Examples 1–4 Simplify each expression. Assume that no denominator equals zero.

19. $\dfrac{m^4 p^2}{m^2 p}$

20. $\dfrac{p^{12} t^3 r}{p^2 t r}$

21. $\dfrac{3m^{-3} r^4 p^2}{12 t^4}$

22. $\dfrac{c^4 d^4 f^3}{c^2 d^4 f^3}$

23. $\left(\dfrac{3xy^4}{5z^2}\right)^2$

24. $\left(\dfrac{3t^6 u^2 v^5}{9 t u v^{21}}\right)^0$

25. $\left(\dfrac{p^2 t^7}{10}\right)^3$

26. $\dfrac{x^{-4} y^9}{z^{-2}}$

27. $\dfrac{a^7 b^8 c^8}{a^5 b c^7}$

28. $\left(\dfrac{3np^3}{7q^2}\right)^2$

(29) $\left(\dfrac{2r^3 t^6}{5u^9}\right)^4$

30. $\left(\dfrac{3m^5 r^3}{4p^8}\right)^4$

31. $\left(-\dfrac{5f^9 g^4 h^2}{fg^2 h^3}\right)^0$

32. $\dfrac{p^{12} t^7 r^2}{p^2 t^7 r}$

33. $\dfrac{p^4 t^{-3}}{r^{-2}}$

34. $-\dfrac{5c^2 d^5}{8cd^5 f^0}$

35. $\dfrac{-2f^3 g^2 h^0}{8f^2 g^2}$

36. $\dfrac{12m^{-4} p^2}{-15m^3 p^{-9}}$

37. $\dfrac{k^4 m^3 p^2}{k^2 m^2}$

38. $\dfrac{14f^{-3} g^2 h^{-7}}{21k^3}$

39. $\dfrac{39t^4 u v^{-2}}{13t^{-3} u^7}$

40. $\left(\dfrac{a^{-2} b^4 c^5}{a^{-4} b^{-4} c^3}\right)^2$

41. $\dfrac{r^3 t^{-1} x^{-5}}{t x^5}$

42. $\dfrac{g^0 h^7 j^{-2}}{g^{-5} h^0 j^{-2}}$

Example 5

43. INTERNET In a recent year, there were approximately 3.95 million Internet hosts. Suppose there were 208 million Internet users. Determine the order of magnitude for the Internet hosts and Internet users. Using the orders of magnitude, how many Internet users were there compared to Internet hosts?

44. PROBABILITY The probability of rolling a die and getting an even number is $\dfrac{1}{2}$. If you roll the die twice, the probability of getting an even number both times is $\left(\dfrac{1}{2}\right)\left(\dfrac{1}{2}\right)$ or $\left(\dfrac{1}{2}\right)^2$.

a. What does $\left(\dfrac{1}{2}\right)^4$ represent?

b. Write an expression to represent the probability of rolling a die d times and getting an even number every time. Write the expression as a power of 2.

Simplify each expression. Assume that no denominator equals zero.

45. $\dfrac{-4w^{12}}{12w^3}$

46. $\dfrac{13r^7}{39r^4}$

47. $\dfrac{(4k^3 m^2)^3}{(5k^2 m^{-3})^{-2}}$

48. $\dfrac{3wy^{-2}}{(w^{-1} y)^3}$

49. $\dfrac{20qr^{-2} t^{-5}}{4q^0 r^4 t^{-2}}$

50. $\dfrac{-12c^3 d^0 f^{-2}}{6c^5 d^{-3} f^4}$

51. $\dfrac{(2g^3 h^{-2})^2}{(g^2 h^0)^{-3}}$

52. $\dfrac{(5pr^{-2})^{-2}}{(3p^{-1} r)^3}$

53. $\left(\dfrac{-3x^{-6} y^{-1} z^{-2}}{6x^{-2} yz^{-5}}\right)^{-2}$

54. $\left(\dfrac{2a^{-2} b^4 c^2}{-4a^{-2} b^{-5} c^{-7}}\right)^{-1}$

55. $\dfrac{(16x^2 y^{-1})^0}{(4x^0 y^{-4} z)^{-2}}$

56. $\left(\dfrac{4^0 c^2 d^3 f}{2c^{-4} d^{-5}}\right)^{-3}$

57. CCSS SENSE-MAKING The processing speed of an older desktop computer is about 10^8 instructions per second. A new computer can process about 10^{10} instructions per second. The newer computer is how many times as fast as the older one?