Example from midterms or assignments

[12] The Motorola 68000 microprocessor is byte addressable with a 24-bit address bus and a 16-bit data bus, and one word contains 2 bytes. There are both peripherals and memory units to be connected to build a system and it is expected that the whole address space will be used. The diagram below may help you visualize the required answers to the questions. State the answers in the appropriate boxes. Leave the values in the answers as powers of 2 or simple approximations to them or simple factors - there is no need to give the actual number.

(A) [1] What is the total number of addressable locations for this system?

(A)	2^{24}

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(B) [1] 1 / 4 of the addressable space is to be used for the peripherals requirements. What is the total number of available addresses for peripherals?

(B) 2^{22}

(C) [1] 3 / 4 of the addressable space is to be used for the memory requirements of RAM and ROM. What is the total number of addresses available for memory?

(C) 3×2^{22}

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(D) [1] The ROM has already been bought and its size is 16KB. How many addresses does it need?

$$16KB = 2^4 \times 2^{10} = 2^{14}$$

(D) 2^{14}

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(C) 3×2^{22}

(E) [1] How many addresses are left for RAM?

(E)

$$3\times 2^{22} = (2+1)\times 2^{22} = 2^{23} + 2^{22}$$

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(C) $3 \times 2^{22} = 2^{23} + 2^{22}$

(D) [1] The ROM has already been bought and its size is 16KB. How many addresses does it need?

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(E) [1] How many addresses are left for RAM?

(E) $2^{23} + 2^{22} - 2^{14}$

(A) [1] What is the total number of addressable locations for this system?

(A) 2^{24}

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The addressable space for peripherals is further subdivided as shown below.

(H) [1] 14/16 of the addresses are to be used for disk addressing. How many?

(H) 14×2^{18}

(F) [1] 1/16 of the addresses are to be used for input components. How many?

(F) 2^{18}

(G) [1] 1/16 of the addresses are to be used for output components. How many?

(G) 2^{18}

(A) [1] What is the total number of addressable locations for this system?

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(H) [1] 14/16 of the addresses are to be used for disk addressing. How many?

(H) 14×2^{18}

(I) [1] The chosen disk drives each require 1MB of address space. How many can one fit into the system?

(I)

Rearrange answers: tricks

$$14 \times 2^{18} =$$

$$(7 \times 2) \times 2^{18} = 7 \times 2^{19} =$$

$$(6+1) \times 2^{19} = 6 \times 2^{19} + 2^{19} =$$

$$(3 \times 2) \times 2^{19} + 2^{19} = 3 \times 2^{20} + 2^{19} =$$

$$(2+1) \times 2^{20} + 2^{19} =$$

$$2^{21} + 2^{20} + 2^{19}$$

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What we want is:

$$\frac{2^{21}+2^{20}+2^{19}}{1MB}=\frac{2^{21}+2^{20}+2^{19}}{2^{20}}$$

$$\frac{2^{21}}{2^{20}}+\frac{2^{20}}{2^{20}}+\frac{2^{19}}{2^{20}}=2+1+\frac{1}{2}\Rightarrow 3$$

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(H) 14×2^{18}

$2^{21} + 2^{20} + 2^{19}$

(I) [1] The chosen disk drives each require 1MB of address space. How many can one fit into the system?

(I) 3

(E) [1] How many addresses are left for RAM? (Following up)

(E) $2^{23} + 2^{22} - 2^{14}$

$$1440 \times 900 = 1,296,000$$

$$2^{20} < 1,296,000 < 2^{21}$$

(J) [1] We want to buy a giant screen with a maximum resolution of 1440x900 pixels, where each pixel needs 1 byte of storage. It is normal to buy a RAM buffer to support such a display. How big must this be? Approximate to a power of 2, in bytes, which covers the display requirements.

(J) 2^{21}

(E) [1] How many addresses are left for RAM? (Following up)

(E) $2^{23} + 2^{22} - 2^{14}$

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(J) 2^{21}

(K) [1] How many addresses are left now for the main RAM?

(K) $2^{23} + 2^{22} - 2^{14} - 2^{21}$

(M) [1] The cheapest RAM chips contain 1M words. How many chips can you buy to fit into this system?

(M)

1M words = 2^{20} words
$= 2^{21}$ bytes

(in this system 1 words = 2 bytes as stated at the very beginning)

$$\frac{2^{23}+2^{22}-2^{14}-2^{21}}{2^{21}}$$

(M) 4

(M) [1] The cheapest RAM chips contain 1M words. How many chips can you buy to fit into this system?

(K) $2^{23}+2^{22}-2^{14}-2^{21}$