物理猛男实验自救手册

General

- Common Practice
  - Read through the question **Clearly** and do exactly the question do, especially in question 2 (otherwise you may obtain incorrect answer
  - Skim through to read the paper as soon as you get it because you will need to have a time management balance during the experiment
- Significant figure
  - Always record the same minimal decimal points from the given instrument (**reflect the accuracy** of the instrument by giving the same decimal points as the smallest division)
  - Digit should be consistent in the experiment to all values (include calculate value), for example if you are demand to calculate 0.5x in your table and the original value is 0.237, then you should give 0.119
  - Significant figure should be the **same** or **one more** to the smallest variable in the calculation (constant does not applicable to this)

Question 1

- Measurement
  - Follow the guidance of the measurement and do as the question demand. **Do Not** alter the experiment (unless you could not obtain the similar value or the experiment does not work in that way [in which case you might need to check if you follow **ALL** the instruction correctly])
  - Read from the question and make justice on how the data will varies in **range** (for example if you have
  - Think of what roughly the **trend** is before you proceeded in the experiment, you could use the combination of both your knowledge and your common sense (for example a smaller size tube should row faster down the slope, not slower; a falling object with greater surface area should reached terminal velocity faster, etc.)
  - Write down the rough data in **pencil** therefore you could be able to change them during the case that there is abnormal data, you can erase it to replace the correct data
  - Pay especially attention to the instruction diagram as it will contain additional information that may be vital for the measurement, for example the direction of pendulum, the side of the electrode, etc.
- Making tables
  - Suggested to use ruled pencil line to make the table before any measurement are taken

0. Quality [5]
   a) Major help -2
   b) Minor help -1(the only case you will not loose this mark is the replacement for apparatus, for example in electricity the correct circuit does not show the correct result and you can ask for replacement for the apparatus)

c) Six sets of values for IV and DV, if only five set correct then -1
d) Order in the correct way to show the trend (either increase or decrease)

1. Headings [1]
   a) Each column must contain a quantity and an appropriate unit. There must be a distinguishing mark between the quantity and unit e.g. I / mA. (the unit with I(mA) will also be accepted)
   b) The numerical values are without units (or with [numerical unit)])
   c) Take care if any calculated value is a reciprocal; 1 / (2 mA) is not 0.5 mA-1, it is 500 A-1. Similar situation could happen in unit conversion if you have something in mm divide by cm/m, remember to read the question carefully
2. Range [1]
   a) Use **as large range as possible** in the given measuring limit
   b) Normally it will be safe if you take 80% of the measuring limit, that is roughly 10% above the minimum value you can take and 10% below the maximum value, but this is not guaranteed, so better take careful look at the question
3. Consistency of raw data [1]
   a) The raw data must reflect the accuracy of the measuring instrument by giving the decimal places same as the smallest decimal places in the instrument
   b) The number of decimal point must be keep constant through the table
4. Decimal places and Significant figures [1]
   a) Significant figure should be one or one more in applying this to raw data(With the least s.f. non-coefficient terms)
   b) the consistency of significant figure should also be shown in the recorded table
5. Calculation [1]
   a) Values of the given calculated term [if applicable]
   b) **ALL** value must be correctly calculated (examiner will check), so come back to check them if you have extra time (and all other calculation as well)

- Drawing graphs
  1. Axes [1]
     a) Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). – if using false origin, a F.O. should be labelled on the graph to help examiner identify the candidate's conduct
     b) Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions.
     c) Scales must be labelled with the quantity that is being plotted. -x axis should be IV and y axis should be DV, in the form of I/mA, etc.
     d) Scale markings should be no more than three large squares apart. - just label at every 5 square – the first half square)
  2. Graph plotting [1]
     a) All observations must be plotted on the grid. – the number of data set must be 6 sets)
     b) Diameter of plotted points must be $\leqslant$ half a small square (no "blobs"). – recommend to use a sharp pencil line to do this)
     c) Points must be plotted to an accuracy of half a small square.

3. Quality [1]
    a) All points in the table must be plotted (at least 5) for this mark to be awarded.
    b) It must be possible to draw a straight line that is within ± 1.0 cm (to scale) of all the plotted points in the h direction.
4. Line of best fit [1]

- Notice that there could be both curve or straight line, so read of the question carefully
    a) Judge by balance of all points on the grid (at least 5) about the candidate's line. There must be an even distribution of points on either side of the line along the full length. - some of the new ms also take abnormal into account, so just redo it if needed
    b) Allow one anomalous point only if clearly indicated (i.e. circled or labelled) by the candidate. There must be at least five points left after the anomalous point is disregarded.
    c) Lines must not be kinked or thicker than half a square.

- Graph application(gradient/y-intercept/tangent)
    - Y- intercept
        - could either be directly read off from the graph without F.O. (Be advice about the significant figure produced) or calculated by equation using two data points, and show all workings to work out the correct equation (please write out the value for the examiner to see)
    - Gradient/tangent
        - Calculate use the formula k = (y2-y1)/(x2-x1) (**Δx / Δy. is not allowed**)
        - Two data points indicate on the graph using dashed line
        - The triangle formed must take up at least half space of the graph, so be at large at possibe
    - There will be question asking for the formula of the graph - With the case you have the y-intercept within the graph and that is not F. O. it will simply be the case to transfer the value you read off from gradient and y-intercept to the question with attention to unit and significant figure
- Calculation
    - In some cases, the examiner might put in the calculation question separately to check the accuracy of the data (there will be the range base of the supervisor report)
    - Follow the whatever formula is given(they might not make sense at all because they are meant to be only checking), notice to give the unit for it

Question 2

- Measurement
    - Demonstrate the sign of repeat from the beginning of the measurement because this is a question 2 type and there will definitely mark for repeat.
    - Try repeat at any variables you can because you will only make two group of experiment, so it will be safe if you show your sign of repeat in all case
    - Ensure that you show in your answer all readings and the calculation of their mean. For measurements such as time periods, the repeats should be for t = nT (with n at

least 5) and then find T from your mean value of nT - the evidence for this repeat should also be shown

- Uncertainty evaluation
  - Evaluation of uncertainty needs to be related to the accuracy of the equipment. However, most of the question 2 type question demand an answer that is higher than the smallest division of the equipment, normally 2-5 times. This is due to other measurement error, for example, human reaction time or the parallax error(these are also the point which your analysis of limitation should focus on)
  - Alternatively, if you take repeat on the previous question(which is recommend for the measurement), you can calculate the range of the repeat measurement and use that for your uncertainty to calculate %uncertainty
- Evaluation and Justification of the result
  - First you need to calculate %difference= $(y_2-y_1)(y_{average})$
  - Then you can make justification about the %difference, please refer to how difficult the measurement you obtain
  - If the measurement is <20%, then you can make justification about it saying it should be the correct justification. But if it~>30%, you can make justification saying it does not support the argument (slightly under or over the justification should not cause the problem because the uncertainty in the measurement could explain this, but if it is highly unlikely, then it could not be explain by the conclusion in the experiment
- Limitation and Improvement
  - Common limitation and improvement

1. Two readings are not enough to draw a valid conclusion
   - Take more readings and plot a graph
   Note: This answer can be used for all experiments

2. The value of (a physical quantity) is small so the percentage uncertainty of (the quantity) is large
   - (The way to make the value of the quantity larger, for example, increase the measurement length or increase the length of track or increase the time interval for measurement)

3. The movement/oscillation of (something) is affected by wind movement
   - Turn off AC or fans and use a wind shield when carrying out the experiment, notice, normally it is not recommend for the experiment unless this is a pendulum experiment or it is the falling object(light weight)

4. Difficult to determine the start and end of oscillation/movement of (something) because it moves too fast
   - Use a video camera with slow motion feature and timer to video the experiment with scale, then view the video playback frame by frame. Alternatively, you may choose light gate in some rare cases

5. Difficult to release (something) without applying a force
   - Use a mechanical hand / electromagnet (depending on the object) to release the (object), usually appear in something related to falling or moving object

6. Difficult to shape the plasticine into the shape of (something)
   - Use a mould to shape the plasticine

7. Heat loss through the sides and bottom of beaker/container
   - Use a polystyrene container or insulate the beaker/container
   Note: This answer should be used for experiments involving the temperature of liquid.

8. The (measuring instrument) is not precise enough
   - Use another (instrument) with greater sensitivity and precision
   Note: You should state in your answer the specific degree of precision for the limitation and the improvement. **USE THIS AS A LAST RESORT.**

9. The length/diameter/thickness of (something) is not uniform
   - Measure the length around/along the (thing) and calculate the mean, normally appear in something related to spring or plasticine

10. Difficult to measure (something) due to (specific reason based on experiment)
    - (Suggest a better way to measure it), this is usually what you will notice on when you try to conduct the measurement, for example the object not rolling on track or the newton meter move to sudden that you could not take the correct reading, etc.

11. Parallax error when measuring (something)
    - (Suggest a better way to measure it, such as use mirror scale)
    Note: This answer should only be used if the measurement is difficult to make and parallax error is very likely to occur. For example ask you to use a protracter with non-uniform shape measurement or the reading can not be directly obtain by measurement

12. Something) moves
    - (Way to keep it in the original position) This usually happened in the balance experiment which require you to take measure when the weight is inbalance

13. Oscillation does not occur in one plane only
    Note: No possible improvement for this limitation. You should give an improvement for any other limitation.(that is the reason why it should not be taken unless it is the last resort)

14. Difficult to maintain (something) at (a particular position) / keep ruler vertical
    - Use a clamp/square set to make sure it is vertical

15. Difficult to zero the newton-meter when used horizontally
    Note: No possible improvement for this limitation. You should give an improvement for any other limitation. (Therefore, this is not recommended in the experiment)

16. Friction at pulley
    - Apply oil to lubricate the pulley

17. Resistance of contacts
    - Clean the contacts
    Note: This answer should be used for electric experiments.

18. Difficult to determine when (something) reaches the maximum height because it remains there for too short a time
    -use slow motion camera to record frame by frame and find the maxima

19. Difficult to take the reading of newton-meter immediately when (something) starts to move because it moves suddenly
    -use slow motion camera to record frame by frame and find the initial reading

20. Difficult to start or stop the stopwatch immediately when (something) passes through (somewhere)
    - Use a video camera with slow motion feature and (the measuring device) to video the experiment with scale, then view the video playback frame by frame.