<2026 APhO, Experiment Marking Scheme>

Water Clock Experiment

A.1

W = 10.0 ($\pm$ 0.1) cm,

D = 10.0 ($\pm$ 0.1) cm

Marking Spacing = 1.0 ($\pm$ 0.05) cm

value within the range: 0.1 pt each

Significant figure (Total 0.2 pt)

All values are represented well	0.2 pt
One or two values are okay	0.1 pt

A.2

Number of repetitions,

Over 5	0.4 pt
3 – 4 repetitions	0.3 pt
2 repetitions	0.2 pt
1 measurement	0.1 pt

average value in a range of

13.1 – 13.9 sec.	0.4 pt
12.8 – 14.2 sec. but not in above range	0.2 pt

Calculate standard deviation,

< 0.2	0.2 pt
< 0.5	0.1 pt

A.3

Number of repetitions for over 4 initial heights,

Over 5	0.4 pt
3 – 4 repetitions	0.3 pt
2 repetitions	0.2 pt
1 measurement	0.1 pt

Less than 4 initial heights,

reduce 0.1 pt from the repetition scores.

(i.e. Record 2 initial heights, but repeat 5 times for each height: 0.3 pt

0.4 pt for over 5 repetitions and -0.2 pt for lack of initial height)

NOTE :
If the number of repetitions varies for each measurement height, select the 4 with

the most repetitions and calculate the average. Then, calculate the score using the rounded value.

(i.e. 3, 4, 5, 5 repetitions: average and rounded value is 4. then the score is 0.3 pt)

Compare experimental results of averaged time to the table,

If the value is in range A, 0.2 pt each,

in range B but not in range A, 0.1 pt each. The full score is 0.8 pt.

(If a student performs an experiment at 6 different heights, calculate points of 4 high scored experiments.)

Int. heights (cm)	Range A (sec.)	Range B (sec.)
4	14.7 – 15.7	14.4 – 16.0
5	13.1 – 13.9	12.8 – 14.2
6	11.8 – 12.6	11.6 – 12.8
7	10.7 – 11.3	10.5 – 11.6
8	9.8 – 10.4	9.6 – 10.6
9	9.3 – 9.9	9.1 – 10.1
10	8.6 – 9.2	8.5 – 9.3
11	8.1 – 8.7	8.0 – 8.8
12	7.8 – 8.2	7.6 – 8.4
13	7.5 – 8.0	7.4 - 8.2

Number of standard deviations less than 0.3,

over 4 measurements	0.3 pt
3 measurements	0.2 pt
2 measurements	0.1 pt

A.4

Compare the calculated speed with table.

Full score 1 pt.

In range A, 0.2 pt each and in range B but not in range A, 0.1 pt each.

(Include 5 cm results, at least 5 calculations are expected. If the number of results is over 5, consider high scored 5 answers.)

Int. heights (cm)	Range A (cm/s)	Range B (cm/s)
4	50.9 – 54.0	49.9 – 55.1
5	57.3 – 60.8	56.2 – 62.1
6	63.4 – 67.3	62.2 – 68.7
7	70.3 – 74.6	68.9 – 76.2
8	76.5 – 81.3	75.1 – 83.0
9	80.5 – 85.5	79.0 – 87.3
10	86.9 – 92.2	85.2 – 94.2
11	92.0 – 97.7	90.3 – 99.8
12	96.6 – 102.6	94.8 – 104.8
13	99.4 – 105.5	97.5 – 107.7

A.5

Plot $log - log$ graph : 0.3 pt

$h - v^a$ graph : 0.1 pt

Plot details (total 0.5 pt)

Labeling	0.2 pt
Unit	0.1 pt
Error bar	0.1 pt
graph area covers over 70 %	0.1 pt

Answer

0.49 – 0.56	0.2 pt
0.46 – 0.59	0.1 pt

B.1

Compare data with table

In range A (0.2 pt each), In range B (0.1 pt each)

The full score is 1.0. pt and only consider 5 data sets of high scored.

Int. heights (cm)	Range A (sec.)	Range B (sec.)
4	12.7 – 13.5	12.5 – 13.8
5	10.2 – 10.9	10.0 – 11.1
6	9.2 – 9.7	9.0 – 9.9
7	8.7 – 9.3	8.5 – 9.5
8	8.1 – 8.6	7.9 – 8.9
9	7.5 – 8.0	7.3 – 8.2
10	7.1 – 7.5	6.8 – 7.7
11	6.8 – 7.2	6.6 – 7.4
12	6.3 – 6.7	6.1 – 6.9
13	6.2 – 6.6	6.0 – 6.8

Number of repetitions

over 5	0.3 pt
3 ~ 4	0.2 pt
1 ~ 2	0.1 pt

standard deviations

over 3 measurements < 0.3	0.2 pt
1~2 measurements < 0.3	0.1 pt

B.2

Compare the calculated values with table.

in Range A : 0.1 pt

in Range B but not in range A : 0.05 pt

Init. Heights (cm)	Range A (cm/s)	Range B (cm/s)
4	58.8 – 62.5	57.7 – 63.8
5	73.2 – 77.8	71.8 – 79.4
6	81.8 – 86.8	80.2 – 88.6
7	95.9 – 91.2	83.5 – 94.1
8	92.2 – 97.9	89.5 – 101.0
9	99.9 – 106.1	97.1 – 109.5
10	106.2 – 112.8	103.2 – 116.4
11	110.2 – 117.0	107.1 – 120.7
12	118.4 – 125.7	115.0 – 129.7
13	120.5 – 128.0	117.1 – 132.0

B.3

$C_2 = 0.82$

0.79 – 0.85	1 pt
0.76 – 0.88	0.5 pt

C.1

Explain/Show Experiment <Idea 1> or <Idea 2> - 0.3 pt

Perform Experiment – 0.2 pt

<Idea 1>

Measure speed of the water supplied from tank B and compare the speed from tank A is fully filled. Then calculate the heights.

<Idea 2>

While watching the tank A, open the hole plug of the tank B. Once the overflowing is stopped, close the hole and measure the height.

h_C : between 4.0 cm and 5.0 cm 0.5 pt

between 3.5 cm – 4.0 cm or 5.0 cm – 6.5 cm 0.2 pt

C.2

Explain experiments one of followings – 0.5 pt

1. measurement of the time to reach the h_c which is obtained C.1.
2. measurement of the time to stop the overflowing at tank A.

time :

50 – 57 sec.	0.5 pt
45 – 65 sec.	0.2 pt