$$49.1875_{10} = 31.3_{16} = 0011 0001.0011_2 = 61.14_8$$
$$.11 00010011 \times 2^6$$

Positive - Nasa Format

0.110 0010	0110 0000	0000 0000	0000 0110 $_2$
6 2	6 0	0 0	0 6

$$\boxed{49.1875_{10} = 62600006}$$

Negative nasa Format
$$-49.1875_{10}$$

$$0.1100010.00110 \times 2^6 \qquad \text{positive. } 49.1875$$
$$1001 1101 1001 \qquad \text{flip bits}$$
$$\underline{+1}$$
$$1001 1 1011010 \times 2^6 \qquad \text{negative } 49.1875_{10} \checkmark$$
$$0110 0001 00110$$
$$0000 00 000 0$$

1.001 1101	1010 0000	0000 000 0	0000 0110
9 D	A 0	0 0	0 6

$$\boxed{-49.1875_{10} = 9DA00006}$$

Positive: 49.1875₁₀ — 49.1875_{10}

Negative

Left column (Positive):

① Base 10 → Base 16:

Ⓐ
$$49_{10} \rightarrow 49 \% 16 = 1$$
$$\text{int}(49/16) \% 16 = 3$$

$$\boxed{49_{10} = 31_{16}}$$

Ⓑ
$$.1875_{10} \times 16 = 3.0 \text{ stop}$$

$$\boxed{.1875_{10} = .3_{16}}$$

Ⓒ
$$\boxed{49.1875_{10} = 31.3_{16}}$$

② Base 16 to base 2

$$3 \quad 1 \quad . \quad 3$$
$$0011\,0001 . 0011_2$$

$$\boxed{31.3_{16} = 0011\,0001.0011_2}$$

③ Base 2 → Base 8:

$$0011\,0001 . \,001\,100$$
$$6 \quad 1 \quad . \quad 1 \quad 4_8$$

$$\boxed{110001.0011_2 = 61.14_8}$$

Right column (Negative):

① Positive base 10 → negative base 10:

Ⓐ
$$\begin{array}{r} -9 -9 \\ 4\ \ 9_{10} \\ \hline 5\ 0_{10} \\ +\quad 1_{10} \\ \hline 51_{10} \end{array}$$

Ⓑ
$$\begin{array}{r} -9\ -9\ -9\ -9 \\ .\ 1\ 8\ 7\ 5 \\ \hline .\ 8\ 1\ 2\ 4 \\ +1 \\ \hline .8\ 1\ 2\ 5_{10} \end{array}$$

Ⓒ
Positive → Negative
$$-49.1875_{10} = 51.8125_{10}$$

$$51 \% 2 = 1$$
$$(51/2)\% 2 = 1$$
$$(25/2)\% 2 = 0$$
$$(12/2)\% 2 = 0$$

$$.8125 \times 2 = 1.625$$
$$.625 \times 2 = 1.25$$
$$.25 \times 2 = 0.50$$
$$.5 \times 2 = 1.0$$

$$0.11.1101\ 2 \times 2^0$$

② Positive base 16 → negative base 16:

Ⓐ
$$\begin{array}{r} -15 \ -15 \\ 3 \quad 1_{16} \\ 12 \quad 14 \\ \hline 12 \quad 15_{16} \\ C \quad F_{16} \ . \quad 16 \end{array}$$

Ⓑ
$$\begin{array}{r} -15 \\ 3 \\ \hline 12 \\ +1 \\ \hline .13_{16} \end{array}$$

Ⓒ
Positive → Negative
$$31.3_{16} = CD.1_{16}$$

$$0.111101 \times 2^2$$

③ Convert negative base 16 to base 2:

Neg
$$CF.D_{16} = \boxed{1100\,1111\!\!D.1101_2}$$

$$.D_{16}$$
$$1100\,1111 . 110_2$$

Negative
$$.1100\,111\,01101 \times 2^8$$

④ Confirm neg base 2, by converting positive base 2 to negative base 2:

$$\begin{array}{ll} 0011\,0001 . 0011_2 & \text{Positive} \\ 1100\,1110 . 1100 & \text{1's comp} \\ \quad\quad\quad +1 & \\ \hline 1100\,1110 . 1101_2 & \text{2's comp - Neg.} \\ 0011\,0001 . 0011 & \text{confirm} \\ \hline 0000\,0000 . 0000 & \end{array}$$

they are equal!

Bottom section:

Positive:

Scientific Notation → NASA Format

sign bit
$$0011\,0001.0011 \times 2^0 \rightarrow .1100\,0100\,11 \times 2^6$$

Power Characteristic

$$\underline{0.}\,\underline{1110}\ \underline{0010}\ |\ \underline{0110}\ \underline{0010}\ |\ \underline{0000}\ \underline{0000}\ |\ \textcircled{0}\underline{000}\ \underline{0110}_2$$
$$\quad 6 \quad\quad 2 \quad\quad 6 \quad\quad 0 \quad\quad 0 \quad\quad 0 \quad\quad 0 \quad\quad 6 \rightarrow \text{Hex Rep}$$

Positive

Flip bits , but base Pow

Negative:

$3.07421875_{10} = 3.13_{16} = 0011.0001\ 0011_2 = 3.0468$

00.1100010011×2^2

$$0.1\ 1\ 0001\ 0\ |\ 0\ 110\ 0000\ |\ 0000\ 0000\ |\ 00000\ 0010$$
$$6\quad 2\quad \quad 6\quad 0\quad \quad 0\quad 0\quad \quad C\quad 2$$

$\boxed{3.07421875_{10} = 626\ 00002_{\text{Hex rep}}}$

-3.07421875_{10}

$0.11\ 0001\ 0011_2 \times 2^2 \rightarrow$ positive 3.07421875

$1.00\ 1110\ 1100$ flip bits

$\underline{1.00\ 1110\ 1101_2} \rightarrow -3.07421875$ $+1$

$011\ 0001\ 0011_2$ $+3.07421875$

$000\ 0000\ 0000$ confirm ✓

$$1.0\ 01\ 1101\ |\ 1\ 010\ 0000\ |\ 0000\ 0000\ |\ 0000\ 0010$$
$$9\quad D\quad \quad A\quad 0\quad \quad 0\quad 0\quad \quad 0\quad 2$$

$\boxed{-3.07421875_{10} = 9DA\ 00002_{\text{Hex Rep}}}$

Positive $3.0742\,1875_{10} \times 10^0$

① Base 10 → Base 16

(A) $3_{10} \rightarrow 3\%16 = 3_{16}$
int$(3/16)\%16 = 0$

(B) $.0742\,1875_{10} \times 16 = 1.\underline{1875}$
$.1875 \times 16 = 3)\,\underline{0}$ Stop ↗

$.13_{16}$
↑
$\frac{1}{16} + \frac{3}{16^2} = .0742$ ✓

(C)
$\boxed{3.13_{16}}$ →

② Base 16 to Base 2

$3\,.\,1\qquad 3_{16}$
↓
$0011.0001\,0011_2$

$\boxed{0011.0001\,0011_2}$ → (negative)

③ Base 2 to Base 8

$0011.000\,100\,11\underset{\sim}{0}_2$

$3\,.\,0\quad 4\quad 6_8$

$\boxed{3.046_8}$

---

midterm #6 Base conversions

neg $-3.0742\,1875_{10}$

① B10 → B16 negative

(A) $.9-9$
$\quad 3._{16}$
$\overline{\quad 96_{10}}$

(B) $-9\,-9\,-9\quad-9\quad-9\,-9\,-9\,-9$
$.\;0\;7\;4\;2\;1\;8\;7\;5_{10}$
$\overline{.9\;2\;5\;7\;8\;1\;2\;4_{10}}$ 1's comp
$\qquad\qquad\qquad\quad +1$
$\overline{.9\;2\;5\;7\;8\;1\;2\;5_{10}}$ 2's comp

(C)
$-3.07421875_{10} = \boxed{6.925781\,25_{10}}$

② Positive base16 → negative base16

$-15\;-15\;-15$
$3\,.\,1\;\;3_{16}$ 1's comp
$\overline{12.14\;12}$
$\;\;\times\!\!\!\!/\quad +1$
$\overline{12.14\;13_{16}}$
$\boxed{C.ED_{16}} = -3.13_{16}$

③ Convert neg base 16 to base 2

$-3.13_{16} \approx C.ED_{16} = \boxed{1100.1110\,1101 \times 2^0}$

④ confirm convert positive base 16 to 2 to negative base 2

sign bit ↓
$\overset{1\;1\;1\;1\;1}{0011}.\,0001\,0011_2$ – positive
$1100.\,1110\,1100$ 1's comp
$\times\!\!\!/\qquad\qquad +1$
$\boxed{1100.\,1110\,1101_2}$ – neg. 2's comp
$+)\,0011\;\;.+0001\,0011_2$ confirm
$0000\qquad 0000\,0000$ ✓

Scientific Notation
$1101.1110\,1101 \times 2^3$

theyre
equal!

$0.110\,0010\,0110 \times 2^2$
$1001\,1101\,1001\;\;+1$
$\overline{1001\;1101\;1010 \times 2^2}$ $A\,00002$
$\;9\qquad D$

Nasa Format

Positive
$0011.0001\,0011 \times 2^0$
(sign) $0.110\,0010\,011 \times 2^2$

⓪	1 1 0	0 0 1 0	0 1 1 0	0 0 0 0	0 0 0 0	0 0 0 0	⓪ 0 0 0	0 0 1	0 2
	6	2	6	0	0	0	0	2	

Power Characteristic
sign ↑   Positive → Hex Rep
$\times 2^2$

$.110\,0010\,0110 = 11.0001\,0011 \times 2^0$ ✓
$1100.1110\,1101 \times 2^0 = 1.1001\,1101\,101 \times 2^3$

negative
(sign)
1	0 0 1	1 1 0 1	1 0 1 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 1
	9	D	A	0	0	0		

negative → Hex Rep

$.110\,1111\,0\,1101$

$= \dfrac{1101_{-2's}}{1100}$

$\begin{array}{c}1100\\0011\end{array}\;\dfrac{}{[0011]_2}$

$\begin{array}{c}1110\,1101\;2's\,comp\\ \overline{1110\,1100}\\ 0001\,0011\end{array}$

$0011.0001\,0011_2$
$3.13_{16} = 3 \times 16^0 \cdot \left(\frac{1}{16} + \frac{3}{16^2}\right)$
3.07_{10} ✓

midterm #6 nasa Format

$0.20_{10} = 0.3_{16} = .0011_2 = 0.1463$

$.0011 \times 2^{-2}$

0.110 0000	0000 0000	0000 0000	1111 1110
6	0	0	0 0	F E

$_2$

$$\boxed{0.20_{10} = 60000\,0FE \quad \text{Hex Rep}}$$

$-.20_{10}$ in Hex Rep

0.110

1.001
   +1
1.010₂ $\times 2^{-2} \to$ neg -0.20_{10}

10110
0000 ✓

$\times 2^{-2} \to 0.20_{10}$ positive

flip bits

1.010 0000	0000 0000	0000 0000	1111 1110
A	0	0 0	0 0	F E

$$\boxed{-0.20_{10} = A0000\,0FE \quad \text{Hex Rep}}$$

Positive

$.20 \times 10^0$

① Base 10 → Base 16:

$.20 \times 16 = 3.2$
$.20 \times 16 = 3.2$

$$.2_{10} = .3_{-16}$$

② Base 16 to Base 2:

$$.3_{-16} = .0011_2$$

③ Base 2 to Base 8:

$.001100\ 1100\ 11\ 0011\ 0011\ 0011$
$.\ \ \ \ 4\ \ \ \ 6\ \ 3_8\ \ \ \ 1\ \ 4\ 6\ 3$

$$.0011_2 = .1463_8$$

Negative

① Positive base 10 → negative base 10

$\begin{array}{r} -9 \\ .2_{10} \\ \hline .7_{10} \end{array}$ ∴

Posit	→	Neg
$.2_{10}$	=	$.7_{10}$

② Positive base 16 → neg. base 16

$\begin{array}{r} -15 \\ .3_{16} \\ \hline .12 \\ \cancel{+1} \\ \hline .13_{16} \end{array}$ ∴

Posit.	→	Neg
$.3_{16}$	=	$.D_{-16}$

③ Convert neg base 16 to neg base 2:

Post → Neg

D_{16}	=	$.1101_2$

④ confirm neg base 2, by converting positive base 2 to neg. base 2:

$.0011_2$ Positive
$.1100$ 1's comp
$\underline{\ \ \ \ +1}$
$.1101_2$ neg - 2's comp
$+.0011$ confirm
$\overline{0000}$ ✓

they are equal!

Scientific Notation   **Nasa Format**   **Power characteristic**

Positive: $.0011 \times 2^0 \rightarrow .11 \times 2^{-2}$

Sign bit

$\underline{0}.\underline{1\ 1\ 0}\ \underline{0\ 1\ 1\ 0}\ |\ \underline{0\ 1\ 1\ 0}\ \underline{0\ 1\ 1\ 0}\ |\ \underline{0\ 1\ 1\ 0}\ \underline{0\ 1\ 1\ 0}\ |\ \underline{1}\underline{0\ 0\ 0}\ \underline{0\ 0\ 1}\ \underline{0}_2$

$\ \ \ 6\ \ \ \ \ \ \ 6\ \ \ \ \ \ \ \ 6\ \ \ \ \ \ \ 6\ \ \ \ \ \ \ 6\ \ \ \ \ \ \ 6\ \ \ \ \ \ \ 8\ \ \ \ \ \ 2$

negative $\times 2^{-2}$ → Hex Rep Positive

$.01100110 = .00110011_2 = .0011_2$ ✓

Scientific Notation   **Power characteristic**

Negative: $.1101 \times 2^0 \rightarrow .1101 \times 2^0$

Sign bit

$\underline{1}.\underline{1\ 1\ 0}\ \underline{1\ 1\ 1\ 0}\ |\ \underline{1\ 1\ 1\ 0}\ \underline{1\ 1\ 1\ 0}\ |\ \underline{1\ 1\ 1\ 0}\ \underline{1\ 1\ 1\ 0}\ |\ \underline{0\ 0\ 0}\ \underline{0\ 0\ 0\ 0}_2$

$\ \ E\ \ \ \ \ \ E\ \ \ \ \ \ E\ \ \ \ \ \ E\ \ \ \ \ E\ \ \ \ \ E\ \ \ \ \ 0\ \ \ \ \ \ 0$

Negative Hex Rep

$\begin{array}{r} 1101_2 \\ \underline{\ \ \ \ 1} \\ 1100 \\ \underline{/0011_2} \end{array}$ 1's comp flip bits ✓

Hex
↓
Scientific notation
↓

| 6 | 9 . | 9 | 9 | 9 | 9 | 0 | 2 |

0.110 1001 1001 1001 1001 1001 0000 0010
$\times 2$

$\times 2^0$ 0011. 0100 1100 1100 1100 1100 1000

↓
base 16

| $3_{16.}$ | 4 | $\overset{12}{\cancel{C}}$ 3 | $\overset{12}{\cancel{C}}$ | $\overset{12}{\cancel{C}}$ | $\overset{12}{\cancel{C}}$ | 8 |
| 3×16^0. | $\dfrac{4}{16^1}$ | $\dfrac{}{16^2}$ 64 | $\dfrac{}{16^3}$ | $\dfrac{}{16^4}$ | $\dfrac{}{16^5}$ | $\dfrac{}{16^6}$ 16 |

$3_{10.}$ $0.25 + .046875 + .0029$ L_1

$\longrightarrow$ 3.2999997139_{10}
                       $\overline{3.30_{10}}$

B10
↓
B16

$13 \% 16 = B_{16.}$

$.2999997139 \times 16 = 4.80$

$.80 \times 16 = 12.80$
$.80 \times 16 = 12.8$
$.8 \times 16 = 12.8$
$.8 \times 16 = 12.8$
$.8 \times 16 = 12.8$

B16
↓
B2
↓
S.N

| B.4 | $\overset{12}{C}$ | $\overset{12}{C}$ | $\overset{12}{C}$ | $\overset{12}{C}$ | $\overset{12}{C}$ |
| 3.4 | C | C | C | C | C_{16} |

0011. 0100 1100 1100 1100 1100 11 0 $\times 2^0$

0011. 0100 1100 1100 1100 1100 1100 $\overset{\times 2^{-2}}{0000}$ 0010

0.1101 0011 00 1100 1100 1100 1100 -0.2
       9   9   9   9   9
6   9   9.

$$6\ 9 \mid 9\ 9 \mid 9\ 9 \mid 0\ 3$$

0110. 1001 | 1001 1001 | 1001 1001 | 0000 0011

$\times 2^3$

0110. 1001 1001 1001 1001 1001 $\times 2^0$

$6.\quad \dfrac{9}{16^1} + \dfrac{9}{16^2} + \dfrac{9}{16^3} + \dfrac{9}{16^4} + \dfrac{9}{16^5}\bigg|_{16}$

16^0

$.5625 + .035 + .0022 + .000137 + .0000008583$

$\boxed{6.5999994278_{10}} \quad \checkmark$

Reverse to confirm

$6 \% 16 = 6_{16}$

$.5999994278 \times 16 = 9.599$

$.6 \times 16 \qquad = 9.6$

$.6 \times 16 \qquad = 9.6$

$6 . \underline{9}\ _{16}$

0.110. 1001 1001 1001 | 1001 1001 $\times 2^0$

$\left(\begin{array}{c} 0.110\ \underline{1001} \mid \underline{1001}\ \underline{1001} \mid \underline{10011\ 001} \mid \underline{0000}\ \underline{0011} \\ \times 2^3 \end{array}\right)$

$6\ 9\quad 9\ 9\quad 9\ 9\quad 0\ 3\quad \checkmark$

neg 9   6   6   6   6   7   neg F   F

↓

1.001 0110 | 0110 0110 | 0110 0111 | 1111 1111

1.001 0110 0110 0110 0110 0111

.-1

1.001 0110 0110 0110 0110 0110
0.110 1001 1001 1001 1001 1001   flip $\times 2$

.0110 1001 1001 1001 1001 1001 $\times 2^0$ positive

Base 16

. $\dfrac{6}{16^1}$ + $\dfrac{9}{16^2}$ + $\dfrac{9}{16^3}$ + $\dfrac{9}{16^4}$ + $\dfrac{9}{16^5}$ + $\dfrac{9}{16^6}$ $_{16}$

Base 10

= $\boxed{.412499642_{10}}$