sum when you only change the number of one species of millipede?

LA 6 / Task 4

**Tip 3 for Task 4:**



Make a table and fill it in.

millipede (8 pairs of legs)	millipede (12 pairs of legs)	equation	sum
...			

LA 6 / Task 4

Vocabulary cards for the word wall

spider

dung beetle

millipede

6 legs

8 legs

Please enlarge by 141% to have a size appropriate for use on the board

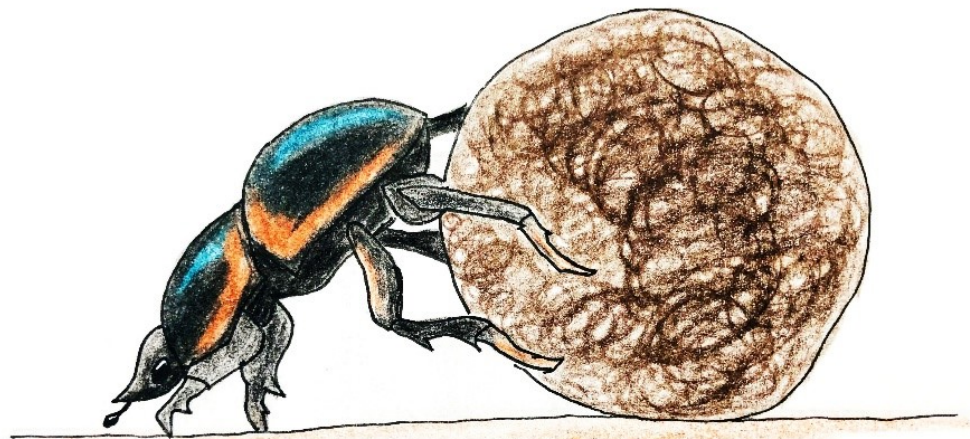
How many legs does a millipede have?

There is a species with 1306 legs.

That's \_\_\_\_\_ pairs of legs.



Please enlarge by 141% to have a size appropriate for use on the board.



Language Worksheet to aid in the presentation of a solution for **Task 2**

... beetles have ... legs.

... spiders have ... legs.

Together the beetles and spiders have ... legs.

We think that...

We have thought about ...



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**Task 1:**

Amount	Legs (beetles)	Legs (spiders)
1	6	8
2	12	16
3	18	24
4	24	32
5	30	40
6	36	48
7	42	56
8	48	64
9	54	72
10	60	80
11	66	88
12	72	96
13	78	104
14	84	112
15	90	120
16	96	128
17	102	136
18	108	144
19	114	152
20	120	160

**Task 2:**

12 beetles and 6 spiders were observed.  $72 \text{ legs} + 48 \text{ legs} = 120 \text{ legs}$

Amount	Legs (beetles)	Legs (spiders)
1	6	8
2	12	16
3	18	24
4	24	32
5	30	40
6	36	48
7	42	56
8	48	64
9	54	72
10	60	80
11	66	88
12	72	96
13	78	104
14	84	112
15	90	120

**Task 3:**

Centipedes have an odd number of pairs of legs, for example 49, 51, 53 and so on.

For 100 legs you need 50 pairs of legs. 50 is an even number.

A centipede can therefore not have 100 legs because it can only have an odd number of pairs of legs.

**Task 4:**

There are 7 possible solutions. Answers calculating with legs:

millipede (8 pairs of legs)	millipede (12 pairs of legs)	Equation	Sum
3	14	$8 \cdot 3 + 12 \cdot 14 = 24 + 168$	192
6	12	$8 \cdot 6 + 12 \cdot 12 = 48 + 144$	192
9	10	$8 \cdot 9 + 12 \cdot 10 = 72 + 120$	192
12	8	$8 \cdot 12 + 12 \cdot 8 = 96 + 96$	192
15	6	$8 \cdot 15 + 12 \cdot 6 = 120 + 72$	192
18	4	$8 \cdot 18 + 12 \cdot 4 = 144 + 48$	192
21	2	$8 \cdot 21 + 12 \cdot 2 = 158 + 24$	192

There are 7 possible solutions. Answers calculating with pairs of legs:

A millipede with 8 pairs of legs has 16 legs, because  $8 \text{ pairs} \cdot 2 = 16 \text{ legs}$ .

A millipede with 12 pairs of legs has 24 legs, because  $12 \text{ pairs} \cdot 2 = 24 \text{ legs}$ .

millipede (8 pairs of legs)	millipede (12 pairs of legs)	Equation	feet
3	14	$16 \cdot 3 + 24 \cdot 14 = 48 + 336$	384
6	12	$16 \cdot 6 + 24 \cdot 12 = 96 + 288$	384
9	10	$16 \cdot 9 + 24 \cdot 10 = 144 + 240$	384
12	8	$16 \cdot 12 + 24 \cdot 8 = 192 + 192$	384
15	6	$16 \cdot 15 + 24 \cdot 6 = 240 + 144$	384
18	4	$16 \cdot 18 + 24 \cdot 4 = 288 + 96$	384
21	2	$16 \cdot 21 + 24 \cdot 2 = 336 + 48$	384

## Sources

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- Hoffmann, Antje: „Ein Huhn und ein Schwein haben zusammen sechs Beine“ Viertklässler entwickeln, nutzen und wählen Darstellungen aus für die Bearbeitung eines mathematischen Problems. In: Grundschulunterricht Mathematik (2011) 2, S. 11-14
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- <http://www.biologie-schule.de/mistkaefer-steckbrief.php> [07.07.2020, 11:30 Uhr]
- <http://www.biologie-schule.de/kreuzspinne-steckbrief.php> [07.07.2020, 11:30 Uhr]
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- <http://www.tierchenwelt.de/tierarten/wirbellose.html> [09.01.2020, 11:30 Uhr]

## Further Reading

- Steinweg, Anna Susanne (2013): Algebra in der Grundschule. Berlin, Heidelberg: Springer

**Picture/Illustration Sources**

Page	Picture/Illustration	Source (title/copyright holder/license/link to license/place of origin)
2	symbols for individual, partner and group work	Symbole Einzel-, Partner- und Gruppenarbeit, Solveg Schlinske, <a href="#">CC BY SA 4.0</a> , LU Sehenswürdigkeiten
12-15	light bulb	Glühlampe, Laura Jahn, <a href="#">CC BY SA 4.0</a> , LU Kernaufgaben
2, 19	drawing: centipede	Zeichnung Hundertfüßer, Belinda Anderschitz, <a href="#">CC BY SA 4.0</a> , LU Wirbellose
2	drawing: boy	Zeichnung Junge, Laura Jahn, <a href="#">CC BY SA 4.0</a> , LU Würfel kippen
2, 4, 16, 18	drawing: garden spider	Zeichnung Kreuzspinne, Belinda Anderschitz, <a href="#">CC BY SA 4.0</a> , LU Wirbellose
2	drawing: girl	Zeichnung Mädchen, Laura Jahn, <a href="#">CC BY SA 4.0</a> , LU Würfel kippen
2, 4, 17, 18	drawing: dung beetle	Zeichnung Mistkäfer, Belinda Anderschitz, <a href="#">CC BY SA 4.0</a> , LU Wirbellose
1, 4, 1	drawing: millipede	Zeichnung Tausendfüßer, Belinda Anderschitz, <a href="#">CC BY SA 4.0</a> , LU Wirbellose