From 2018 the mark scheme design/layout has improved. The content and marks remain the same.
mark scheme abbreviations

( ) the word, phrase or unit in brackets is not required but is in the mark scheme for clarification

accept accept the response

AND both responses are necessary for the mark to be allowed

c.a.o. correct answer only

e.c.f. error carried forward; marks are awarded if a candidate has carried an incorrect value forward from earlier working, provided the subsequent working is correct

ignore this response is to be disregarded and does not negate an otherwise correct response

NOT do not allow

note: additional marking guidance

/ OR alternative responses for the same marking point

owtte or words to that effect

underline mark is not allowed unless the underlined word or idea is used by candidate

units there is a maximum of one unit penalty per question unless otherwise indicated

any [number] from: accept the [number] of valid responses

max indicates the maximum number of marks
1 (a) table:
   at least 2 \(d\) values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.5 cm
   (accept values 50–\(d\))
   rule readings subtracted from 50 cm
   all 5 \(d\) values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.2 cm
   1/\(d\) values correct (note: at least 2 significant figures)

(b) any one difficulty and corresponding solution from:
   difficulty obtaining balance as rule tips one way then the other
   allow to tip one way then the other and take average
   mass obscuring marks on rule
   mark centre of the mass so it can be read against rule
   OR take average of right hand and left hand readings for mass position
   mass sliding off rule
   OR rule sliding off pivot
   suitable means for preventing mass or rule sliding

(c) graph:
   axes labelled with quantity and unit
   scales suitable, plots occupying at least half grid
   plots all correct to ½ square (take centre of plot if large)
   well-judged thin line (≤ ½ square)

(d) triangle method used and shown (any indication on graph) using at least half line
   (can be seen in calculation)

(e) \(\mu = 27 – 33\) (g) to 2 or 3 significant figures

2 (a) 23 (°C)

(b) any one from:
   wait for thermometer reading to stop rising
   eye level with top of (mercury) thread owtte
   stir water

(c) s, °C, °C, words or symbols AND
   30, 60, 90, 120, 150, 180

(d) uninsulated (owtte) OR no significant difference
   justified by reference to temperature differences and time
   relevant science, consistent with readings and conclusion
   (e.g. therefore cotton wool is a good/not a good insulator OR most cooling is due to convection or radiation etc.)
(e) quality poor due to small temperature differences

any two improvements from:
increase initial temperature of water
ensure initial temperatures are identical
use a lid
stir to eliminate differences between top and bottom of the water
use thicker insulation
use more sensitive thermometer or datalogger [max 2]

(f) any two from:
laboratory temperature
draughts/open windows
accept temperature of hot water source [max 2]

(g) 5–50 cm³ [1]

3 (a) correct symbol [1]
correct position [1]

(b) table:
1.68 (V) [1]

(c) (brightness) decreases (as length increases) [1]

(d) statement: no
justification matches statement and by reference to results
e.g. \( \frac{V}{l} \) not constant, as \( l \) increases \( V \) decreases, \( V \) does not double as \( l \) doubles [1]

(e) any one from:
width of sliding contact
achieving exact same position on wire
accept heating changes resistance of wire
accept other sensible practical reason [max 1]
NOT human error

(f) do not touch (bare/hot) wire
OR do not allow C to touch terminal between lamp and supply [1]
4 (a) apparatus:
measuring cylinder/jug OR ruler OR balance (to measure amount of water) [1]
protractor OR rule to measure height of raised surface
OR other means of measuring angle of tilt
OR newtonmeter to apply variable force
OR other method of applying quantifiable force [1]

instructions:
method of tilting or applying variable force and measuring point at which bottle topples [1]

attention to accuracy, any two from:
just starts to topple
slowly
repeats / more than 10 values for quantity of water
very large protractor
or any other suitable precaution which would improve accuracy of data [max 2]

values:
at least 5 values with range at least 1500 cm³ or 30 cm or 1500 g, approximately evenly spaced [1]

graph:
plot of measured variable (angle or height or force) against quantity of water (volume or height or mass) (accept vice versa) [1]

(b) 20° [1]