p. 481 #20-38 even, 42-51

Solve each equation. Check your answers.

20. $\ln 3x = 6$

21. $\ln x = -2$

22. $\ln (4x - 1) = 36$

23. $1.1 + \ln x^2 = 6$

24. $\ln \frac{x-1}{2} = 4$

25. $\ln 4r^2 = 3$

26. $2 \ln 2x^2 = 1$

27. $\ln (2m + 3) = 8$

28. $\ln (t - 1)^2 = 3$

Use natural logarithms to solve each equation.

29. $e^x = 18$

30. $e^{\frac{x}{5}} + 4 = 7$

31. $e^{2x} = 12$

32. $e^{\frac{x}{2}} = 5$

33. $e^{x+1} = 30$

34. $e^{2x} = 10$

35. $e^{3x} + 5 = 6$

36. $e^{\frac{x}{9}} - 8 = 6$

37. $7 - 2e^{\frac{x}{2}} = 1$

Space **For Exercises 38 and 39, use $v = -0.0098t + c \ln R$, where v is the velocity of the rocket, t is the firing time, c is the velocity of the exhaust, and R is the ratio of the mass of the rocket filled with fuel to the mass of the rocket without fuel.**

Space **A spacecraft can attain a stable orbit 300 km above Earth if it reaches a velocity of 7.7 km/s.**

38. Find the velocity of a spacecraft whose booster rocket has a mass ratio of 20, an exhaust velocity of 2.7 km/s, and a firing time of 30 s. Can the spacecraft achieve a stable orbit 300 km above Earth?

Simplify each expression.

42. $\ln 1$

43. $\frac{\ln e}{4}$

44. $\frac{\ln e^2}{2}$

45. $\ln e^{83}$

46. $\ln e$

47. $\ln e^2$

48. $\ln e^{10}$

49. $10 \ln e$

50. $\ln e^3$

51. $\frac{\ln e^4}{8}$