Reality Check !

Scientific research is not done in a vacuum. Usually there are lots of other behind-the-scenes issues that an astronomer has to deal with while doing the exciting tasks that go along with research and discovery. Here are a few 'real-world' problems that an astronomer might have to deal with, and that involve nothing more than simple addition, subtraction, multiplication and division..honest!!

Problem 1: Suppose an astronomer makes $75,000 each year (before paying State and Federal taxes). He works 40-hours a week, and gets the same 2-week vacation and 10-holidays off as everyone else, for a total of 1840 hours of work each year. Suppose that if he works for the Federal Government, he is charged 1.6 times his salary to cover his benefits, the use of his office, lab, utilities, and support staff. Suppose that another astronomer works at Company A which charges 1.8 times his salary to cover the same expenses. Suppose a third astronomer works at a university that charges 1.4 times his salary.

A) What is his take-home hourly pay rate in dollars/hour?

B) To bring home $75,000, how much money does he have to get from his grants to cover his salary plus the various benefits and other work expenses charged by his employer?

C) If he only received $75,000 each year for a research grant, how many hours each year would he be able to actually work and get paid?

Problem 2: A research satellite has a full compliment of experiments, which generate 40,000 bits of data every second (1 byte = 8 bits). The satellite orbits Earth once every 16 hours, but this data can be downloaded only once every orbit for 20 minutes at a time, when the tracking station is free to receive the satellite's transmissions. If the tracking stations can receive a downlink data stream with a bandwidth of 1.3 megabits/second,

A) How large a 'hard drive' will the satellite need to temporarily store the data before the next data transmission time arrives?

B) How much data will have been lost each orbit because it could not be downloaded?

Problem 3: NASA's total budget during 1969, the year of the Apollo 11 moon landing, was $4 billion dollars. The Federal budget (Income Tax revenues) that year was $187 billion. In 2006, the Federal budget included Income Tax revenues of $1.1 Trillion, and NASA's budget was $16.2 billion.

A) What percentage of the 1969 Income Taxes were used for space exploration (Apollo 11 moon landings etc)?

B) If there were 76 million tax payers in 1969, how much would each payer be paying for NASA's budget that year?

C) What percentage of the 2006 Income Tax is used for space exploration?

D) If there were 136 million tax payers that year, what was the average amount each payer paid for NASA's space exploration programs?

E) Since 1969, the value of the dollar has 'inflated' so that 1 dollar in 1969 now equals about $5.60. In view of this, what is the actual contribution to space exploration in 2006 compared to 1969 in problem 3(D)?

Answer Key:

Problem 1: A) What is his take-home hourly pay rate in dollars/hour?
Answer = $75,000/1840 hrs = $40.76 an hour

B) To bring home $75,000, how much money does he have to get from his grants to cover his salary plus the various benefits and other work expenses charged by his employer?
Answer: Government = $75,000 x 1.6 = $120,000
Company A = $75,000 x 1.8 = $135,000
University = $75,000 x 1.4 = $105,000

C) If he only received $75,000 each year for a research grant, how many hours each year would he be able to actually work and get paid?
Answer: Government = $75,000/(1.6 x $40.76) = 1,150 out of 1,840 hours in a full work year = 63%
Company A = $75,000 / (1.8 x $40.76) = 1,022 hours or 56% of a full work year.
University = $75,000 / (1.4 x $40.76) = 1,314 hours or 71 % of a full work year.

Problem 2: A) How large a 'hard drive' will the satellite need to temporarily store the data before the next data transmission time arrives?
Answer: The tracking station can download a maximum of 20 minutes x 60 sec/min x 1.3 million bits/sec = 1.6 billion bits of data or (1.6 billion/8) = 200 megabytes of data at the downlink time. The hard drive or Mass Storage Unit (MSU) has to be at least this big.

B) How much data will have been lost each orbit because it could not be downloaded?
Answer: During each 16-hour orbit, the satellite generates 16 hours x (3600 seconds/hour) x (40,000 bits/sec) = 2.3 billion bits of information, or (2.3 billion bits/8) = 287 megaBytes of data. But the tracking station can only handle 200 megabytes of data, so 87 megabytes of data have to be lost each orbit to make room for the next-orbit's data.

Problem 3: A) What percentage of the 1969 Income Taxes were used for space exploration (Apollo 11 moon landings etc)?
Answer: 100% x (4 billion / 187 billion) = 2.1%

B) If there were 76 million tax payers in 1969, how much would each payer be paying for NASA's budget that year?
Answer: $187 billion / 76 million = $2,460 per tax payer for the full federal income tax.
$2,460 x 2.1/100 = $52 dollars per tax payer.

C) What percentage of the 2006 Income Tax is used for space exploration?
Answer: 100% x (16.2 billion / 1.1 trillion) = 1.4 %

D) If there were 136 million tax payers that year, what was the average amount each payer paid for NASA's space exploration programs?
Answer: $1.1 trillion / 136 million = $8,088 per tax payer.
$8,088 x 1.4/100 = $113 per tax payer.

E) Since 1969, the value of the dollar has 'inflated' so that 1 dollar in 1969 now equals about $5.60. In view of this, what is the actual contribution to space exploration in 2006 compared to 1969 in problem 3(D)?
Answer: Today NASA spends $16.2/5.6 = $2.9 billion dollars, and the average tax payer spends $113/5.6 = $20 dollars for space exploration by NASA.