PRINCIPAL EXAMINER'S REPORT

BOTSWANA
EXAMINATIONS
COUNCIL

BGCSE PHYSICS

2023

Paper 1: Multiple Choice: 0571 / 01

Section 1: General Comments

The performance of the candidates was similar to that of the previous year with a mean of 22.45. As usual, the performance varied across the items with some having very high proportions of candidates getting the item correct while others had very low proportions. There were 8 items: 6, 7, 16, 18, 22, 24, 29 and 36 in which the candidates did exceptionally well with more than 80% of them getting the item correct. On the other hand, there were 15 items: 2, 4, 5, 8, 15, 17, 19, 25, 31, 34, 35, 37, 38, 39 and 40, where less than 40% of the candidates got the item correct. The questions were generally spread across topics.

The strongest distractors and distribution of the candidates across the options generally indicate the misconceptions that the candidates may have. Where reported, such information should be used to improve the teaching and learning.

Section 2: Comments on Individual Items

Item 1: Well done. Most candidates were able to relate graph C (decreasing acceleration) with the motion of the ball .falling through a long tube with a fluid.

Item 2: The item was poorly done. The strongest distractor was B, showing that the candidates confused the series and parallel set-ups. The force constant in series decreases while in parallel it increases.

Item 3: Fairly done. The candidates were mainly split between A and D, which was the key. Candidates should be made aware of the commonly used for fundamental quantities and the SI unit for each quantity.

Item 4: The question was poorly done. The candidates were spread across options A, C and D. While candidates may have known how to determine the force, F = ma, they did not relate the force to the resultant force. The force applied should be the sum of the resultant force and the force of friction, which is D.

Item 5: Poorly done. The candidates were mainly spread across options A, C and D. The candidates may not have noted that the total distance covered will be 120 m or they failed to recall the equation to use to determine the final velocity, $v^2 = u^2 + 2as$.

Item 6: Well done. Almost all the candidates were able to recall weight as a vector quantity, though there is a considerable proportion that selected speed.

Item 7: Well done. Almost all candidates recalled that firewood was the most common source of energy in Botswana.

Item 8: Poorly done. The candidates were spread almost evenly across all the options with C being the most popular option. The candidates should be given formulas that are complete for them to understand the concepts easily, W = Fs where s is the displacement or the distance in the direction of the force, which was similar.

Item 9: Well done. Most candidates were able to identify density as the factor that changes as temperature decreases. The strongest distractor was C.

Item 10: Well done. Most candidates related the concept of thermal expansion to liquid-in-glass thermometers. There were some candidates who thermocouple with hydrometer having almost no candidates.

Item 11: Fairly done. The candidates were mainly spread between A, being the key, and C. The thin capillary tube is responsible for quick response while the large bulb is the one that makes the thermometer more sensitive.

Item 12: Well done. The candidates were aware of the factors that can increase the rates of evaporation and condensation hence identified amount of water as having no effect on the rate at which water collects.

Item 13: Fairly done. The candidates were mainly split between options A and C. The specific heat for vaporisation gave a guidance to the expected answer as it was the largest.

Item 14: Well done. Most candidates selected the speed of the gas particles as the correct answer. There were a few who selected the space between the particles even though it was stated that the volume is fixed.

Item 15: The item was poorly done. The candidates were spread between options A, C and D, with D being the strongest option. Candidates should be made aware that during transfer of heat by radiation, heat travels through a vacuum.

Item 16: Well done. Almost all the candidates were able to use the two graphs to determine the speed of the wave.

Item 17: Poorly done. Most candidates selected option B as the answer. Thus, the candidates did not realise that the question was asking for similar concepts, frequency and period which are inversely related.

Item 18: Well done. Almost all the candidates recalled amplitude as the factor that is related to loudness of a sound wave.

Item 19: Poorly done. The most popular option was ultraviolet radiation. A few candidates were able to recall that gamma rays are deflected by a photographic film.

Item 20: Fairly done. The strongest distractor was A. The candidates were able to use the concept of echo to determine the time interval between the two echoes.

Item 21: Fairly done. The strongest distractor was A. Candidates should be made aware that a thin converging lens forms a virtual image when the object is placed between the lens and the principal focus.

Item 22: Almost all the candidates were able to figure out the combination in which attraction takes place.

Item 23: Fairly done. The candidates were mainly split between A, the unit for electric charge, and C, the symbol for charge.

Item 24: Well done. Almost all the candidates were aware that magnetic field is concentrated by a magnetic metal, iron. The candidates were also aware of the direction of the magnetic field between the magnets.

Item 25: Poorly done. The candidates were mainly spread across options B, C and D. A positively charged rod will increase the deflection of the leaf while a negatively charged rod will attract the positive charges and make the leaf to drop.

Item 26: Well done. The candidates were able to recognise that voltmeter V_4 records the highest reading.

Item 27: Fairly done. The strongest distractors were A and C. Candidates should be made aware that for an ideal transformer, when voltage steps up, the current decreases. The current in the primary coil should be five times greater than the one in the secondary for an ideal transformer.

Item 28: Well done. Almost all the candidates were able to use the combinations of the values given to get the power of the heater.

Item 29: The item was well done. Almost all the candidates were able to show understanding that the a safety measure is obtained through connecting the wire to a metal buried underground.

Item 30: Well done. Most of the candidates were able to recall the characteristics of power during transmission and at households. The strongest distractor was C. Candidates should be made aware that power, which is a product of voltage and current, is constant.

Item 31: Poorly done. The candidates were mainly split across options A, B and D. This could be indicative of them not knowing the direction of the magnetic field around a current carrying conductor, which is anticlockwise for a current out of the paper.

Item 32: Fairly done. The most common distractor was C, showing that the candidates did not take note that a single cycle was being described in the item.

Item 33: Fairly done. Most candidates managed to select the split ring commutator as the part that ensures continuous rotation.

Item 34: Poorly done. Options A and B were more popular than the answer. This shows two major misconceptions, candidates not using the divisions on the grid to obtain the period of the wave and candidates not converting time to standard units.

Item 35: Poorly done. The most popular option was A, even though current in a series circuit is the same at each and every point. The voltage drop across components in series is the one that is determined by the resistance of the component.

Item 36: Well done. The best performed item in the whole paper. Almost all the candidates were able to determine the number of electrons, neutrons and protons from the figures provided.

Item 37: Poorly done. The candidates were spread across options B, C and D. The candidates had to relate the changes light intensity with the resistance of the LDR and how the current split between the routes. Decrease in light intensity causes increase in resistance which results in decrease of the current in the LDR and increase of the current in the relay switch.

Item 38: Poorly done. The candidates were distributed across all the options indicative of them guessing rather than knowing the concept. The candidates may not be aware of the charge of alpha particles and how they behave within a magnetic field.

Item 39: Poorly done. The strongest distractor was A. The candidates should be made aware that for the half-life the time reduces equally while the radioactive samples or activity is the one that reduces by half.

Item 40: Poorly done. The candidates were spread almost equally across all the options. Candidates may have been confused by the industrial use rather than the use only.

MARKING KEY

1 C	2 C	3 D	4 D	5 D
6 D	7 A	8 D	9 A	10 C
11 A	12 B	13 A	14 D	15 A
16 B	17 D	18 A	19 A	20 C
21 C	22 B	23 C	24 A	25 D
26 D	27 B	28 B	29 B	30 B
31 D	32 A	33 C	34 C	35 D
36 A	37 D	38 A	39 C	40 C

Paper 3: Written Theory

Section 1: General Comments

Candidates exhibited limited skills in responding to questions that were basic like the ones that required them to state. Candidates were on the main repeating the wording that was already contained in the question. They offered definitions of terms when asked to state differences.

Section 2: Comments on Individual Questions

1 **(a)** Well done. Candidates used clear differences, however there were some who chose to state definitions of the two terms. Centres should emphasise to candidates that when a question requires differences, that's all they need to focus on and not create a situation where Examiners should interpret the differences.

(b) Fairly done. The majority of the candidates described the motion in terms of acceleration as required by the question and on the whole noticed that it was a constant motion because of the straight lines. However, the candidates failed to differentiate between constant acceleration and no acceleration.

(c) Poorly done. Candidates got the wrong shape for the shape under the graph they had to resolve hence making it difficult for them to determine the initial speed. Most of the candidates used the triangle not realising that it was a trapezium. Centres are advised to emphasise identification of correct shapes under the graphs.

*Answer***:** 5 m / s

(d) Well done. Most candidates were able to obtain the correct expression for average speed. Some opted for $\frac{u+v}{2}$, thereby loosing marks.

Answer: 17.39 m / s

2 **(a)** Fairly done. Candidates exclude important words in definition, in this case they left out per unit area and instead per area was frequent. Centres are urged to emphasise to candidates that definitions are as stated.

(b) Fairly done. Most candidate failed to recognise that both ends of the tube are open to the same condition. Some candidates referred to pressure of the gas supply ahead of time.

(c) **(i)** Fairly done. Candidates attempted to calculate pressure as they failed to recognise that Q was acted upon only by atmospheric pressure. Some candidates gave Pascal as a unit for the same given value.

Answer: 760 mm / hg

(ii) Poorly done. Candidates failed to recognise pressure difference and attempted to use an expression that required additional non available information $P_{atm} + \rho gh$.

Answer: 840 mm / hg

(d) Poorly done. Common answer was, pressure increase with altitude as they failed to focus on the pressure of the gas as required by the question.

3 **(a)** Poorly done. The candidates were able to note that boiling point is definite stage where the vapour pressure is equal to the external atmospheric pressure. Some used descriptions such as change of state. This was a definition that needed to be given as was taught.

(b) **(i)** Poorly done. Candidates would give two states, yet they were asked for a state. Common response was liquid and solid with some mentioning water and ice. Candidates should be made aware that change of state (two state) is indicated by a horizontal line.

(ii) Poorly done. Most candidates gave a general definition of specific heat capacity but failed to link the definition with the 133 000 J / kg °C given in their answer. The answer was thus incomplete. Some of those that included the figure in their answer, included all of the units despite stating that it was energy.

(iii) Fairly done. Candidates calculated temperature change and but failed to determine the final temperature from their answer.

Answer: 56.05 °C

4 **(a)** **(i)** Poorly done. Candidates failed to use comparative terms or gave answers that did not make comparisons as required by the question. Centres are urged to emphasise the correct terminology.

(ii) Poorly done. Candidates failed to use comparative terms. Some candidates gave answers like particles vibrate about fixed positions without stating in which state. Centres are urged to emphasise the correct terminology.

(b) **(i)** Well done on effect but candidates showed misconception regarding the cause of pressure as they alluded to particle and particle collision. Centres should emphasise that pressure is due to collision of particles with the walls of a container.

(ii) Well done. There were some candidates who attempted to use ratios and missed out on inverting them. Centres should emphasise the gas laws as they are.

Answer: 50 kPa

(iii) Poorly done. Candidates would mention laws by name and not address the question. Centres are urged to make it clear of what assumptions are.

5 **(a)** **(i)** Fairly done. Candidates failed to make mention of the angle of incidence whereas some made reference to a ray.

(ii) Poorly done. Most candidates were able to recall the formula $n = \frac{\sin i}{\sin r}$ but failed to correctly place the values of angles where they should be. When their calculations yielded a wrong value they would write the value that they already knew but would lose marks because they failed to show their working as per the instruction.

Answer: 41.8°

(b) **(i)** Poorly done. Candidates failed to recognise that the ray is incident along the normal at end A and end up trying to explain total internal reflection. Some candidates gave the angle of incidence as 90°.

(ii) Poorly done. Candidates failed to explain repeated total internal reflection, that allowed the ray to emerge from the optical fibre.

6 **(a)** Fairly done. Most candidates left out mention of direction of vibration of particles. Common statement mentioned movement or vibration of the wave. Centres urged to emphasise the terminology used in describing waves and stress on differences between the two types of waves.

(b) **(i)** Well done. Most candidates were able to recognise the labelled region as compression.

(ii) Well done. Most candidates were able to recall the wave equation, $f = \frac{v}{\lambda}$. There were no issues with units and using the equation.

Answer: 25000 Hz

(iii) Fairly done. Candidates failed to state the range of audible frequencies for normal human beings and only gave general statements.

7 **(a)** Poorly done. Candidates showed lack of familiarity with the magnetic field due to a solenoid, they also treated the solenoid as individual straight conductors. Those that had an idea, presented poor quality diagrams. Centres are urged to emphasise the concept as expected by the syllabus.

(b) **(i)** Fairly done. Candidates referred to a magnetic field in the coil when the magnet was pushed into the coil, even though the magnetic field was from the moving magnet. Electromagnetic induction needs to be given improved attention with illustrations.

(ii) Well done. Generally, candidates were able to recall all the factors; speed, number of turns and strength of the magnet. However, most candidates stated the factors without showing that they were changing. Centres to emphasise use of comparative terms.

(iii) Well done. Some candidates confused devices as a result of responses at **(b)(i)**. Motor appeared as a response despite requiring current to work as opposed to causing a current to be produced. Centres urged to distinguish between induction and motor effect.

8 **(a)** Fairly done. Candidates introduced the cathode in their responses which was not given in the diagram and made reference to current flowing to the anode. Cathode to advice prospective candidates to only refer to what has been presented to them and avoid showing knowledge of a theory that does not quite address the demands of the question.

(b) **(i)** Well done. Most candidates recalled the diode as a device that conducts current in one direction. Some candidates used path to refer to direction.

(ii) Fairly done. The drawings were of poor quality, amplitude and wavelength not close to being equal. There was evidence of limited knowledge of the concept of rectification. Centres are urged to place emphasis on the correct diagrams and also adequately address the syllabus.

9 **(a)** Well done. Some candidates failed to factor in tolerance whereas others gave it as 5% from the provided information. Centres are urged to give more practice on resistor colour coding.

Answer: 2100 Ω

(b) Well done. Some candidates failed to state the correct expression for the total resistance.

Answer: 500 Ω

(c) Fairly done. Some candidates failed to get the correct equation and where the standard form was used, the answer missed out on a zero. Centres are urged to teach functions on the calculator that are of use in physics.

Answer: 0.0068 Ω

10 **(a)** Well done. Some candidates had challenges with spelling the name of the component and some called it a heat sensitive resistor. Centres are urged to alert candidates on what is required by the question “State the name…”.

(b) Fairly done. The candidates failed to describe the concept of how the reed switch and the thermistor work. Thus, a decrease in the resistance of the thermistor allows for more current in the coil/reed switch. Magnetic field from the coil makes reeds to be magnetised and attract completing the circuit. Some candidates mentioned current in the reeds and some failed to articulate the knowledge they have. Centres urged to close gaps and address styles of answering questions.

11 **(a)** Poorly done. Candidates merely repeated the wording in the question and went on to give a word that required elucidation such as spontaneous. Most candidates defined radioactivity, suggesting misunderstanding of what the question was demanding. Centres are urged to follow the ambit of the syllabus.

(b) Fairly done. Common response was helium atom. Candidates should be made aware that an alpha particle is equivalent to the **nucleus** of a helium atom only. Centres urged to emphasise nature of radioactive emissions.

(c) Poorly done. Candidates were unable to establish the background radiation count rate which was crucial in determining the count rates due to alpha and beta radiations. Centres urged to emphasise penetrating power of radioactive emissions.

Answers: (c) (i) 20 counts / s (c) (ii) 30 counts / s (c) (iii) 50 counts / s

(d) Well done. Candidates showed outstanding familiarity with the dangers of exposure to radiation.

Paper 4: Practical Test

Section 1: General Comments

The candidates generally performed well in this paper. Mostly they were able to record their findings to the accuracy of the instrument they used. They also substituted their values well in the equations given and were able to obtain correct answers. The candidates mostly paid attention to the significant figures on their final answers. They were able to round-off their answers to 2 or 3 significant figures or to 2 or 3 decimal places which ever was most appropriate to give a meaningful answer i.e. an answer like 234.91027 is better rounded to decimal places, and 0.025718 to significant figures. Centres are advised to advice their candidates to round off indefinite answers appropriately. Candidates generally have challenges when it comes to worded questions, like precautions, or any follow up question. Generally, candidates have good tabulation and graphing skills, which are basically observed in question 4.

Section 2: Comments on Individual Questions

1 Generally the question was well done.

Most candidates were able to record the weights and the volume with the correct unit(s), and to the correct precisions of the force meter (0.2 N) and the measuring cylinder (1 cm^3). They were also able to calculate the upthrust and the weight of the stone as well. Most candidates were able to draw the correct conclusion from their findings. The expected answer was upthrust equals the weight of the water. Most candidates were able to write the correct precaution like, position the eyes perpendicular to the scale at the point where the reading is taken when measuring weight or volume, place the displacement can or measuring cylinder on flat surface, reading the volume from the bottom of the meniscus. Some candidates missed a mark because they mentioned taking a reading below the meniscus, as this has no definite point.

2 This question was fairly done by most candidates.

Most candidates were able to draw a correct diagram with evidence of where they inserted their pins. Most candidates were able to use a protractor to measure and draw angles correctly, they even recorded their measured angles to the correct accuracy/precision of the protractor which is to 1°. Most candidates were able to calculate the critical angle accurately and rounding off indefinite answers correctly. Mostly their answers were between 39° and 45° showing that they did the experiment accurately. For part (c) most candidates gave the answer which indicated how the parallax error was a source of inaccuracy, the expected answer failure to position the eyes directly above the point where the reading is taken of failure to position pin P_3 with images of pins P_1 and P_2. Some candidates lost a mark because they just mentioned just parallax error.

3 This question was fairly done by most candidates.

Most candidates were able to record the final and the initial temperatures to the correct accuracy of a thermometer which is to 1°C and final temperatures being more than the initial showing that they performed the experiment. The results mostly showed that the temperature difference for metal with a higher specific heat capacity was higher. For part (b) where they had to suggest an

improvement, the expected improvements were stirring the cold water after transferring the hot metal, for even distribution of heat. Transferring the metals to cold water quickly, insulating the cups, and covering the cups with a lid to reduce heat loss by evaporation to the environment. The best answer was repeating the experiment in order to establish trend.

4 This question was generally well done

Records

Most candidates were able to give their records of voltages (V) and currents (I) with correct units. Most candidates were able to the draw a proper table for recording their results (with headings, l, V, I and R with correct units and at the top of the table only. Most candidates gave their V values to the accuracy of the voltmeter, and I values to the accuracy of the ammeter which is 0.02 A. but some lost a mark for using the accuracy of 0.01 for the current. Most candidates were able to calculate the resistance R correctly and to the same rounding offs (consistent). A few of candidates failed to give the correct unit for R (Ω) so ended up losing a mark.

Graph

Mostly the graph was well done.

Most candidates were able to draw and label the axes correctly with correct units and correct orientation. Most candidates were able to make readable scales (the smallest division on their scale was easy to obtain) for the horizontal but were a bit challenged for the vertical. Mostly the scales were suitable, i.e. the points to be plotted would cover more than half of the graph sheet. Most points were plotted accurately to within half a small square of the exact position where they should be. Some candidates plotted only 4 points forgetting the first one which comes before the repetition. They also used the correct notation (small cross (×) or encircled dots (Θ)). Most candidates were able to draw the line of best fit (passing through most points, straight and thin). Some candidates ignored the trend of their points and drew a forced line to pass through the origin. Candidates are advised to plot all their points. A few candidates drew free hand lines, with such lines the gradient cannot be determined.

Deductions

This part of the question was fairly done by most candidates.

For part (d), most candidates were able to draw a big triangle or used points which were on their line when calculating the gradient of the line. Some candidates ignored their line and used points from their table which are not even on the line. Nevertheless, they were mostly able to calculate the gradient correctly.

For part (e) most candidates managed to calculate the resistivity ρ of the wire correctly. Most candidates failed to give the correct unit for ρ which is Ω m.

For part (f), this one was fairly done. The expected variables to be kept constant were length of conductor, resistivity or conductor, electromotive force (e.m.f.), potential difference (p.d.), temperature of the wire.

For part (g), the reason for switching off is mainly to prevent over heating of the wire to ensure that that the temperature of the wire remains constant. Some candidates lost a mark because they gave an answer like prevent heating up of the wire. This cannot be prevented.

Paper 5: Alternative to Practical Test

Section 1: General Comments

The candidates generally performed well in this paper. Mostly they were able to record their findings to the accuracy of the instrument given in the paper. They also substituted their values well in the equations given and were able to obtain correct answers. Candidates were able to round their answers to 2 or 3 significant figures or to 2 or 3 decimal places which ever was most appropriate to give a meaningful answer i.e. an answer like 234.91027 is better rounded to decimal places, and 0.025718 to significant figures. Centres are advised to advice their candidates to round off indefinite answers appropriately. Candidates generally have challenges when it comes to worded questions, like precautions, or any follow up question.

Section 2: Comments on Individual Questions

1 The question was well done by most candidates.

(a) Most candidates were able to read and record the weight correctly and to the accuracy of the force meter.

Answer: 5.0 N and 0.8 N

(b) The question well done by most candidates. Most candidates were able to record their volumes to the accuracy of the measuring cylinder.

Answer: 80 cm^3

(c) This question was well done by most candidates. They were able to calculate W_w correctly using the formula provided.

Answer: 0.8 N

(d) Most candidates were able to draw the correct conclusion of the experiment which the expected answer was W_l is equal to W_w.

(e) Most candidates were able to write the correct precaution like, position the eyes perpendicular to the scale at the point where the reading is taken when measuring weight or volume, place the displacement can or measuring cylinder on flat surface, reading the volume from the bottom of the meniscus. Some candidates missed a mark because they mentioned taking a reading below the meniscus, as this has no definite point.

2 **(a)** This question was generally well done by most candidates. They were able to draw the correct diagram with RS, TU, and VW at the right places. They were also able to correctly measure RS, TU, and VW positions correctly.

(b) Most candidates were able to read and record the length l correctly and to the correct accuracy of a ruler which is to 1 mm.

Answer: 6.8 cm

(c) The question was fairly done by candidates. Most candidates were able to use the formula to determine the refractive index *n* of the block.

(d) Most candidates gave the answer which indicated how the parallax error was a source of inaccuracy, the expected answers was failure to position the eyes directly above the point where the reading is taken, failure to measure correct distances due to parallax error, failure to mark correct positions where the readings are taken.

Answers: (b) 6.8 cm (c) 1.47

3 The question was fairly done by most candidates.

(a) Most candidates were able to record temperatures T_1 and T_2 correctly for both setups and to the accuracy of the thermometer which is 1 °C.

Answer:

	T_1 / °C	T_2 / °C
readings for water in cup K	*25*	*36*
readings for water in cup M	*25*	*28*

(b) Most candidates were able to give answers that show direct transfer of heat between water and the metals only. Some candidates lost the mark because they mentioned to reduce heat lost to the environment.

(c) For part where they had to suggest an improvement, the expected improvements were stirring the cold water after transferring the hot metal, for even distribution of heat. Transferring the metals to cold water quickly, insulating the cups, and covering the cups with a lid this is to reduce heat loss to the environment. The best answer was repeating the experiment in order to establish trend.

4 **(a)** This question was well done. Most candidates were able to give the correct units for current (A), voltage (V) and for resistance (Ω). They were able to read and record the voltage from the voltmeter and to the accuracy of the voltmeter which is 0.1 V. Mostly they were able to calculate the resistance using the given formula.

l / m	I / A	V / V	R / Ω
0.20	0.46	0.9	1.96
0.40	0.46	1.8	3.91
0.60	0.46	2.7	5.87
0.80	0.46	3.6	7.83
1.00	0.46	4.5	9.78

(b) Most candidates were able to mark the correct position of the ammeter needle to the correct precision of the instrument.

(c) Most candidates were able to draw and label the axes correctly with correct units and correct orientation. Most candidates were able to make readable (the smallest division on their scale was easy to obtain) and suitable scales (the points to be plotted would cover more than half the graph sheet). Most points were plotted accurately to within half a small square of the exact position where they should be. They also used the correct notation (small cross (×) or encircled dots (Θ)). Most candidates were able to draw the line of best fit (passing through most points, straight and thin). A few candidates drew free hand lines, with such lines the gradient cannot be determined.

(d) Most candidates were able to draw a big triangle or used points which were on their line when calculating the gradient of the line. Some candidates ignored their line and used points from their table which were not on the line. Nevertheless, candidates were able to calculate the gradient correctly.

(e) Most candidates managed to calculate the resistivity ρ. Some candidates lost a mark because they failed to write the correct units for ρ, which the expected was Ωm.

(f) This question was fairly done. For part the reason for switching off is mainly to prevent over heating of the wire to ensure that that the temperature of the wire remains constant. Some candidates lost a mark because they gave an answer like prevent heating up of the wire. This cannot be prevented.

(g) **(i)** The question was fairly done. The expected variables to be kept constant were length of conductor, resistivity or type of conductor, electro motive force (e.m.f.)., potential difference (p.d.) and temperature of the wire.

(ii) For instruments that can be used, the candidates did well. The expected answers were ruler, voltmeter, ammeter, and micrometer screw gauge.