

Exponential Functions: practice solutions, Grade 11 – download the PDF

Written solutions to the chapter problems. Check each step, then correct yourself.

1 Evaluating an exponential function



$$f(0) = 4 \cdot 3^0 = 4 \cdot 1 = 4.$$

$$f(1) = 4 \cdot 3 = 12.$$

$$f(2) = 4 \cdot 9 = 36.$$

$$f(-1) = 4 \cdot 3^{-1} = \frac{4}{3}.$$

2 Growth or decay?



a. $b = 1.08 > 1$: growth of 8% per step.

b. $b = 0.9$, between 0 and 1: decay of 10% per step ($1 - 0.9 = 0.1$).

c. $b = 1.5 > 1$: growth of 50% per step.

d. $b = 0.25$: decay of 75% per step ($1 - 0.25 = 0.75$).

3 True or false?



- a. True: the variable is in the exponent and the base **5** is positive and not 1.
- b. False: the variable is the base, so this is a power function.
- c. False: $1^x = 1$ for every x , so it is a constant function; exponential bases must differ from 1.
- d. True: $y = 2 \cdot 3^0 = 2$.
- e. True: the base **0.5** is between 0 and 1, so the function decays.

4 Completing a table



The outputs are multiplied by $10 \div 5 = 2$ each step, so $b = 2$ and $f(3) = 20 \cdot 2 = 40$.

Since $f(0) = 5$, $a = 5$ and $f(x) = 5 \cdot 2^x$.

$$f(5) = 5 \cdot 2^5 = 5 \cdot 32 = 160.$$

5 A growing town



(a) Growth of 3% gives $b = 1.03$, so $P(t) = 12000(1.03)^t$.

(b) $P(2) = 12000 \cdot 1.03^2 = 12000 \cdot 1.0609 = 12730.8$. After 2 years the town has about 12,731 people.

6 Percent to factor



(a) $b = 1 + 0.06 = 1.06$.

(b) $b = 1 - 0.12 = 0.88$.

(c) $b = 1 + 0.025 = 1.025$.

(d) $b = 1 - 0.40 = 0.60$.

7 Reading a graph



- (a) The curve crosses the y-axis at **A**, so the y-intercept is **(0, 3)**.
- (b) Point **C** gives $h(2) = 12$.
- (c) The curve flattens toward the x-axis: $y = 0$.
- (d) Point **D** gives $h(3) = 24$, so $x = 3$.
- (e) The outputs double each step, so $h(x) = 3 \cdot 2^x$ is a growth function.

8 A phone that loses value



- (a) $b = 1 - 0.20 = 0.8$, so $V(t) = 900(0.8)^t$.
- (b) $V(3) = 900 \cdot 0.512 = 460.80$: about 460.80 dollars.
- (c) $V(4) = 900 \cdot 0.4096 = 368.64 < 400$, while $V(3) = 460.80 > 400$. The phone is worth less than 400 dollars after 4 years.

9 Equation from two points



- $f(0) = a = 3$.
- $f(2) = 3b^2 = 48$, so $b^2 = 16$. Since $b > 0$, $b = 4$.
- The formula is $f(x) = 3 \cdot 4^x$, and $f(3) = 3 \cdot 64 = 192$.

10 Monthly or yearly?



- (a) $A = 1500 \left(1 + \frac{0.05}{12}\right)^{36} \approx 1742.21$ dollars.
 - (b) $A = 1500(1.05)^3 = 1500 \cdot 1.157625 = 1736.4375 \approx 1736.44$ dollars.
- Monthly compounding earns $1742.21 - 1736.44 = 5.77$ dollars more.

11 Shifting left and down



- (a) Shift the graph of $y = 3^x$ 2 units left and 4 units down.
- (b) The asymptote moves from $y = 0$ to $y = -4$; the range is $y > -4$.
- (c) $g(0) = 3^2 - 4 = 5$ and $g(-2) = 3^0 - 4 = -3$.

12 A reflected exponential



- (a) Reflect $y = 2^x$ across the x-axis, then shift it up 5 units.
- (b) The asymptote is $y = 5$. The curve lies below it, so the range is $y < 5$.
- (c) $h(0) = -1 + 5 = 4$ and $h(3) = -8 + 5 = -3$.

13 Doubling every three hours



- (a) $N(9) = 400 \cdot 2^3 = 3200$ cells.
- (b) $N(12) = 400 \cdot 2^4 = 6400$ cells.
- (c) $N(1) = 400 \cdot 2^{1/3} \approx 400 \cdot 1.26 \approx 504$ cells.

14 Find the mistakes



- (a) Maya multiplied **2** and **3** before applying the exponent. By the order of operations, the exponent comes first: $2 \cdot 3^2 = 2 \cdot 9 = 18$.
- (b) Leo looked at $a = 0.4$, but growth or decay depends on the base $b = 2$. Since $b > 1$, the function is a growth function that starts at 0.4.

15 Which grows faster?

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Values: **A**: 200, 300, 450, 675, 1012.5, 1518.75, 2278.125. **B**: 500, 600, 720, 864, 1036.8, 1244.16, 1492.992.

At $x = 4$, $1012.5 < 1036.8$; at $x = 5$, $1518.75 > 1244.16$. So **A** first exceeds **B** at $x = 5$ years.

The base 1.5 is larger than 1.2, so **A** is multiplied by a bigger factor each year; a larger base always beats a larger starting value in the long run.

16 Half-life

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(a) $A(18) = 80 \cdot \left(\frac{1}{2}\right)^3 = 10$ grams.

(b) $A(9) = 80 \cdot 2^{-1.5} \approx 80 \cdot 0.35355 \approx 28.3$ grams.

(c) Halving repeatedly: 80, 40, 20, 10, 5, 2.5, which is 5 halvings, so $t = 5 \cdot 6 = 30$ days.

17 Three ways to compound

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(a) $8000(1.035)^{10} \approx 11284.79$ dollars.

(b) $8000\left(1 + \frac{0.035}{4}\right)^{40} \approx 11335.27$ dollars.

(c) $8000e^{0.35} \approx 11352.54$ dollars.

Difference: $11352.54 - 11284.79 = 67.75$ dollars.

18 Finding a transformed function

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The asymptote of $a \cdot 2^x + k$ is $y = k$, so $k = -3$.

$g(0) = a \cdot 1 - 3 = 5$, so $a = 8$ and $g(x) = 8 \cdot 2^x - 3$.

$g(2) = 8 \cdot 4 - 3 = 29$ and $g(-1) = 8 \cdot \frac{1}{2} - 3 = 1$.

19 Approaching e



$n = 12$: $(1.08333\dots)^{12} \approx 2.6130$, gap $2.7183 - 2.6130 \approx 0.1053$.

$n = 365$: $(1.00274)^{365} \approx 2.7146$, gap ≈ 0.0037 .

The gap shrinks as n grows: the values approach e . Even with interest added every day, 1 dollar grows to only about 2.71 dollars in one year, never beyond $e \approx 2.72$ dollars.

20 Doubling an investment



$5000(1.06)^{11} \approx 9491.49 < 10000$ and $5000(1.06)^{12} \approx 10060.98 > 10000$. So it takes 12 years.

Exactly: $1.06^t = 2$, so $t = \frac{\ln 2}{\ln 1.06} \approx \frac{0.6931}{0.05827} \approx 11.9$ years, consistent with the table.

21 Continuous doubling time



(a) $A(t) = 1500 e^{0.04t}$.

(b) Divide by 1500: $e^{0.04t} = 2$. Take $\ln$: $0.04t = \ln 2 \approx 0.6931$, so $t \approx 17.33$ years.

(c) $1500 e^{0.04 \cdot 17.33} = 1500 e^{0.6932} \approx 1500 \cdot 2.0001 \approx 3000$ dollars. It checks out.

22 Modeling app users



(a) The ratios $60 \div 50 = 1.2$, $72 \div 60 = 1.2$ and $86.4 \div 72 = 1.2$ are equal, so the growth is exponential: $N(t) = 50(1.2)^t$.

(b) $N(6) = 50 \cdot 1.2^6 = 50 \cdot 2.985984 \approx 149.3$ thousand, about 149,300 users.

(c) $N(3) = 86.4 < 100$ and $N(4) = 50 \cdot 2.0736 = 103.68 > 100$: in year 4.



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