Notes on the Alternative to Practical Paper

1. This paper is an alternative to a practical exam, not an alternative to a practical course.
2. The preparation for students is a well-designed practical course.
3. The course should teach candidates how to make measurements using many different types of instruments. They should see the instruments, handle them, discuss their scales and the scale units before using the instruments.
4. Students should understand why the choice of range for the measuring scale should match the size of the quantity being measured.
5. Students should know how to record measurements in a table. A table should record all the measurements needed to obtain the value of a given physical quantity. For example if a length l is derived from $l = l_2 - l_1$ then l_1 and l_2 should appear in the table. Columns (or rows) in the table should be headed with the name of symbol of the physical quantity. The unit in which the quantity is measured should be included. The SI method is recommended. Encourage neat work.
6. Ideally, when performing an experiment (and relevant readings are recorded) it is helpful to arrange the experiment so that one variable is increased step by step. Candidates should always look for a trend in the recorded results. Some trends are
   - *y* increases as *x* increases
   - straight line through the origin, if *x* is doubled then *y* is doubled, direct proportionality
   - *y* decreases as *x* increases
   - *x* times *y* = k, inversely proportionality. Inverse proportionality is generally not properly understood
7. A graph is the best way to display the results of an experiment.
   - *y*/unit against *x*/unit should be understood as the label of each axis
   - axes should
     - ❑ be labelled with quantity, unit and scaled
     - ❑ as large as possible, but should not use an awkward scale to achieve the size
   - plotting should be neat and as accurate as possible
   - graph lines should be neat, thin and a good fit (if there is scatter of points they should lie either side of the line{in a rough way!! }). Straight lines should FILL the page (even beyond the range of points) so that any gradient calculation can use the largest Δy and Δx. Students should understand why! (Δy is a measurement.)
   - students should describe what information is obtained from a graph, see note 6.
8. Students should understand the idea of a **fair test** or comparison in which only one variable is altered at a time, eg when investigating how rate of cooling experiment depends on temperature room to be kept constant--room draughts, volume and type of liquid, amount of stirring.
9. Students should be trained to give a conclusion to an experiment.
10. **Good procedures**: -
    - repeat readings to spot anomalous errors or to calculate an average
    - avoid making parallax errors, {the line of sight should be perpendicular to the reading on the scale}
    - look carefully at any scale that is used eg
      - ❑ notice the unit in which the scale is calibrated - always give the unit of any measurement
      - ❑ notice the maximum reading that can be obtained
      - ❑ notice the smallest change in value that can be obtained
      - ❑ aim to use quantities that have magnitudes that are towards the upper values of the scale

- **in experiments involving the measurement of a length**
    - try to use lengths that are at least 100 mm in length
    - you can measure to the nearest mm with a rule, or perhaps 0.5 mm
    - when measuring heights ensure that the rule is held perpendicular to the base
    - know how to arrange apparatus so that it is parallel or perpendicular to a bench
    - know how to arrange a set square either side of a cylinder/sphere to measure diameter
- **in light experiments using objects, lenses and a screen**
    - ensure that each item is aligned so that the centre of each item is at the same height and on the same horizontal straight line (ideally use the term optic axis)
    - use a fiducial aid when measuring a length, eg mark the middle of the lens on the bench
    - try to use a translucent screen
    - perform the experiment in a shaded part of the laboratory
- **in ray tracing experiments**
    - when using marker pins space the pins so that they are at least 60 mm apart
    - ensure that the pins are vertical
    - draw neat thin lines
    - use the largest angles available and draw the arms of the angle longer than the radius of any protractor being used, ie a large radius is desirable
- **when using a thermometer**
    - position the eye so that the mercury thread appears to touch the scale
    - decide whether you can read between the marks on the thermometer, ie some thermometers can be read to better than 1 ºC even though the marks are every º C
    - check whether the thermometer is full or 1/3 immersion
- **in heat experiments**
    - choose volume/mass values of the quantities that give large changes in the temperature
    - insulate the container, cover the container
    - stir and wait for highest temperature after stopping heating
- **in electrical experiments**
    - check for a zero error
    - tap the meter to avoid sticking
    - initially choose the highest range for the ammeter/voltmeter, then reduce the range for the ammeter so that the deflection is almost full scale
    - always check polarities before closing the switch (completing the circuit)
    - always check that connections are clean.
    - switch off the current when not making a measurement.
    - when measuring resistance use low currents/voltages to avoid heating and changing the resistance you are measuring
- **when measuring an interval of time**
    - a stopwatch can measure to about 0.1 s, although it may give a reading to 0.01 s
    - for oscillations (of a pendulum or vibrating rule), be able to define a complete oscillation
    - time N oscillations, usually N>10 and use the terminology periodic time $T = t/N$
    - explain how to use a fiducial aid at the centre of the oscillation
    - explain where the eye should be placed to avoid parallax errors