CALIBRATION WORKBOOK

This workbook has been developed to provide additional support to Assessors following the 2018/19 Pesticide Assessor Updates.

We haven't developed it to be PA unit specific. It covers the principles of calibration which can be applied to many of the items of application equipment that we see during assessment.

Assessor Name: ……

Assessor Number: ……

Date Completed: ……

Throughout this workbook there are questions to answer. Each question is prefixed by a number and the answers are provided at the rear of the workbook.

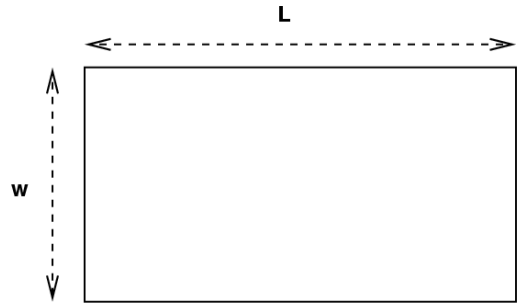
Please answer all the questions and keep the completed copy in your assessor portfolio.

What is calibration?

To calibrate is to determine, check, or rectify the graduation of any instrument giving quantitative measurements.

In our case, the 'instrument' is the pesticide applicator.

Area Calculations



Area can be calculated in hectares (ha) or square metres (m^2).

As a general rule, large scale equipment = ha and small scale equipment = m^2.

To convert ha to m^2, multiply by 10,000

To convert m^2 to ha, divide by 10,000

Area questions

Q1: Convert 0.14ha to m^2.

A1: ……

Q2: Convert 13,400m^2 to ha.

A2: ……

Q3: Convert 0.009ha to m^2.

Q3: ……

Speed Calculations

Speed is most commonly expressed in kilometres per hour (kph) for both large and small scale spraying.

To calculate forward speed:

360 ÷ time (sec) to travel 100m = speed in kph

E.g. 360 ÷ 45 = 8 kph

However, metres per second (m/s) can also be used. To convert to seconds per 100 metres:

100 ÷ speed in m/s = seconds per 100m.

E.g. 100 ÷ 1.1 = 90.9 seconds per 100m

We can then calculate forward speed (kph) in the usual way (using the 360 factor above).

Another method of converting metres per second (m/s) to kilometres per hour (kph) is as follows:

Speed in m/s x 60 x 60 ÷ 1000 = speed in kph

E.g. 1.3 x 60 x 60 ÷ 1000 = 4.68 kph

Speed questions

Q4: 100m run took 90 sec. Calculate speed in kph.

A4: ……

Q5: 50m run took 20 sec. Calculate speed in kph.

A5: ……

Q6: 1.25 metres per sec. Calculate speed in kph.

A6: ……

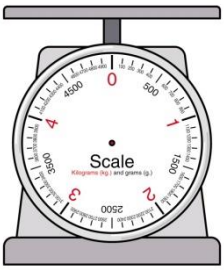
Remember…..

…..it is quite common to carry out a ‘timed run’ over a range of distances. For example, if space is an issue a candidate may walk 50m and the result multiplied by 2 to give seconds per 100m.

Seconds ÷ distance travelled x 100 = seconds per 100m

E.g. 48 seconds ÷ 50 metres x 100 = 96 seconds per 100m

Volume/weight calculations



Volume can be expressed in litres (l) or millilitres (ml). Weight can be expressed in kilograms (kg) or grams (g).

To convert litres to millilitres, multiply by 1,000

To convert millilitres to litres, divide by 1,000

To convert kilograms to grams, multiply by 1,000

To convert grams to kilograms, divide by 1,000

Time calculations

In calibration calculations, time is usually expressed in minutes (min), or seconds (s).

The majority of speed-based calibration methods require the operator to record the number of seconds taken to cover a distance.

Applicator outputs are quite often expressed in litres/kilograms per minute.

Time questions

Q7: Express 1min 18s in seconds.

A7: ……

Q8: Express 105s in minutes and seconds.

A8: ……

Q9: Express 6min 24s in seconds.

A9: ……

Speed based calibration

Large scale application (e.g. boom sprayer with a pressure gauge or granule applicator)

A forward speed, nozzle spacing/row width/spread width and application volume/rate is required. From this information we can calculate either individual nozzle/outlet or overall output.

Speed based (large scale) examples

For boom sprayers:

Forward speed (kph) x application volume (l/ha) x nozzle width (m) ÷ 600 = individual nozzle output (l/min)

E.g. 8 kph x 200 l/ha x 0.5 m ÷ 600 = 1.33 l/nozzle/min

For broadcast (orchard) sprayers:

Forward speed (kph) x application volume (l/ha) x row width (m) ÷ 600 ÷ number of nozzles = individual nozzle output (l/min).

E.g. 4 kph x 500 l/ha x 5.4 m ÷ 600 ÷ 8 = 2.25 l/nozzle/min

For granule applicators:

Forward speed (kph) x application rate (kg/ha) x spread width (m) ÷ 600 = applicator output (kg/min).

E.g. 16 kph x 5 kg/ha x 12 m ÷ 600 = 1.6 kg/min

We could then follow with a flow-based calibration – as covered further on in this workbook.

Speed based (large scale) questions

Q10: 0.5m width, 150 l/ha, 9 kph. Calculate individual nozzle output (l/min).

A10: ……

Q11: 12m width, 7 kg/ha, 12 kph. Calculate overall output (kg/min).

A11: ……

Q12: 5.4m row, 500 l/ha, 4 kph, 6 nozzles. Calculate individual nozzle output (l/min).

A12: ……

Small scale spraying (e.g. knapsack or hand-held mist blower)

A forward speed, swath width/row width and applicator output is required. From this information we can calculate the overall application volume/rate.

Speed based (small scale) examples

For knapsack sprayers:

> Nozzle output (l/min) x 600 ÷ forward speed (kph) ÷ swath width (m) = overall application volume (l/ha)
>
> *E.g. 2.1 l/min x 600 ÷ 3.85 kph ÷ 1.1 m = 297.52 l/ha*

For hand-held mist blowers:

> Applicator output (l/min) x 600 ÷ forward speed (kph) ÷ row/bed width (m) = overall application volume (l/ha)
>
> *E.g. 1.95 l/min x 600 ÷ 2.1 kph ÷ 3 m = 185.71 l/ha*

However…..

…..the small scale example can also be used for large scale applicators. This is often the case with broadcast sprayers.

There are disadvantages with doing this type of calibration for large scale application as operators tend to like to work to round figures (e.g. 100, 150 or 200 litres per ha) to make field planning easier.

Speed based (small scale) questions

Q13: 1 l/min output, 3.5 kph, 2m width. Calculate application volume (l/ha).

A13: ……

Q14: 4.2 kph, 1.1m width, 1.25 l/min output. Calculate application volume (l/ha).

A14: ……

Q15: 2.35 kph, 2 l/min, 3m bed width. Calculate application volume (l/ha).

A15: ……

Non-speed based calibration

Non-speed based calibration is usually carried out for small scale applications.

The output of the applicator is calculated by measuring the amount of product used for a given area. There isn't a requirement to calculate a forward speed.

Non-speed based example

Time (seconds) to walk a known distance (e.g. 100m)
Record applicator output for time required to cover the known distance (e.g. 100m)

Output (kg or l) for 100m ÷ distance walked ÷ width (m) x 10,000 = application rate per ha.

E.g. 2.05 litres ÷ 100m ÷ 1.2m x 10,000 = 170.83 l/ha

This can work over any distance. If you re-calculate the above using 1.025 litres used over a 50m run and you will end up with the same answer.

E.g. 1.025 litres ÷ 50m ÷ 1.2m x 10,000 = 170.83 l/ha

Non-speed based questions

Q16: 1 litre output for 50m run. 1.3m width. Calculate application volume (l/ha).

A16: ……

Q17: 1.75 litre output for 100m run. 1.25m width. Calculate application volume (l/ha).

A17: ……

Q18: 0.7 kg output for 100m run. 3m width. Calculate application rate (kg/ha).

A18: ……

Dynamic calibration

This is where a quantity for a known area is added to the applicator, followed by application to the known area.

Commonly used (but not exclusively) for calibrating granule applicators or for checking flow meters on boom sprayers.

Dynamic examples

Example 1 (boom sprayer):

10,000 ÷ working width (m) = distance to travel to cover 1 hectare.

E.g. 10,000 ÷ 24m = 416.66m

The amount of liquid required for 1ha (e.g. 200 litres) is added to applicator and the 1ha 'run' is travelled.

Example 2 (granule applicator):

Application rate/volume (kg or l/ha) ÷ 10,000 x distance travelled (m) x working width (m) = product required for area (kg or l)

E.g. 5kg/ha ÷ 10,000 x 100m x 12m = 0.6kg required for area.

Dynamic questions

Q19: 24m boom width, 75 litres used over 208.4m. Calculate application volume (l/ha).

A19: ……

Q20: 12m spread width, 100m run, 7 kg/ha. Calculate amount required for run (kg).

A20: ……

Q21: 18m boom, 50 litres used over 138.9m. Calculate application volume (l/ha).

A21: ……

Dynamic calibration – useful information:

Working Width (m):	Distance to travel to cover 1ha (m):
12m	833.33m
18m	555.55m
20m	500m
24m	416.66m
30m	333.33m
36m	277.77m

Flow based calibration

This is where a known quantity is added to the applicator, followed by the amount of time required for the machine to deposit the known quantity.

Commonly (but not exclusively) used for static calibration of granule applicators and mist blowers/fogging machines.

Flow based example

Amount in tank/hopper ÷ time (sec) to discharge tank/hopper contents x 60 = output per min.

E.g. 2kg ÷ 80 x 60 = 1.5kg/min

This can be preceded by a speed based (large scale calibration) or followed by a speed based (small scale) calibration – depending on type of equipment.

Flow based questions

Q22: 3kg in hopper, 130 sec to discharge. Calculate flow rate (kg/min).

A22: ……

Q23: 2 litres in tank, 63 sec to discharge. Calculate flow rate (l/min).

A23: ……

Q24: 2 kg in hopper, 1 min 45 sec to discharge. Calculate flow rate (kg/min).

A24: ……

Calculating quantities

Quantities for a known area – large scale (ha)

Pesticide:

Pesticide dose rate (l/ha) x area (ha) = pesticide required for area (litres).

Example:

3 l/ha dose rate, 15ha field.

3 x 15 = 45 litres

Quantities for a known area – large scale (ha)

Water:

Water volume (l/ha) x area (ha) = water required for area (litres).

Example:

200 l/ha water volume, 15ha field.

200 x 15 = 3000 litres

Quantities for known areas (large scale ha) questions

Q25: 19.5ha field, 2.75 l/ha dose rate. Calculate amount of pesticide required.

A25: ……

Q26: 200 l/ha volume, 9.25ha field. Calculate total volume required.

A26: ……

Q27: 3 l/ha dose rate, 24ha field, 100 l/ha volume. Calculate amount of pesticide, and amount of water required.

A27: ……

Remember…..

…..when calculating water required for field/plot, please allow for the amount of pesticide as follows:

Total volume for area – pesticide for area = water for area.

Quantities for a known area – small scale (m^2)

Pesticide:

Pesticide dose rate (l/ha) ÷ 10,000 x area (m^2) = pesticide required for area (litres).

Example:

5 l/ha dose rate, 205m^2 plot.

5 ÷ 10,000 x 205 = 0.1025 litres (102.5ml)

(If quantity required in ml, then multiply by 1000)

Quantities for a known area – small scale (m^2)

Water:

Water volume (l/ha) ÷ 10,000 x area (m^2) = water required for area (litres).

Example:

150 l/ha water volume, 205m^2 plot.

150 ÷ 10,000 x 205 = 3.075 litres (3075ml)

(If quantity required in ml, then multiply by 1000)

Quantities for known areas (small scale m^2) questions

Q28: 195 l/ha volume, 10m x 18.5m plot. Calculate total volume required.

A28: ……

Q29: 190 m^2 plot, 2.75 l/ha dose. Calculate amount of pesticide required.

A29: ……

Q30: 15m x 14m plot, 205 l/ha volume, 3 l/ha dose. Calculate amount of pesticide and amount of water required.

A30: ……

Remember…..

…..when calculating water required for field/plot, please allow for the amount of pesticide as follows:

Total volume for area – pesticide for area = water for area.

Full tank calculations

Pesticide dose rate (l/ha) ÷ water volume (l/ha) x tank capacity (litres) = concentrate required for full tank (litres)

Example:

5 l/ha pesticide dose rate, 200 l/ha volume, 2000 litre tank.

5 ÷ 200 x 2000 = 50 litres

(If quantity required in ml, then multiply answer by 1000)

Full tank calculation questions

Calculate amount of pesticide for a full tank:

Q31: 16 litre tank, 5 l/ha dose, 145 l/ha volume.

A7: ……

Q32: 3.5 l/ha dose, 200 l/ha volume, 1500 litre tank.

A7: ……

Q33: 187 l/ha volume, 15 litre tank, 2.75 l/ha dose.

A7: ……

Rounding up/down

Most calculations can be rounded to 2 decimal points.

However, when working in millilitres it is often difficult to measure small quantities e.g. 56.58ml would usually be rounded to 56ml.

As a general rule, dose rate is always rounded down to avoid the risk of overdosing when the maximum dose rate has been selected.

Rounding questions

Round the following, taking into consideration the 'practicalities' of measuring small amounts:

Q34: 5.654 litres of water

A34: ……

Q35: 93.56 ml of pesticide

A35: ……

Q36: 2.8951 litres of water

A36: ……

Q37: 27.44 ml of pesticide

A37: ……

Other useful information

To calculate speed required at a fixed volume:

Flow rate (l/min) x 600 ÷ volume (l/ha) ÷ nozzle spacing (m) = speed (kph)

To calculate a spot work rate:

600 ÷ boom width (m) ÷ speed (kph) = minutes per hectare

360 Factor

3600 (seconds in an hour) ÷ seconds to travel 1 kilometre (1000 metres) = speed (kmh)

However, it is not feasible to carry out a timed run over 1000 metres so we divide both figures by 10 to give us the following:

360 ÷ seconds to travel 0.1 km (100 metres) = speed (kph)

600 Factor

This factor is used to convert units as follows:

10,000 (m2 per ha) ÷ 1000 (metres per km) x 60 (minutes per hour) = 600

ANSWERS

Question No.:	Answer:		Question No.:	Answer:
Q1	1,400 m2		Q20	0.84 kg
Q2	1.34 ha		Q21	200 l/ha
Q3	90 m2		Q22	1.38 kg/min
Q4	4 kph		Q23	1.90 l/min
Q5	9 kph		Q24	1.14 kg/min
Q6	4.5 kph		Q25	53.62 litres
Q7	78 seconds		Q26	1,850 litres
Q8	1 minute 45 seconds		Q27	72 litres + 2328 litres
Q9	384 seconds		Q28	3.61 litres
Q10	1.13 l/min		Q29	52 ml
Q11	1.68 kg/min		Q30	63 ml + 4.24 litres
Q12	3 l/min		Q31	0.55 litres (550 ml)
Q13	85.71 l/ha		Q32	26.25 litres
Q14	162.34 l/ha		Q33	0.22 litres (220 ml)
Q15	170.21 l/ha		Q34	5.65 litres
Q16	153.85 l/ha		Q35	93 ml
Q17	140 l/ha		Q36	2.90 litres
Q18	23.33 kg/ha		Q37	27 ml
Q19	150 l/ha			