# IQM3013 A1 Teacher marking exercise

Physics reflective laboratory log

Selected synthetic examples for teacher standardisation. Review before distribution.

Use the approved question paper and marking guidance alongside these extracts. Read each selected extract and record the evidence and criterion judgement independently before consulting the separate reference commentary. Partial excerpts cannot establish a whole-script or whole-portfolio mark.

## Selected task P01

Compare uncertainty reasoning and unit handling across the same raw data.

### Example X

Dimensions give about 9980 kg $m^{-3}$ and displacement about 9940 kg $m^{-3}$. I take their closeness as support for the result.

Evaluation and reflection
The micrometer seems more precise than the water scale. Trapped bubbles could change the water reading. I have not combined the uncertainty of two meniscus readings or considered a shared mass bias.

Evidence and proposed judgement: _____
Reason: _____

### Example Y

I divide 245 by 24.65 and obtain 9.94. I report this as 9.94 kg $m^{-3}$. For dimensions I use $\pi dL$ instead of $\pi d^2L/4$.

Evaluation and reflection
The two methods use the same object, so I think their answers must be identical. I would take more readings, but have not explained what error they address.

Evidence and proposed judgement: _____
Reason: _____

### Example Z

Mean d=25.0025 mm and L=49.9933 mm. $V=\pi d^2L/4=2.4545$ e-05 $m^3$; density=9982 kg $m^{-3}$. Displacements 24.6 and 24.7 $cm^3$ average 24.65 $cm^3$; density=9939 kg $m^{-3}$. The individual displacement densities are 9959 and 9919 kg $m^{-3}$, not identical. The two method estimates differ by about 0.6%.

Evaluation and reflection
Using conservative bounds $\Delta m=0.1$ g, $\Delta d=0.02$ mm and $\Delta L=0.03$ mm, the dimensional density bound is $0.1/245+2(0.02/25.0025)+0.03/49.9933\approx0.26\%$, about 26 kg $m^{-3}$. Two meniscus readings each uncertain by 0.1 $cm^3$ give a displacement-volume bound 0.2 $cm^3$, hence density uncertainty about 85 kg $m^{-3}$. The ranges overlap. Trapped bubbles would increase displaced volume and lower inferred density. Shape irregularity weakens the dimensional model. I prefer dimensions here because the bound is smaller, while retaining displacement as a check. Agreement cannot rule out a shared balance bias.

Evidence and proposed judgement: _____
Reason: _____

## Selected task P03

Distinguish signed momentum from kinetic energy and evidence from an assertion of conservation.

### Example X

Signed momenta before/after are 0.410/0.390,0.205/0.200 and 0.220/0.210 kg $m^{-1}$ $s^{-1}$. Kinetic energy falls in the coupled collisions; run 1 falls from 0.1681 to 0.07605 J.

Evaluation and reflection
Friction or a sloping track could account for lost momentum. I would re-level it. I have not quantified whether the discrepancy is greater than measurement uncertainty, and my written momentum unit is incorrect.

Evidence and proposed judgement: _____
Reason: _____

### Example Y

For run² I add 0.500×0.61 and 0.500×0.20 to get 0.405 kg m $s^{-1}$, ignoring direction. Since the trolleys couple, I say kinetic energy should also be conserved.

Evaluation and reflection
The measured final speed is lower than expected. I call the difference human error without testing friction, alignment or the uncertainty.

Evidence and proposed judgement: _____
Reason: _____

### Example Z

p(before)=m 1 u 1+m 2 u 2; p(after)=(m 1+m 2)v. Before/after momenta are 0.410/0.390,0.205/0.200 and 0.220/0.210 kg m $s^{-1}$. Kinetic energies, using squared velocities, are 0.1681/0.07605,0.103025/0.0200 and 0.0484/0.02205 J. Run² requires the negative initial velocity in momentum but its square in energy. Momentum discrepancies are 0.020,0.005 and 0.010 kg m $s^{-1}$; kinetic energy decreases in every coupled collision.

Evaluation and reflection
Adding conservative velocity contributions gives about 0.02 kg m $s^{-1}$ uncertainty in each before or after momentum, plus a small mass term. The combined bounds can cover the observed differences, but this is a broad test, not proof of exact conservation. Coupling transfers kinetic energy into deformation, sound and internal energy. A slight track slope or velocity measured well away from impact creates external impulse. I would check level in both directions and shorten the sensor-to-impact interval. Repeating the same collision setting would help distinguish scatter from a systematic shortfall.

Evidence and proposed judgement: _____
Reason: _____

## Selected task P05

Interpret the intercept and negative gradient of a voltage-current relationship.

### Example X

The V-I slope is−0.60 V $A^{-1}$. I quote internal resistance−0.60 Ω and emf 1.51 V. The final repeat is 0.01 V lower.

Evaluation and reflection
The cell may have discharged, so I would allow more rest. I have not separated the negative graph gradient from the positive physical resistance or estimated a fitted range.

Evidence and proposed judgement: _____
Reason: _____

### Example Y

At 0.25 A I calculate V/I=1.36/0.25=5.44 Ω and call this the internal resistance. I call 1.36 V the emf.

Evaluation and reflection
The terminal voltage falls at higher current. I think the voltmeter has used up part of the voltage. I have not used the line intercept or distinguished the load from internal resistance.

Evidence and proposed judgement: _____
Reason: _____

## Example Z

$V=\varepsilon-Ir$. The first sequence gives gradient $-0.60\ V\ A^{-1}$ and intercept 1.51 V, so $r=+0.60\ \Omega$ and $\varepsilon=1.51\ V$. The intercept is an extrapolation to zero current, not a directly observed open-circuit voltage. At 0.20 A, internal power $I^2r=0.024\ W$. The repeated final voltage is 0.01 V lower and is retained separately from the first-sequence fit.

Evaluation and reflection
Using endpoints with±0.01 V and±0.001 A gives a rough gradient range of about 0.49–0.71 Ω and intercept uncertainty of a few hundredths of a volt. The repeat drift is comparable to voltage resolution; it could reflect discharge, heating or reading variation. It cannot by itself identify the cause. Reverse-order runs with fixed rest time and an independent open-circuit reading would help. I now distinguish a useful constant-r model over this narrow range from a claim that a real cell has one unchanging internal resistance.

Evidence and proposed judgement: _____
Reason: _____