GREENWOOD COLLEGE

Mathematics Methods Unit 4 2019
Investigation 3: Pressure and Balloons
Validation Exercise

Name: Marking Key

Marks:____ / 40 Time allowed 55 minutes.

Mobile phones must be switched off and stored in bags.
The mark for this section will constitute 100% of the total investigation mark. Notes will not be allowed in this section, however calculators will be allowed.
Answer the questions in the spaces provided.

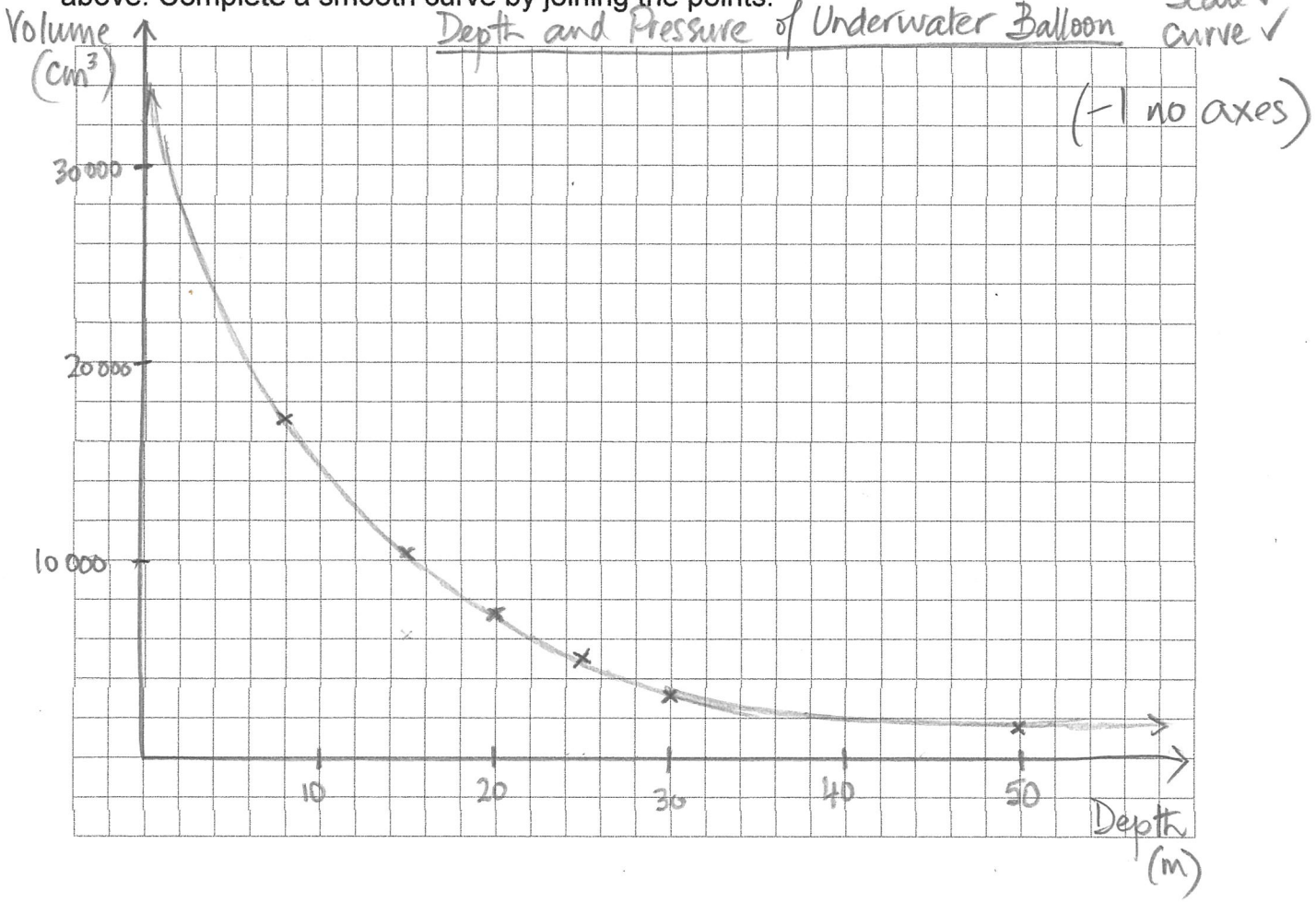
In a deep-sea diving experiment, a balloon is inflated while submerged at 30 metres depth below the surface of the water. The Volume of the balloon (in cm^3) was found to increase as the depth (in metres) got less. The table below gives information on how the volume of a balloon changes at various depths.

d (m)	25	15	8	50	20	30
V ***(cm^3)***	5 213.2	10 498.1	17 136.3	905.9	7 397.9	3 673.7

1. [5 marks]

Labels ✓
Title ✓
points ✓
scale ✓
curve ✓

On the graph grid below, choosing the scale of your axes carefully, plot the points above. Complete a smooth curve by joining the points.



12 14
2. **[~~9~~,2 = ~~11~~ marks]**

a) Verify the nature of the relationship between depth and the volume of the balloon by considering a number of options that produce curved graphs. You should show and compare the results you have found to verify that you have found the best option.

✓ Quadratic regression gives $r^2 = 0.9936134$ ✓

✓ Cubic " " $r^2 = 0.999945$ ✓

✓ Quartic " " $r^2 = 0.99999998$ ✓

✓ Exponential " $r^2 = 1$ ✓

so exponential is best ✓

with $y = 30000 \times e^{-0.07x}$ ✓ ✓

Only the above regressions are explored (ie not linear) as the points are not in a straight line ✓

b) Were the other options considered like or very different from the preferred option? Why should this be?

The others were very close too ✓

This is maybe because the domain values (depth) are so close to each other. ✓

(or similar)

3,5,6 2 19.

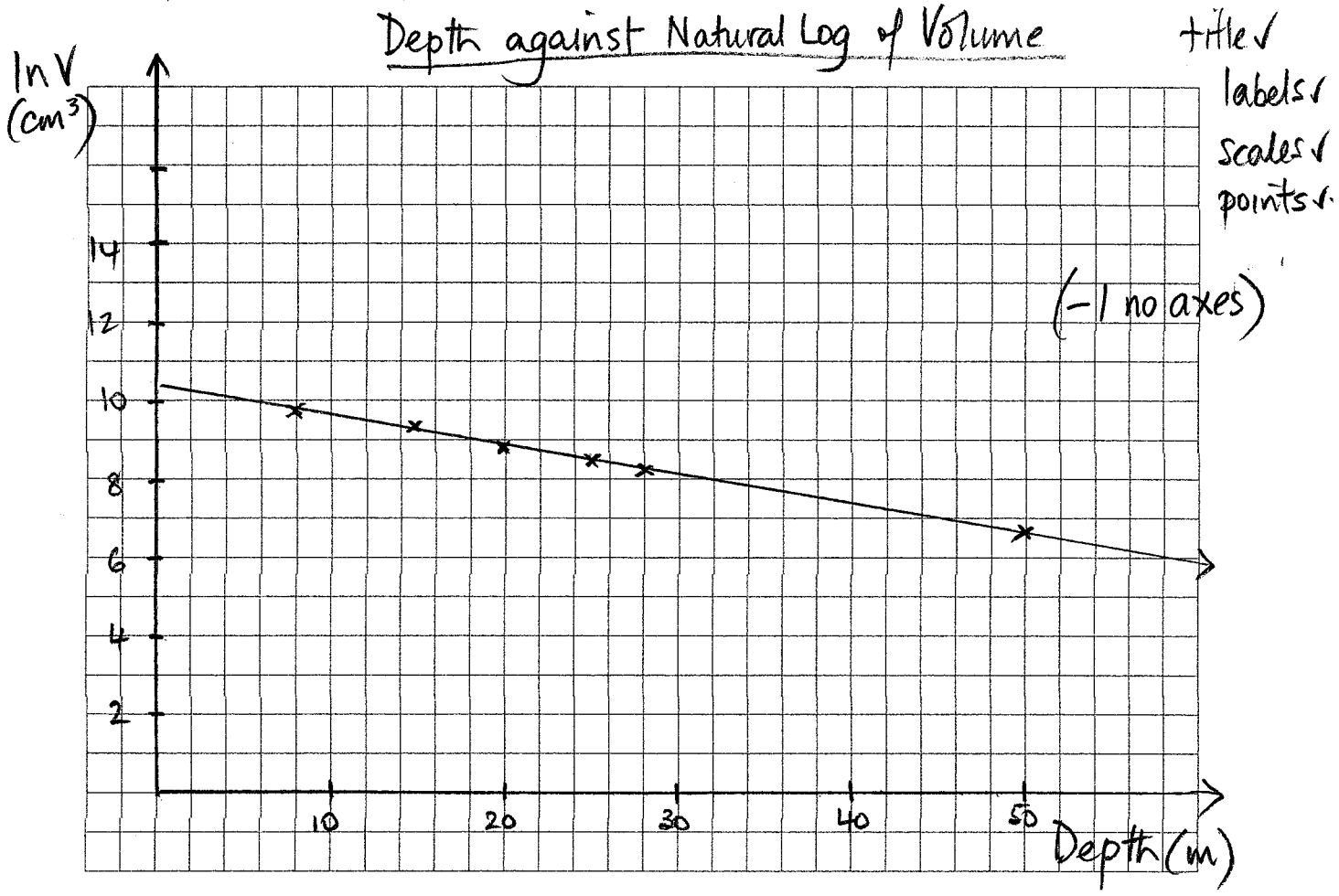
3. **[~~8,7,5,1,2,1~~ = ~~24~~ marks]**

The perfect match or correlationship between two variables is verified by a straight line graph. By applying a particular function to one of the variables show that this possible and verifiable.

a) Complete the table below and **b)** redraw your graph accordingly.

$d(m)$	8	15	20	25	30	50
$\ln V$ (cm^3)	9.75	9.26	8.91	8.56	8.21	6.81

✓✓✓



c) Use your graph to verify the original function (to two decimal places) of the relationship between the depth and the volume of the underwater balloon.

Gradient of line = $\frac{6.81 - 9.75}{42}$ ✓ = -0.07 ✓

y-intercept is approx. 10.31 ✓ based on $6.81 = 50x - 0.07 + y$ ✓

$\Rightarrow y = 10.31$

$V_0 = e^{10.31} \simeq 30031$ (0dp) ✓

So $V \simeq 30031\, e^{-0.07d}$ ✓

d) Comment on any possible reason you may not have the same exact answer as in Question 2.

- The difficulty of plotting exact points on the graph ✓ means the result is more approximate than accurate.

or Limited by small size of grid or rounding

or other considerations

e) Comment on the Volume of the balloon at the surface. Why might this not be theoretically possible?

$V = 30\,000 \times e^{-0.07 \times 0}$ ✓

$\simeq 30\,000$

Theoretically the exponential function has an assymptote at $V=0$ ✓

f) When would the volume of the balloon be zero?

Never, as this is also an assymptote ✓

✓

4. [2 marks]

How might this information be important for any diver?

The lungs are like balloons - their volume will increase as the diver goes down. ✓

He/she needs to let their breath out when ascending ✓

Comparison needs to be to lungs, not to oxygen tanks.

END OF PAPER