**Instructors Manual**

**to accompany *Technical Mathematics with Calculus,*Third Canadian Edition by Calter et al.**

**CHAPTER 1: NUMERICAL COMPUTATION**

**Class Problems**

1. Determine the number of significant digits in each of the following: (a) 5.088; (b) 230; (c) 0.07; (d) 4.0.

**ANSWER:** (a) 4; (b) 2; (c) 1; (d) 2.

1. Determine the accuracy and precision of each of the following: (a) 1.09; (b) 3.600; (c) 1200.

**ANSWER:** (a) three significant digits, precise to the hundredths; (b) four significant digits, precise to the thousandths; (c) two significant digits, precise to the hundreds.

1. Round as indicated: (a) 3.082 to nearest hundredth; (b) 5.071 to one decimal place; (c) 52 638 to nearest thousand; (d) 73.95 to nearest tenth.

**ANSWER:** (a) 3.08; (b) 5.1; (c) 53 000; (d) 74.0.

1. Perform the indicated operations on these approximate numbers: (a) 16.95 + 5.2; (b) 15.3 + 5.93 – 0.098.

**ANSWER:** (a) 22.2; (b) 21.1.

1. Determine why a negative base (a) to an even power yields a positive number and (b) to an odd power yields a negative number.

**ANSWER:** The negative signs “pair off” with an even power.

1. Evaluate the following formulas:
   1. ( = 3.14; *r* = 5.20 cm)
   2. (*n* = 64; *p* = 0.80; *q* = 0.20)
   3. *c* = *a*2 + *b*2 (*a* = 6 mm; *b* = 8 mm)

**ANSWER:** (a) 84.9 cm2; (b) 3.2; (c) 100 mm2.

**Applications**

1. Determine the area of a room that measures 1.2 m by 2.15 m.

**ANSWER:** 2.6 m2.

1. Determine the thickness of a 5.000 cm metal part that has worn by 0.1%.

**ANSWER:** 4.995 cm.

**Case Study—Accuracy and Precision in Chemical Samples**

Use the principles of this chapter to evaluate this case study. You’ll find one possible evaluation at the end of the chapter.

A chemical technologist pours 32.5 ml from a collection vessel and separates the liquid samples into seven equal parts in seven test vials. Using a calculator, the technologist calculates the size of each sample by dividing: 32.5 ml ÷ 7 = 4.642 857 143 ml. When the technologist records in the log that each sample is 4.642 857 143 ml, he finds himself in trouble with the lab shift supervisor for recording an inaccurate measurement. Double checking the calculation, he finds it still comes out to 4.642 857 143 ml and decides that he needs to be more accurate by using more digits. Using a calculator with a larger display, he records 4.642 857 142 86 ml. Again an email arrives the next day encouraging a more accurate measurement. Using the calculator application on a PC, the technologist calculates and records 4.642 857 142 857 142 857 142 857 142 8571 ml. Why has the technologist made things even worse? Why would this final result be considered inaccurate when it’s reporting the sample size to a precision smaller than a trillionth of a millilitre?

**Case Study Discussion—Precision and Accuracy in Chemical Samples**

Our technologist assumed that more digits represent a more accurate representation of the amount of each sample. The problem is that when you use many digits, you're telling the reader that you have used instrumentation accurate enough to measure such precise amounts. Now if that is true, fine, you can use the number of digits that correctly represents the precision of your measuring instruments and techniques. In this case, however, the starting amount, 32.5 ml, is precise only to the nearest tenth of a millilitre. Additionally, the lab supervisor seemed to realize that the technologist was very unlikely to be able to divide the sample into so many samples accurate to a million-trillion-trillionth of a millilitre. Reporting such a long number falsely claims a precision that cannot be true.

**Solutions**

**Exercise 1: The Number Types**

**1**. 7 < 10

**2.** 9 > –2

**3**. –3 < 4

**4**. –3 > –5

**5.** 

**6**. 

**7.** 

**8.** 

**9.** 

**10.** 

**11. **

**12.** 

**13**. 3

**14**. 4

**15.** 4

**16.** 5

**17.** 4

**18.** 5

**19.** 2

**20.** 2

**21.** 1

**22.** 3

**23.** 5

**24.** 6

**25.** 4

**26.** 5

**27.** 5

**28.** 6

**29.** 38.47

**30.** 2.00

**31.** 96.84

**32**. 55.87

**33**. 398.37

**34**. 2.96

**35.** 2985.34

**36.** 278.38

**37.** 14.0

**38.** 745.6

**39**. 5.7

**40**. 0.5

**41**. 398.4

**42.** 34.9

**43.** 9839.3

**44.** 0.8

**45.** 28 600

**46.** 7600

**47.** 3 845 200

**48**. 274 800

**49.** 9.28

**50.** 2860

**51.** 0.0483

**52.** 484 000

**53.** 0.0838

**54.** 29.6

**55**. 29.5

**56.** 8370

**Exercise 2: Numerical Operations**

**1.** –1090

**2.** 5238

**3.** –1116

**4.** $149.18

**5.** 105 233

**6.** 181 776

**7**. –576 – 553 = –1129

**8.** –207 – 819 = –1026

**9.** 1123 + 704 = 1827

**10.** 818 + 207 + 318 = 1343

**11.** 67.15 round to 67.2

**12.** 593.437 round to 593.44

**13.** –307.52 round to –307.5

**14.** –0.000 3098 round to –0.000 31

**15.** Height Difference = 15 572 ft. – 14 000 ft. =1572 ft. round to  ft.

**16.** Area Difference= 1 540 681 km2 – 1 068 582 km2 = 472 099 km2

**17.** Wife’s Share = $125,435 – $44,675 – $26,380 = $54,380

**18.** Outside Diameter of Insulation = 2 (outside radius). Thus,

D = 2(10.6 + 2.125 + 4.8) = 2(17.525) = 35.05 round to 35.1 cm

**19.** Total Mass = 267 + 125 + 75.5 + 25.25 = 492.75 round to 493 kg

**20.** Total Resistance = 27.3 + 4.0155 + 9.75 = 41.0655 round to 41.1 Ω

**21.** 7299.28 round to 

**22.** 290.57 round to 291

**23.** 0.524 976 12 round to 0.525

**24.** 266.295 582 round to 266

**25.** –17 802 round to –17 800

**26.** 884.653 round to 885

**27.** 22.922 787 89 round to 22.9

**28.** 492.090 7555 round to 492

**29.** Cost = 52.5 tonnes × $99.25/tonne = 5210.625 = $5,210 (rounded to three

significant digits)

**30.** Tonnage required = 68 t/km × 762 km = 51 816 t = 52 000 t (rounded to two

significant digits)

Cost = (68 t/km × 762 km) × $1,425/t = $73,837,800 = $74, 000,000 (rounded

to two significant digits)

**31.** Total Tonnage = 3 × 26 t + 35 t = 113 t

Total Value = 113 t × $22.75 / t = $ 2,570.75 = $2,571

**32.** Distance for first car = 45 km/h × 6.0 h = 270 km

Distance for second car = 55 km/h × 6.0 h = 330 km

Distance apart = 270 km + 330 km = 

**33.** Cost = 274 km × $5,723 /km = $1,568,102 = $1,570,000 (rounded)

**34.** Power dissipated = 4.7 A × 115.45 V = 542.615 W = 540 W (rounded)

**35.** Number of revolutions = 1808 rpm × 9.500 min = 17 176 r = 17 180 r (rounded)

**36.** Weight = 1000 washers × 2.375 grams/washer = 2375 g

**37.** 385.84 in. × 2.54 cm/in. = 980.0336 = 980.03 cm (rounded)

**38.** Number of degrees = 360o/rev × 4.863 rev = 1750.68 o = 1751o (rounded)

**39.** 162.714 7766 round to 163

**40.** 102.928 8703 round to 103

**41.** –0.346 945 8988 round to –0.347

**42.** 1.877 199 844 round to 1.9

**43.** 0.706 195 547 round to 0.7062

**44.** 1.380 715 966 round to 1.381

**45.** 70 841.674 39 round to 70 840

**46.** –0.504 461 0209 round to –0.5045

**47.** Length = 1858.54 ÷ 5 = 371.708 m

**48.** 24.5 km ÷ 8.25 h = 2.969 696 97 = 2.97 km/h (rounded)

**49.** Consumption per day = 1.73 billion ÷ 365 days

= 0.004 739 726 billion per day × 1000 =

= 4.739 726 (round to 2 d.p.) = 4.74 million per day

**50.** The value per share = $84,099 ÷ 867 shares = $97.00

**51.** 0.001 44

**52.** 159

**53.** –0.000 002 53

**54.** –175

**55.** 0.001 066

**56.** 0.9930

**57.**



**58.**



**59.** (rounded to 3 s.d.)

**60.** (rounded to 3 s.d.)

**61.** 8

**62**. 125

**63**. –8

**64**. 81

**65**. 1

**66.** 1

**67.** 9

**68.** 1

**69.** –1

**70.** 100

**71.** 10

**72.** 1

**73.** 100 000

**74.** 0.01

**75.** 0.1

**76.** 10 000

**77.** 0.001

**78.** 0.000 01

**79.** 625.026375 round to 625

**80.** 5959.84 round to 5960

**81.** 0.014 586 1047 round to 0.0146

**82.** 0.335 834 238 round to 0.336

**83**. 0.027 947 1204 round to 0.0279

**84.** 5.93295879 round to 5.93

**85.** 59.762 393 63 round to 59.8

**86.** Distance = 16(5.448)2 = 474.891264 = 470 ft (rounded to 2 s.d.)

**87.** Power = (0.5855)2(365) = 125.1257413 =125 W (rounded to 3 s.d.)

**88.** Volume = (35.8)3 = 45 882.712 = 45 900 cm3 (rounded to 3 s.d.)

**89.** 

**90.** 5

**91.** 3

**92.** –3

**93.** –2

**94.** 7.014 271 167 round to 7.01

**95.** 1.36491758 round to 1.365

**96.** 4.453008948 round to 4.45

**97.** –1.790455636 round to –1.79

**98. **

**99. **

**100**. ****

**Exercise 3: Order of Operations**

**1.** 3340

**2.** 1595

**3.** –5940

**4.** 4180

**5.** 5

**6.** 7

**7.** 3

**8.** 2

**9.** 121

**10.** 16

**11.** 27

**12.** 4

**13.** 27

**14.** 30

**15.** 24

**16.** 5

**17.** 12

**18.** 2

**19.** 2

**20.** 30

**21.** 46.2

**22.** 8650

**23.** 978

**24.** 2.28

**25.** 4.58

**26.** 3.61

**27.** 59.8

**28.** 129

**29.** 55.8

**30.** 483

**31.** 3.51

**32.** 3.00

**33.** 7.17

**34.** 12.9

**35.** 3.23

**36.** 1.04

**37.** 0.871

**38.** 6.66

**39.** 7.93

**40.** 64.5

**Exercise 4: Scientific and Engineering Notation**

**1.** 102

**2.** 106

**3.** 10-4

**4.** 10-3

**5.** 100 000

**6.** 0.01

**7.** 0.000 01

**8.** 0.1

**9.** 1.86 × 105; 186 × 103

**10.**  5.46 × 10-5; 54.6 × 10-6

**11**. 

**12.** 1.25742 × 105; 125.742 × 103

**13.** 8.00 × 103; 8.00 × 103

**14.** 1.6 × 104; 16 × 103

**15.** 

**16.** 8.734 × 104; 87.34 × 103

**17.** 

**18.** 8.71 × 10-5; 87.1 × 10-6

**19.** 2850

**20.** 0.000 0175

**21.** 90 000

**22. **

**23.** 0.003 667

**24.** 76 300

**25.** 0.000 2482

**26.** 7 000 000

**27.** ****

**28.** 0.000 000 942 56

**29.** 107

**30.** 10

**31**. 10-9

**32.** 103

**33.** 103

**34.** 10-2

**35.** 107

**36.** 102

**37.**



**38.**



**39.**

****

**40.**

****

**41**.

****

**42**.

****

**43**.

****

**44**.

****

**45.**



**46**.



**47**.



**48**.



**49.**



**50.**



**51.**



**52.**



**53.**



**Exercise 5: Units of Measurement**

**1.** 

**2.** 

**3.** 

**4.** 

**5.** 

**6.** 

**7.** 

**8.** 

**9.** 

**10.** 

**11.** 

**12.** 

**13.** 

**14**. 

**15.** 

**16.** 

**17.** 

**18.**  

**19.** 

**20.**



**21.** 

**22.**



**23.**



**24.**



**25.** 

**26.** 

**27.** 

**28**. 

**29.** 

**30.** 

**31.**



**32.** 

**33.**



**34.**



**35.** 

**36.**



**37.** 

**38.**



**39.** 

**40.** 

**41.**



**42**. 

**43**. 19.8 ¢/m2

**44.**  22.1 ¢/ oz.

**45.** 

**46.** 

**47**. 

**48**. 

**49.** 

**50.**



**51**. 

**52**. 7653.45 km2, 2955.01 sq. mi.

**53**. 31.6756 fl. oz. (imperial)

**54**. 

**Exercise 6: Substituting into Equations and Formulas**

**1.** 

**2.**



**3.**



**4.**



**5.** 

**6.** 

**7.** 

**8.** 

**9.** 

**10.** 

**11.** 

**12.** 

**13.**



**14.**



**15.**



**Exercise 7: Percentage**

**1.** 372%

**2.** 87.7%

**3.** 0.55%

**4.** 56.3%

**5.** 40.0%

**6.** 75.0%

**7.** 70.0%

**8.** 42.9%

**9.** 0.23

**10.** 0.0297

**11.** 2.875

**12.** 0.0625

**13.** 

**14.** 

**15.** 

**16.** 

**17.** (0.411)(255)= 105 t

**18.** (0.153)(326 mi) = 49.9 mi

**19.** (0.333)(662 kg) =kg

**20.** (0.125)(72.0 gal) = 9.00 gal

**21.** R to be added = (7250)(0.150)

=1090

**22.** Amount of Metal obtained

= (0.105) (375 t) =39.4 t

**23.** B = 86.5/0.167= 518

**24.** B = 45.8 / 0.0146 = 3140 (3 s.d.)

**25.** B = 1.22 / 0.0186 =65.6

**26.** B = 55.7 / 0.252 = 221

**27.** Let *t* =amount in the bank

(0.25)*t* = amount withdrawn

(0.33)(0.25*t*) = $25

*t* = $25 / 0.0825 = $303

**28.** Cost for 100% oil heat

= $225/(1.00-0.65) = $640

**29.** 12.3 /26.8 = 0.459 = 45.9 %

**30.** 12.7 /36.3 = 0.350 = 35.0 %

**31.** 8.27 km /44.8 km = 0.185 = 18.5 %

**32.** 428 /844 = 0.507 = 50.7 %

**33.** 287 t /483 t = 0.594 = 59.4 %

**34.** 



**35.** 



**36.**



**37.**



**38.**



**39.**



**40.**



**41.** Final weight

= 115 lb – (0.220)(115 lb)

= 115 (1 – 0.220) = 89.7 lb

**42.**



**43.**









**45.**



**46.** 



**47.** Low Voltage

=125.0 V – (0.10)(125.0 V)

=112.5 V

High Voltage

= 125.0 V + (1.50)(125.0 V)

= 312.5 V

Between 112.5 V and 312.5 V

**48.**



**49.** 



**50.** 



**Chapter 1: Review Problems**

**1.** (a) 4 (b) 4 (c) 4 (d) 3

**2.** – |–2| – |–16| + 5

= – 2 – 16 + 5 = – 13

**3.** (a) 7.98 (b) 4.66

(c) 11.84 (d) 1.00

**4.** (a) 179 (b) 1.08

(c) 4.86 (d) 45 700

**5.** 5 – |– 5| + 6 = 5 – 5 + 6 = 6

**6.** (a) 6 (b) 6 (c) 3 (d) 2

**7.**

–4 – 31 + 41 – 12 – |+5| + 7 – 2

= –6 – 5 + 5 = – 6

**8.** (a) 4 and 1 (b) 8 and 3

(c) 3 and 6 (d) 5 and 3

**9.**

|–12| – 21 + |+1|

= 12 – 21 + 1 = –8

**10.** 83.35

**11.** 9.64

**12.** 

**13.** 94.7

**14.** 0.0166

**15.** 5.46

**16.** 

**17.** 2.42

**18.** 

**19.** 0.180

**20.** 4.939

**21.** 109

**22.** 17.0

**23.** 

**24.** 14.7

**25.** 0.0172

**26.** 6.20

**27.** 

**28.** 0.37

**29.** 7.239

**30.** 121

**31.** 9.54

**32.**



**33.** 0.30

**34.** 88.1

**35.** 75.2

**36.** 6.76

**37.** 

**38.** – 385 + 272 + 102 – 284 = – 295

**39.** (–33.1)(2.84) = – 94.0

**40.**



**41.**



**42.**



**43.**



**44.**

(a) 

(b)



**45.**



**46.** 

**47.** 52 800

**48.**



**49.**



**50.**



**51.** 



**52.**



**53.**



**54.**



**55.**



**56.**



**57.**



**58.**



**59.**



**60.**



**61.**



**62.**



**63.**



**64.** Let *y* = new speed



**65.**



**66.** 

**67.**





**69.**



**70.**



**71.**



**72.**



**73.**

