1 Manipulation of formulae and dilutions

This first chapter of questions is specifically designed to cover a range of numeracy skills. It will give the user further experience in the skills of addition, subtraction, multiplication and division. Competence and confidence in these four skills, along with a heightened understanding of the place of calculations for the modern-day pharmacist, is key to success within the area of pharmaceutical calculations. We suggest for this chapter, as with the other chapters, that students should work in a methodical fashion and clearly record their 'working out' so that they can quickly identify any errors when reference is made to the worked answers. It is also important to show your 'working out' if you are sitting an examination that involves an external examiner, which is applicable to most undergraduate programmes and some registration body examinations. It is important when manipulating any formula to pay particular attention to the units used within the formula and then to compare these with the units within the suggested answers. The concept of dilutions is important and a frequent calculation carried out in practice by pharmacists. If a product is not diluted appropriately it can have fatal consequences for a patient.[1]

After completing the questions in this chapter you should be able to:

- arrange formulae in the most appropriate format for manipulation
- recognise when units need to be changed to be able to identify the correct answer
- demonstrate your ability to calculate a dosage regimen
- perform calculations involving the dilution and mixing of solutions and suspensions.

Reference

1. Anon (1998). Baby dies after peppermint water prescribed for colic. *Pharmaceutical Journal* **260**: 768.

QUESTIONS

Directions for Questions 1–7. In this section, each question or incomplete statement is followed by five suggested answers. Select the best answer in each case.

1   A liquid medicine is supplied in a concentration of 20 mg/5 mL. A patient requires 40 mg orally three times daily for 5 days, then 20 mg three times daily for 5 days, then 20 mg twice daily for 5 days and then 20 mg once daily for 5 days. Which of the following is the volume of liquid medicine that you will need to dispense?

    A   600 mL
    B   200 mL
    C   300 mL
    D   60 mL
    E   30 mL

2   You are required to make 350 g of a paste that contains 15% w/w zinc oxide. Which of the following is the amount of zinc oxide required?

    A   5.25 g
    B   52.50 g
    C   35.00 g
    D   3.50 g
    E   15.00 g

3   A 1 in 10 000 solution of potassium permanganate contains which of the following concentrations?

    A   50.0 mg potassium permanganate in 500 mL solution
    B   1.0 mg potassium permanganate in 100 mL solution
    C   5.0 mg potassium permanganate in 500 mL solution
    D   1.0 mg potassium permanganate in 1000 mL solution
    E   3.0 mg potassium permanganate in 300 mL solution

4   Which of the following volumes of an adrenaline 1 in 100 solution would be given by intramuscular injection to a 2-year-old child for treatment of anaphylaxis if the dose were 120 micrograms stat?

    A   12.00 mL
    B   120.00 mL

C   0.12 mL
D   24.0 mL
E   0.24 mL

5   Which of the following amounts of copper sulphate is required to make 400 mL of an aqueous stock solution, such that, when the stock solution is diluted 50 times with water, a final solution of 0.1% w/v copper sulphate is produced?

A   0.2 g
B   20.0 g
C   0.4 g
D   40.0 g
E   50.0 g

6   A child requires a single oral daily dose of 7.0 mg/kg body weight of drug A. The child's weight is 8.0 kg. Which of the following oral daily doses of drug A is received by this child?

A   0.82 mg
B   8.20 mg
C   82.00 mg
D   5.60 mg
E   56.00 mg

7   A patient in one of the residential homes to which you supply medication is going on holiday and needs her prescriptions made up for the 5 days that she will be away. If she usually takes ranitidine 150 mg twice daily and atenolol 50 mg in the morning, which of the following combinations of Zantac syrup (75 mg ranitidine/5 mL) and Tenormin syrup (25 mg atenolol/5 mL) would you supply?

A   50 mL Zantac syrup and 50 mL Tenormin syrup
B   100 mL Zantac syrup and 50 mL Tenormin syrup
C   50 mL Zantac syrup and 100 mL Tenormin syrup
D   150 mL Zantac syrup and 50 mL Tenormin syrup
E   75 mL Zantac syrup and 25 mL Tenormin syrup

Directions for Questions 8–10. For each numbered question, select the one lettered option to which it is most closely related. Within the group of questions, each lettered option may be used once, more than once or not at all.

Questions 8–10 concern the following quantities:

    A   100 mL
    B   1000 mL
    C   4200 mL
    D   420 mL
    E   4.2 mL

Select, from A to E above, which is appropriate:

8   The volume of an oral liquid medicine, available as 2 mg drug X/5 mL, which is required for a 14-day supply for a patient prescribed a dose of 4 mg drug X three times daily.

9   The volume of alcohol 95% v/v needed to produce 1.90 L of 50% v/v.

10 The volume of concentrated peppermint water required to make 16.8 L of single-strength peppermint water. (Single-strength peppermint water is 1 part concentrate to 39 parts water.)

Directions for Questions 11 and 12. The questions in this section are followed by three responses. **ONE** or **MORE** of the responses is (are) correct. Decide which of the responses is (are) correct. Then choose:

Directions summarised:

A	B	C	D	E
1, 2, 3	1, 2 only	2, 3 only	1 only	3 only

11 Which of the following is/are correct?

    1   2.0 mL codeine adult linctus (15.0 mg/5.0 mL) is required to make up 100.0 mL paediatric codeine linctus (3.0 mg/5.0 mL)
    2   10.0 g calcium carbonate is needed to prepare 1.0 L solution such that 50.0 mL of this solution diluted to 200.0 mL gives a 0.5% w/v solution
    3   0.045% w/v is equivalent to 450 micrograms/mL

12 Which of the following is/are correct?

    1   20.0 mg in 5.0 mL equates to a 1 in 250 solution

    2   3.2 g of 5-aminolevulinic acid hydrochloride is required to make 800.0 mL of a 0.4% w/v solution

    3   A 1 in 125 solution equates to 0.8% w/v

Directions for Questions 13–19. In this section, each question or incomplete statement is followed by five suggested answers. Select the best answer in each case.

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13 Potassium permanganate solution 1 in 8000 is prepared from a stock of 10 times this strength. How much potassium permanganate will be needed to make sufficient stock solution if a patient uses 200 mL of the diluted solution each day for 20 days?

    A   100 mg
    B   125 mg
    C   250 mg
    D   400 mg
    E   500 mg

14 What volume of phenytoin suspension 30 mg/5 mL is required to be added to a suitable diluent to obtain 150 mL phenytoin suspension 20 mg/5 mL?

    A   75 mL
    B   100 mL
    C   120 mL
    D   125 mL
    E   130 mL

15 Given a 20% w/v solution of chlorhexidine gluconate, what volume is required to make 400 mL of a 2% w/v solution?

    A   40 mL
    B   20 mL
    C   80 mL
    D   2 mL
    E   4 mL

16 Which of the following shows the correct amounts of sodium chloride and anhydrous glucose present in 500 mL of intravenous infusion containing sodium chloride 0.18% w/v and anhydrous glucose 4.00% w/v?

    A Sodium chloride 0.18 g and anhydrous glucose 20.00 g
    B Sodium chloride 0.90 g and anhydrous glucose 20.00 g
    C Sodium chloride 0.90 g and anhydrous glucose 40.00 g
    D Sodium chloride 1.80 g and anhydrous glucose 20.00 g
    E Sodium chloride 1.80 g and anhydrous glucose 40.00 g

17 You are presented with a prescription for allopurinol tablets 100 mg at a dose of 300 mg each day for 14 days, reducing to 200 mg for a further 7 days. How many packs of 28 tablets should you supply?

    A Two
    B Three
    C One
    D Four
    E One and a half

18 An injection solution contains 0.5% w/v of active ingredient. How much of the active ingredient is needed to prepare 500 L of solution?

    A 0.25 kg
    B 0.50 kg
    C 1.00 kg
    D 2.50 kg
    E 5.00 kg

19 A patient taking 10.0 mL Erythroped suspension (250 mg/5 mL) qid will receive how much erythromycin each day?

    A 2.0 g
    B 20.0 g
    C 4.0 g
    D 40.0 g
    E 2.5 g

Directions for Questions 20–22. For each numbered question, select the one lettered option that is most closely related to it. Within the group of questions, each lettered option may be used once, more than once or not at all.

Questions 20–22 concern the following numbers:

    A   10
    B   15
    C   20
    D   60
    E   25

Select, from A to E above, which is appropriate:

20 The number of days a 150 mL bottle of nitrazepam 2.5 mg/5 mL suspension will last a patient prescribed nitrazepam 5 mg at bedtime for insomnia.

21 The number of tablets required to fulfil the following prescription:

> Prednisolone 5 mg e/c tablets
> Take 25 mg daily for 4 days, then reduce by 5 mg every 4 days until the course is finished (total course: 20 days)

22 The number of drops per minute required if 720 mL of 5% w/v glucose is to be given intravenously to a patient over a 12-hour period. It is known that 20 drops = 1 mL.

Directions for Questions 23 and 24. The questions in this section are followed by three responses. **ONE** or **MORE** of the responses is (are) correct. Decide which of the responses is (are) correct. Then choose:

Directions summarised:

A	B	C	D	E
1, 2, 3	1, 2 only	2, 3 only	1 only	3 only

23 Which of the following is/are correct?

    1   In order to make 250 g of 0.5% w/w salicylic acid in Hydrous Ointment, BP, 1.25 g salicylic acid is required

    2   400 mL of a 1 in 2000 solution of proflavine hemisulphate contains 0.02 g of the drug

    3 4×100 mg spironolactone tablets will be required to make 100 mL of a 25 mg/5 mL spironolactone suspension for a patient who is unable to swallow solids

24 Which of the following is/are correct?

    1   A patient weighing 12.5 kg requires an oral daily dose of trimethoprim 2 mg/kg for 10 days. You would need to supply 25 mL trimethoprim suspension 50 mg/5 mL

    2   560 mL cimetidine suspension 200 mg/5 mL is required to be sent to a nursing home resident to cover a 28-day supply if the resident takes 400 mg twice daily

    3   A patient requires four tablets a day for 56 days; you would supply 224 tablets

Directions for Questions 25–31. In this section, each question or incomplete statement is followed by five suggested answers. Select the best answer in each case.

25 In your pharmacy you have a stock solution of drug F with a concentration of 25% w/v. Drug F is used as a mouthwash at a concentration of 0.25% w/v. You are requested to supply 50 mL of a solution of intermediate strength, such that the patient will dilute this solution 1 in 20 to get the correct concentration immediately before use. Which of the following should be the concentration of the intermediate solution?

    A   5% w/v
    B   10% w/v
    C   2.5% w/v
    D   0.5% w/v
    E   15% w/v

26 You receive a prescription for phenindione tablets 50 mg with the following instructions: '200 mg on day 1, 100 mg on day 2 and then 50 mg daily thereafter'. Mitte: 56 days' supply.
Which of the following is the correct quantity to supply?

    A   60 tablets
    B   84 tablets
    C   56 tablets
    D   120 tablets
    E   90 tablets

27 An ointment contains 1% w/w calamine. Which of the following is the amount of calamine powder that should be added to 200 g of the ointment to produce a 4% w/w calamine ointment?

    A 0.625 g
    B 6.250 g
    C 62.50 g
    D 5.0 g
    E 50.0 g

28 A patient weighing 30 kg requires a single oral daily dose of 9 mg/kg of drug B. This drug is available only as a suspension of 15 mg/5 mL. How much suspension would you supply?

    A 1350 mL
    B 45 mL
    C 50 mL
    D 100 mL
    E 90 mL

29 Which of the following is the volume of a 6% w/v solution that is required to give a single dose of 12 mg?

    A 4.0 mL
    B 2.0 mL
    C 0.2 mL
    D 0.5 mL
    E 1.0 mL

30 Fertiliser residues are sometimes found in drinking water in rural areas. For compound Z, the safe limit for drinking water is 9 ppm. Analytical results for the amount of compound Z in the drinking water of various villages are given below. Which **ONE** of the following villages has drinking water that is safe to drink?

    A Toome: 24.6 micrograms/mL
    B Blackhill: 0.3 mg/L
    C Drumhowan: 0.009% w/v
    D Magheracloone: 0.041% w/v
    E Annagassan: 1 in 100 000

31 Which of the following is the concentration of a solution prepared by dissolving 400 mg potassium permanganate in water and making up to a final volume of 4.0 L.

A   4% w/v
B   1% w/v
C   0.4% w/v
D   0.1% w/v
E   0.01% w/v

Directions for Questions 32–34. For each numbered question, select the one lettered option that is most closely related to it. Within the group of questions, each lettered option may be used once, more than once or not at all.

Questions 32, 33 and 34 concern the following quantities:

A   0.8 mL
B   8.0 mL
C   150.0 mL
D   0.15 mL
E   1.5 mL

Select, from A to E above, which is appropriate:

32 The volume of amoxicillin syrup 125 mg/5 mL required by a child prescribed 250 mg amoxicillin orally three times daily for 5 days.

33 The volume of a 5% w/v solution required to give a dose of 40 mg.

34 The volume required to give a 15 mg dose of haloperidol from a 2 mL ampoule containing 10 mg haloperidol/mL.

Directions for Questions 35 and 36. The questions in this section are followed by three responses. **ONE** or **MORE** of the responses is (are) correct. Decide which of the responses is (are) correct. Then choose:

Directions summarised:				
A	**B**	**C**	**D**	**E**
1, 2, 3	1, 2 only	2, 3 only	1 only	3 only

35 Which of the following is/are correct?

1   40 mL of a 5% v/v ethanol solution contains 0.2 mL ethanol

2 1000 mL of a 3% w/v salicylic acid lotion contains 30 g salicylic acid

3 200 mL of a 0.02%w/v beclometasone solution contains 0.04 g beclometasone

36 Which of the following is/are correct?

1 Peptac suspension contains 3.1 mmol sodium/5 mL. A patient taking Peptac suspension 20 mL three times daily receives 37.2 mmol sodium ions from this medication each day

2 A suitable dose of carbamazepine in epilepsy for a child up to 1 year is 100–200 mg daily in divided doses. An appropriate dose of Tegretol liquid (100 mg carbamazepine/5 mL) for a 10-month-old baby with epilepsy is 7.5 mL daily in divided doses

3 A doctor requests 50.00 g of 0.05% w/w salicylic acid cream. The amount of salicylic acid required to prepare this cream is 2.50 mg

Directions for Questions 37–43. In this section, each question or incomplete statement is followed by five suggested answers. Select the best answer in each case.

37 You mix together 50 g of 0.5% w/w hydrocortisone cream and 25 g of 2% w/w sulphur cream (the creams are compatible). What is the final concentration of each of the two drugs?

A 0.5% w/w hydrocortisone cream and 2.0% w/w sulphur
B 0.25% w/w hydrocortisone cream and 1.00% w/w sulphur
C 0.33% w/w hydrocortisone cream and 0.67% w/w sulphur
D 0.67% w/w hydrocortisone cream and 0.33% w/w sulphur
E 0.33% w/w hydrocortisone cream and 0.33% w/w sulphur

38 A patient is prescribed a reducing oral dose of prednisolone as follows:

Day 1: 10 mg
Day 2: 8 mg
Day 3: 6 mg
Day 4: 4 mg
Day 5: 3 mg

Day 6: 2 mg

Day 7: 1 mg

Prednisolone is supplied as 5 mg and 1 mg tablets. Prednisolone tablets cannot be split. Therefore, the patient needs to take a number of whole tablets. How many of each tablet strength would it be most appropriate to supply?

    A   Four 5 mg tablets and fourteen 1 mg tablets

    B   Fourteen 5 mg tablets and four 1 mg tablets

    C   Five 5 mg tablets and fifteen 1 mg tablets

    D   Fifteen 5 mg tablets and five 1 mg tablets

    E   One 5 mg tablet and twenty 1 mg tablets

39 A patient weighing 50 kg requires a single oral daily dose of 9 mg/kg of drug Y. This drug is available only as a suspension of 150 mg/5 mL. How much suspension would it be most appropriate to supply to provide a single dose?

    A   10 mL

    B   5 mL

    C   20 mL

    D   15 mL

    E   25 mL

40 You are requested to supply 35 g of a cream containing 20% w/w methylaminolevulinate for use in a photodynamic therapy clinical trial. You have Cetomacrogol Cream, BP in your hospital pharmacy department and can use this as the cream base. What is the formula for your methylaminolevulinate cream?

    A   10 g methylaminolevulinate and 25 g Cetomacrogol Cream, BP

    B   30 g methylaminolevulinate and 5 g Cetomacrogol Cream, BP

    C   5 g methylaminolevulinate and 30 g Cetomacrogol Cream, BP

    D   7 g methylaminolevulinate and 28 g Cetomacrogol Cream, BP

    E   28 g methylaminolevulinate and 7 g Cetomacrogol Cream, BP

41 You have in your pharmacy a cream containing 0.5% w/w hydrocortisone. You have been requested to use this cream as a base and to add in sufficient calamine such that the final concentration of calamine in the new cream will be 10.0% w/w. What is the concentration of hydrocortisone in the new cream?

    A   0.3% w/w
    B   0.45% w/w
    C   0.5% w/w
    D   0.05% w/w
    E   0.045% w/w

42 A stock solution of drug G is available at 10%w/v. You need to dilute this with Syrup, BP in order to supply a patient with a solution containing 5 mg/mL of drug G. Assuming no volume displacement effects, what is your formula for the preparation of 100 mL of the final solution?

    A   10 mL stock solution and 90 mL Syrup, BP
    B   80 mL stock solution and 20 mL Syrup, BP
    C   20 mL stock solution and 80 mL Syrup, BP
    D   95 mL stock solution and 5 mL Syrup, BP
    E   5 mL stock solution and 95 mL Syrup, BP

43 A patient is on a continuous intravenous drip of drug B. He needs to be dosed at a rate of 25 mg/h. The drip is set to administer 10 drops of fluid/h, with 4 drops equalling 1 mL in volume. Which of the following is the concentration of drug B in the intravenous fluid?

    A   1 mg/mL
    B   10 mg/mL
    C   5 mg/mL
    D   2.5 mg/mL
    E   25 mg/mL

Directions for Questions 44–46. For each numbered question, select the one lettered option that is most closely related to it. Within the group of questions, each lettered option may be used once, more than once or not at all.

Questions 44, 45 and 46 concern the following quantities:

    A   0.02 mg
    B   0.20 mg
    C   2.00 mg
    D   1.00 mg
    E   0.10 mg

Select, from A to E above, which is appropriate:

44 The amount of phytomenadione contained in a 0.2 mL ampoule of 10 mg/mL solution.

45 The weight of chlorhexidine contained in 2 mL of a 1 in 10 000 solution.

46 The weight of ethambutol contained in 0.4 mL of 250 micrograms/mL solution.

Directions for Questions 47 and 48. The questions in this section are followed by three responses. **ONE** or **MORE** of the responses is (are) correct. Decide which of the responses is (are) correct. Then choose:

Directions summarised:

A	B	C	D	E
1, 2, 3	1, 2 only	2, 3 only	1 only	3 only

47 Which of the following is/are correct?

1 125 g porfimer sodium is needed to produce 200 mL of a stock solution which, when 10 mL is diluted to 5 L, produces a 1 in 8000 solution

2 0.02 mL of a 1 in 10 000 solution will provide a 0.2 mg dose of dexamethasone

3 A patient is prescribed three tablets a day for 56 days; you should supply 168 tablets

48 Drug D is given in total daily doses based on body surface area, with the standard total daily dose being 2.2 mg/m². Which of the following is/are correct?

1 A patient with body surface area of 1.80 m² should receive a total daily dose of 3.96 mg

2 A patient with body surface area of 2.00 m² should receive a total daily dose of 4.40 mg

3 A patient with body surface area of 1.50 m² should receive a total daily dose of 3.30 mg

Directions for Questions 49–55. In this section, each question or incomplete statement is followed by five suggested answers. Select the best answer in each case.

49 You are providing prescribing advice to a local surgery. To assist in prescribing inhaled salbutamol cost-effectively you need to compare the cost of the preparations listed. Which one of the following is the **least** expensive for a 200 micrograms dose?

  A   Accuhaler 60 doses/200 micrograms per dose (£6.00/ US$11.70)
  B   Generic inhaler 200 doses/100 micrograms per dose (£2.00/ US$3.90)
  C   Easi-Breathe inhaler 200 doses/100 micrograms per dose (£6.00/US$11.70)
  D   Rotacaps 200 micrograms × 112 doses (£5.60/US$10.92)
  E   Salbutodiscs 200 micrograms/14 × 8 dose refill (£5.60/ US$10.92)

50 It is recommended that fluoride supplements be taken when the municipal water supply has a fluoride content of > 700 micrograms/L. Test results on fluoride content of drinking water from various towns are listed below. People from which **ONE** of these towns should take fluoride supplements?

  A   Tyholland: 0.8 ppm
  B   Cremartin: 0.6 micrograms/mL
  C   Doohamlet: 0.00013% w/v
  D   Carrickmacross: 0.00041% w/v
  E   Annadrummond: 1 in 100 000

51 A liquid medicine is supplied in a concentration of 10 mg/5 mL. A patient requires 20 mg orally three times daily for 5 days, then 10 mg three times daily for 5 days, then 10 mg twice daily for 5 days, then 10 mg once daily for 5 days. Which of the following is the correct volume of the liquid medicine that will provide the full treatment course?

  A   300 mL
  B   200 mL
  C   100 mL
  D   150 mL
  E   250 mL

52 A patient requires an intravenous infusion of 0.9%w/v sodium chloride. In your hospital pharmacy department you have Water for Injections, BP and 4.5%w/v Sodium Chloride Solution, BP. Assuming no volume displacement effects, which of the following volumes of 4.5% w/v Sodium Chloride Solution, BP need to be added aseptically to an expandable PVC infusion bag containing 100 mL Water for Injections, BP to produce the requisite sodium chloride concentration?

    A   25 mL
    B   50 mL
    C   100 mL
    D   125 mL
    E   150 mL

53 A patient needs to use a 1 in 2500 chlorhexidine gluconate solution for wound washing. In your pharmacy you have a stock solution of 20%w/v chlorhexidine gluconate. Using this solution you need to prepare an intermediate solution such that the patient will then dilute this 20-fold to obtain a solution of the requisite concentration. Which of the following is the correct strength of the intermediate solution?

    A   0.5% w/w
    B   0.2% w/w
    C   1.0% w/w
    D   0.4% w/w
    E   0.8% w/w

54 Which of the following is the correct volume of a 5% w/v solution required to supply 150 mg of the active ingredient?

    A   30 mL
    B   20 mL
    C   3 mL
    D   2 mL
    E   5 mL

55 According to an official formula for potassium citrate mixture, 300 mL double-strength chloroform water is required per 1 L mixture. A 2-L bottle of mixture is required. If the double-strength chloroform water is prepared from concentrated chloroform water, which of the following is the correct volume of concentrate required? (Double-strength chloroform water is 2 parts concentrate to 38 parts water.)

A   10 mL
B   20 mL
C   3 mL
D   30 mL
E   15 mL

Directions for Questions 56–58. For each numbered question, select the one lettered option that is most closely related to it. Within the group of questions, each lettered option may be used once, more than once or not at all.

Questions 56–58 concern the following quantities:

A   8.4 mg
B   840 mg
C   8400 mg
D   625 mg
E   6250 mg

Select, from A to E above, which is appropriate:

56 The amount of methylene blue in 3 L of a 2.8 ppm aqueous solution.

57 The amount of fluorescein sodium in 300 mL of a 2.8% w/v aqueous solution.

58 The amount of 5-aminolevulinic acid hydrochloride in 25 g of a 20% w/w cream.

Directions for Questions 59 and 60. The questions in this section are followed by three responses. **ONE** or **MORE** of the responses is (are) correct. Decide which of the responses is (are) correct. Then choose:

Directions summarised:

A	B	C	D	E
1, 2, 3	1, 2 only	2, 3 only	1 only	3 only

59 A patient needs to use a 1 in 10 000 potassium permanganate solution for wound washing. In your pharmacy you have tablets of 400 mg

potassium permanganate. Using (an) intact tablet(s) you need to prepare an intermediate solution such that the patient will then dilute this 10-fold to obtain a solution of the requisite concentration.

Which of the following is/are correct?

1 The intermediate solution has a concentration of 1.0 mg/mL
2 You need to use two tablets to prepare the intermediate solution
3 The volume of the intermediate solution is 500 mL

60 A patient is prescribed 20 g glucose to be given as a glucose 50% w/v injection at a constant rate over a period of 5 hours.
Which of the following is/are correct?

1 The patient will receive 50 mL glucose 50%w/v injection by the end of the 5-hour delivery period
2 After 2 hours, the patient will have received 15 g glucose
3 The amount of glucose in 30 mL of the injection is 15 g