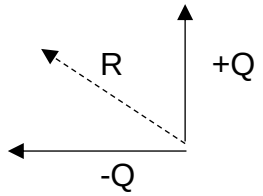
2022 SAASTA SCIENCE OLYMPIAD, GRADES 7-9 – MEMORANDUM

	Answer	Explanation
1	A	Household appliances are connected in parallel. Adding appliances reduces the resistance and increases the current.
2	C	C. The heat of the water reaches the glass first, causing the bulb to expand and the cool mercury sinks into the enlarged bulb. Heat then gets to the mercury and it expands up the tube in the normal way.
3	B	B. 150 000 000 km (300 000 km/s X 500 s = 150 000 000 km
4	A	Loudness is determined by the amplitude (height) and pitch depends on the frequency (wavelength) of the wave.
5	D	Hydroponics involves growing plants, usually crops, without soil, by using water-based mineral nutrient solutions in aqueous solvents. The aeration system is essential for proper oxygenation and circulation of nutrients of the hydroponic system.
6	A	Fynbos is found in the south-western corner of South Africa and is known to be synonymous with the Cape Floral Kingdom. The Nama Karoo biome occurs on the central plateau of the western half of South Africa. Grassland found mainly on the high central plateau of South Africa, and the inland areas of Kwa-Zulu Natal and the Eastern cape. Savannah is found over the Low-veld and Kalahari region of South Africa and is also dominant in Botswana, Namibia and Zimbabwe.
7	A	The genus Protea is one of the most well-known and charismatic of the Cape Floristic Region's (CFR) Fynbos Biome. The King Protea is South Africa's national flower.
8	C	Ep = mgh … with m and g constant. As the object falls, Ep is converted to Ek. After falling ¾h, the height will be ¼h and ¾ of the Ep will be transferred into Ek.
9	B	B. The ice melted while the temperature remained constant. (The temperature of ice rises until it begins to melt at 0^{o}C. Then while the heat continues to be added, it is absorbed as Latent Heat of Phase Change. When the last piece of ice melts i.e. when the phase

		change has been completed, the temperature of the now-liquid water rises again in response to the continued application of heat)
10	B	B. Heat causes the temperature to rise except while the state changes from solid to liquid. (Adding heat can cause a rise in temperature OR a change of state BUT not both at the same time because of the Latent Heat referred to above.
11	B	1 watt is the same as 1 joule of energy transferred in a second. (1 watt = 1 joule per second). There are 1000 watts in 1 kilowatt (kW) and 3 600 seconds in an hour. 1 000 x 60 x 60 = 3 600 000 = 36 x 10^5 J 1 kilowatt hour is the amount of energy you'd use if you kept a 1 000 watt appliance running for an hour. One kilowatt-hour is equal to 3600 000 J (3600 kJ).
12	D	D. Cohesive forces create "surface tension" forming a thin film able to support their weight. (Water molecules deep within the body of the water are pulled in all directions by surrounding molecules BUT molecules on the surface are pulled sideways and downwards. This makes the top layers slightly closer to the layer below them and this creates a thin more dense FILM often referred to as "surface tension." This is also responsible for the curved 'meniscus' seen at the surface of a narrow glass of water. The thin film is what is supporting the Water Striders. You can "float" a needle on the surface too.)
13	D	D. All of the above have been achieved. (Using a Super Computer to coordinate multiple images taken from slightly different angles improves the resolution allowing very finely accurate measurements giving better detail – it is not unlike the pixels in a smartphone camera, but spaced further apart)
14	A	Ultrasonic waves are used in SONAR instead of audible sound waves.
15	C	C. First copper then aluminium then iron. (Their ability to conduct heat is the same as their ability to conduct electricity)
16	A	A. SALT (This is the only OPTICAL instrument among the 3 radio telescopes)
17	C	Carbon dioxide turns clear lime water milky white.

18	D	Ek = ½ mv^2. Ek is directly proportional to v^2 (m is constant). If the speed increase by a factor of 4, the Ek will increase by a factor of 4^2.
19	C	C. Bottle #3 showed the most rust on the nail. (Rusting or oxidising of iron requires the presence of oxygen AND it is enhanced by the presence of moisture. Bottle #1 has oxygen but no moisture. Bottle #2 has water but no oxygen. Bottle #3 has oxygen and a little water)
20	D	D. All three of these advantages are true. (Radio Astronomy, eventually using the biggest BY FAR system, the SKA, will put South African science at the forefront of this field BUT we need to train our young people to be able to benefit from this wide open new field – our education system must rise to meet the challenge, or we will be creating jobs for foreign scientists, technicians, etc)
21	C	Nearsightedness (myopia) is a common vision condition in which you can see objects near to you clearly, but objects farther away are blurry. Images are focused in front of your retina. It can be corrected with glasses with concave lenses.
22	D	With the snake's predator (hawk) removed, the number of snakes will increase. More birds will be hunted by the snakes. Due to the decrease in the number of birds, their prey (grasshoppers) will increase in numbers.
23	B	Carnivores feed on other animals while omnivores feed on plants and animals.
24	D	Ek = ½ mv^2. Ek is directly proportional to m (v is the same for both objects). If the mass is doubled, Ek will be doubled.
25	B	B. The pure water stays clear while the lime water turns milky. (This is the classic test for CO_2)
26	C	C. South African Large Telescope.
27	D	D. All three of these advantages are true.
28	A	A. A diamond is a polymorph of the carbon element.
29	D	D. All three of these are valid conclusions. (A covalent network has very strong internal bonds and so it is hard, has a high MP, and will not react easily – however do not place it in the flame of a Bunsen Burner, it is carbon and it will burn in air forming CO_2)

30	A	When connecting the resistors in parallel the total resistance will decrease. A is therefore the only correct option. $1/R_{\parallel} = ¼ + ¼ = ½$, therefor $R_{\parallel} = 2\Omega$.
31	B	(Having a large "radio quiet" reserve in a remote part of the country AND being able to power the system with solar power was one of the main reasons the Karoo was selected to host the main part of the SKA.
32	D	Tuberculosis (TB) is caused by a type of bacterium called Mycobacterium tuberculosis.
33	D	Light "pollution" is the main problem with optical telescopes. Vibrations from traffic ca also be a problem especially with long-exposure astrophotography. Smoke is a minor issue because lenses can be cleaned, but at Sutherland this is seldom necessary
34	B	B. Gold atoms are packed more densely than Lead atoms. (Even though each gold atom is lighter than each lead atom, the gold atoms form a crystal structure that is much more close-packed than that of lead)
35	D	When bulb Z burns out there will be less resistors in parallel and the total resistance in the circuit will increase. The reading on A will decrease. (A and B are illuminated). The current (1,5A) will be divided between X and Y in the ratio 2:1 respectively. (The bigger resistor will have the smallest current.)
36	A	When the eye is relaxed and the interior lens is the least rounded, the lens has its maximum focal length for distant viewing (diagram B). For viewing objects nearer than 6 meters, the muscle tension around the ring of muscle is increased and the supporting fibers are thereby loosened, the interior lens rounds out (more convex) to its minimum focal length.
37	C	 +Q will exert an upward force on -q (opposite charges attract) -Q will exert a force to the left on -q (like charges repel) The resultant force (R) will be in the direction shown above.
38	A	The top star in the two pointers to the Southern Cross ("Crux") is called Alpha Centauri. An amateur telescope can resolve the "star" into a Double Star, called Alpha Cen. A and Alpha Cen. B. this binary pair was measured to be 4,3 light years from Earth, as was thought to

		be the 'closest star to Earth other than the Sun.' However, more powerful telescopes spotted a very dim 3rd companion called Alpha Centauri C. When Robert Innes measured the distance he found that the Red Dwarf is slightly closer at 4.2465 light years, making it the closest star to our Solar System, so he named it Proxima Centauri – recently it has been found to have an exoplanet named Proxima Centauri b.
39	B	B. The elements that make up water have a ratio of 2:1. (A is wrong because of the word "equally". C is wrong because of the word "mixture". D is not correct. B is correct as the ratio of 2:1 matches the formula H_2O_1)
40	C	C. Both A and B are correct and tell us that the two gases are hydrogen and oxygen. (A and B are both correct so we choose C which covers that eventuality – learners were told to read ALL answers).
41	C	R_1 is in parallel with R_2 and R_3. $V_{R1} = V_{R2 +R3.}$ $V_2 = V_{R3} = ½V_{R1}$
42	A	The Moon reflects about 8% of the Sunlight that hits its surface. To a far smaller extent, there are times e.g. in the Crescent Phase, when the dark part of the Moon is very dimly lit by light being reflected onto it by the Earth – this is called "Earthshine."
43	A	Plants photosynthesize in the presence of sunlight, consuming carbon dioxide, water and energy, and producing glucose and oxygen. The reverse reaction, respiration, goes on all the time, consuming glucose and oxygen, and providing the plant with energy. Plants grow and transpire water during the day and night.
44	B	Like charges repel. They will move away from each other. As the distance between them increases, the repelling force decreases and the acceleration decreases.
45	D	All three of these advantages are true.
46	A	A. As the balloon rises the pressure of the air around it decreases, and the balloon expands until it bursts. The alternative choices make no real sense – even the "Thermosphere" which is measured at ~2000^{o}C is not actually uncomfortably HOT because the air molecules (even though they have high kinetic energy) are so far spread out that they cannot burn anything. That is why satellites and space probes can pass through

		the thermosphere unharmed. By the way, the balloon will POP long before it could reach such altitudes.
47	B	Like charges attracts and opposite charges repel. Q attracts P but repel R, therefore P and R must have opposite signs.
48	A	In Africa, the 'Digging Stars' can signal the time to prepare lands ahead of the coming spring rains. The greater significance is that they signal the start of traditional circumcision schools where young men are also taught tribal traditions.
49	A	Structural adaptations are physical features of an organism, like having a tail. Behavioral adaptations are the things that an organism does to survive, these are learnt actions. Functional adaptations are those that help the organism to survive, the difference being that they are innate functions.
50	C	Photosynthesis is the process by which plants use sunlight, water, and carbon dioxide to create oxygen and energy in the form of sugar. Chlorophyll is needed for this process.
51	D	Newton 3 applies. When the rocket pushes out the exhaust gases, the exhaust gases push the rocket in the opposite direction with the same force.
52	D	D. Oxygen. (in $KMnO_4$ the only element available to become a gas is oxygen)
53	A	A. Decomposition.
54	C	The variable that is manipulated (changed) during the experiment is the independent variable (magnetic strength). The variable that is measured (induced emf) is the dependent variable. To ensure that the investigation is a fair test all other variables (including the number of turns in the coil must be kept constant).
55	B	The process providing energy in living cells is respiration. Respiration occur in the cells of plants, animals and humans, mainly inside mitochondria.
56	C	Respiration equation: Oxygen + glucose -> energy + water + carbon dioxide
57	A	A camera mounted on a tripod is "fixed" to the Earth, so as the Earth turns – so does the camera, and anything off the Earth's surface will appear to circle the Earth causing these "Star Trails" to reveal that the camera is moving relatively quickly against the distant stars – they are so far away that (rather like seeing a high-flying airliner seem to fly s l o w l y across the sky, star motion takes a lifetime to reveal itself. BUT HERE it is the Earth spinning on its axis giving Day and Night that causes the illusion.

58	C	We actually do know this with a reasonable level of confidence because we know that iron and nickel are the end product of the death of many stars (not the super giants), so these metals are abundant in the Solar System. This is confirmed by the fact that many meteorites, like the Hoba Meteorite in Namibia, consist of iron and nickel. Then we also have millions of records of seismic waves passing through the Earth like an MRI Scan of the human body, which have revealed the internal layers in great detail. We also have made calculations of the projected densities of the layers which support these conclusions. Finally we have logic that tells us that when the Earth formed in its <u>molten</u> state AND then <u>re-melted</u> when we were struck by a Mars-sized impactor that tilted Earth's axis over at 23,5^{o} and ripped out the Moon, most of the heavier elements would have sunk through the liquid rocks and concentrated in the centre. This would have included a lot of very heavy elements like gold, lead, platinum and uranium BUT since these are formed only by the <u>very rare</u> super giant stars as they become Supernovae, we know that the idea of a solid gold core is nonsensical. 
59	B	Mechanical energy is conserved (no friction), therefore EQ = ER. Kinetic energy at Q is zero (at rest). As the block moves from Q to R, potential energy is converted to kinetic energy. At R the block reaches maximum velocity and all the potential energy has been converted to kinetic energy.
60	B	Only bacterial infections can be treated with antibiotics. The common cold, flu, most coughs, some bronchitis infections, most sore throats, and the stomach flu are all caused by viruses. Antibiotics won't work to treat them.
61	A	A. Above is a physical process, below is a chemical process. ABOVE: Melting is a change of state which is a physical process, BELOW is combustion – a chemical process when the carbon in the wax is the fuel burning as it reacts exothermically with atmospheric oxygen
62	B	B. The "hot" air molecules are so far apart that there is actually very little heat up there.

63	D	In animal cells there is no cell wall and vacuoles are generally small.
64	B	Transparent glass appears red when it only allows red light to pass through while absorbing the other colours of white light. For the object to appear red, through a red glass it must reflect red light. The object could therefore be either red or white.
65	B	B. Water (The complete reaction is: $C_3H_8 + 5\ O_2 \Rightarrow CO_2 + 4\ H_2O$ Simply by counting the atoms on the left (reactant) side and comparing your count to the right (product) side, you will see that 8 hydrogens and 4 oxygens are missing i.e. 4 water molecules)
66	D	D. [1], [2] and [3] (The force of gravity acts on everything on or in or above the Earth, including the atmosphere, aeroplanes, balloons, rockets, satellites, the International Space Station, the Moon, Mars and all the other planets to lesser and lesser degrees as distance increases. So the rocket before launch, on the way up and on the way down is being attracted towards the centre of the Earth – the strength of the force depends on the MASS and on the SQUARE of the DISTANCE to the object.)
67	A	Ratio is 4,5 : 90 = 1 : 20
68	B	Unlike producers, consumers cannot make their own food. A heterotroph is an organism that eats other plants or animals for energy and nutrients. All consumers are therefore heterotroph.
69	A	(The top of a very high mountain, like Mt Everest, is close to the top of the Troposphere (the lower layer where weather occurs). The air is extremely cold and barely dense enough to support life – especially when exercising. Although a few well-adapted individuals have managed to climb without oxygen, most who try, die – many die even with the help of oxygen near the top – it is called the “Death Zone” for a reason.
70	B	B. A layer of paint prevents oxygen and moisture from coming in contact with the iron.
71	D	At the same voltage (on the x-axis), X has the highest current (y-axis). The smallest resistor will have the highest current. A thicker wire eases the flow of charges and therefore it has a lower resistance.
72	B	The sperm ducts (C) allow the transit of sperm from the testicles to the outside of the body while the urethra (G) connects the bladder to the outside for the removal of urine from the body.

		The scrotum is a bag of skin that holds and helps to protect the testes (testicles). The testes are 2 small organs that are found inside the scrotum.
73	D	Testosterone is the male sex hormone that is made in the testes (testicles). Testosterone hormone levels are important to normal male sexual development and functions. During puberty testosterone helps boys develop male features like body and facial hair, deeper voice, and muscle strength.
74	A	All folded mountain ranges are the result of the movement of tectonic plates. When early cratons coalesced to form continents the sediments in the seas surrounding them were folded and uplifted. The earliest examples predate the Cambrian Era and so there was no marine life (nor any life on land yet) and so such folded sediments are void of any signs of complex life. In the Barberton area there is evidence of 3,5 billion year old algal mats made by archaic algae to protect themselves from the Sun (ozone did not yet exist before the cyanobacteria began to use photosynthesis to utilise CO_2 and release oxygen as a waste product). After the "Cambrian Explosion" living organisms were using $CaCO_3$ derived from CO_2 to build protective shells. Marine sediments – like the floor of the Tethys Sea or the floor of the Mediterranean – that were folded up by advancing continental plates – are found high up on giant mountain ranges. The Himalayas contain fossils pushed up by the Indian Subcontinent colliding with Asia, while the Alps contain fossils pushed up as Africa has collided with Europe. The fact that the types of marine fossils differ in age and type by many millions of years indicates clearly that they cannot have been deposited by a giant world-wide flood.
75	D	D. Evaporation (Washing dries as the moisture evaporates into the air. Coincidently the uV rays of the Sun help to bleach white linen)
76	B	Conduction is the transfer of heat between solid objects that are in direct physical contact with each other. Convection is the transfer of heat from one place to another by the movement of liquid or gas particles. Radiation is the transfer of heat and does not require physical contact or movement of particles.
77	C	At Iron & Steel Refineries, the ore is crushed and mixed with "coke" – a high quality form of coal. When the mixture reaches the right temperature inside the Blast Furnace, the oxygen attached to the iron oxide is released and binds to the carbon from the coal. As a result, pure molten iron can be poured out of the furnace while the CO_2 escapes into the atmosphere. While this makes very useful steel, it is also a major source of carbon dioxide being vented into our atmosphere. This affects climate change.)

78	D	D. They form when supernovae explode or when neutron stars collide. Small stars like the Sun initially undergo thermonuclear fusion reactions that fuse hydrogen atoms into helium. As the supplies of hydrogen become depleted, these stars swell to become Red Giants and fuse helium into carbon, nitrogen and oxygen. Bigger stars have enough energy to fuse bigger elements, but no normal star is able to fuse anything beyond iron (see Q16). They cannot go beyond iron because the fusion of larger nuclei require more energy than is available by fusion alone. So where do these really heavy elements like gold, lead, uranium, etc. come from? We need a new source of non-thermonuclear energy, and this we get when extremely large stars explode as supernovae or when neutron stars collide.
79	C	Repeating multiple trials in an experiment helps to reduce the effect of errors. The more times an experiment is repeated with the same results, the more likely the conclusion will be accurate
80	C	C. Petrol evaporates more easily than water, so water must have the higher Boiling Point. (Since petrol evaporates more easily than water it will soon have enough vapour to match air pressure and will then boil. This can be worked out by comparing the distractors too).
81	B	B. The boiling point of the water was a lot lower at the top. (At high altitude the air is “thinner” and so exerts less pressure. Consequently, as the climber ascends it becomes easier and easier for his water to boil as the “target vapour pressure” becomes lower and lower).
82	D	Instead of using heat to produce light, LEDs use photons. Because it takes very little energy to release these photons, and because their clashes produce so much light, LEDs end up being four to five times more energy-efficient than tungsten (incandescent) bulbs.
83	C	Carbon dioxide accounts for about 76 percent of total greenhouse gas emissions. Greenhouse gases cause climate change by trapping heat increasing the average atmospheric temperature.
84	C	C. Gases from burning fossil fuels.

85	C	cost = power rating × time × price Step 1: Write down the formula cost = power rating × time × price Step 2: List all the given values in the problem power rating = 350 W = 0,350 kW time = 24 hour price = 295 c/kWh Step 3: Substitute the given values into the formula to find the unknown cost = 0,350 kW × 24 hour × 295 c/kWh = 2 478 cents = R 24,78
86	A	Plants grow away from the dark. Sunlight inhibits cell elongation so cells on the sunny side of the plant are shorter than those on the darker side. Manually rotating the plant through 180° once a week changes the direction of growth weekly, resulting in a spiral pattern.
87	D	D. P & Q & S are true, but R is false.
88	B	This is clear from the diagram which shows that ALL types of stars form from clouds of star-forming material – the initial size of the Protostar governs the size(s) of any future stars.
89	A	The time arrow on the X-axis of the diagram clearly shows that Blue Super Giants don't last as long as brown or white dwarfs. This can be realised simply by studying the graph as well as by logic – in an analogy a petrol fire burns quickly and should burn out before a charcoal fire on the braai.
90	C	The third row up in the diagram starts with Protostar, then Sun-like star, then Planetary Nebula and ends with White Dwarf – even with zero knowledge this can be read straight off the graph.
91	D	All of these are valid reasons.
92	D	The light at the violet, indigo, blue range of the spectrum has the highest frequency (shortest wavelength) and orange and red light has the lowest frequency (longest wavelength).
93	D	D. All of these are valid reasons.

		The CO_2 gas forms when the grain touches the moist sides of the new grain pit and begins to ferment. Since it is a heavy gas (44 a.m.u.) it settles to the bottom and builds up from there. This places an envelope of unreactive gas around the food – although it is non-poisonous, most things need oxygen, so within the protection of the CO_2 gas no further fermentation is possible, and the crop is also safe from ants, rat and mice, and insects. This highly effective indigenous technology can be adapted for Grain Silos – all that farmers or co-ops need to do is seal the base of the silo, and then throw a large block of dry ice into the top. The rural indigenous farmer can prevent any fermentation by getting a small block of dry ice from an ice cream vendor and dropping it in CCCC to his grain pit.
94	A	A. 1,28 seconds (384 000 km divided by 300 000 km/s = 1.28 s)
95	C	Urine produced by the kidneys accounts for the largest amount of water leaving the body. The kidneys can adjust the concentration of the urine to reflect the body's water needs, conserving water if the body is dehydrated or making urine more dilute to expel excess water when necessary. In this case more water and less salt will be reabsorbed to maintain the balance.
96	C	Copper (II) chloride solution can be broken down to copper metal (Cu) and chlorine gas (Cl_2) in a process is called electrolysis. Copper is deposited on the negative electrode (cathode) and chlorine gas is formed as bubbles at the positive electrode (anode).
97	B	The level of carbon dioxide in our body is what controls your breathing. When carbon dioxide reaches a certain level, a signal is sent from the breathing center in your brain stem to the breathing muscles, which increases the breathing rate.
98	C	The variable that is manipulated (changed) during the experiment is the independent variable. In this investigation two antibiotics, A and B, was used. This is the independent variable. The average resistance of E. coli against each were measured. The one measured is the dependent variable. All other variables were kept constant during the investigation.
99	B	The results show a lower resistance of E. coli against antibiotic B. Antibiotic B will therefore be more effective against the bacterium.
100	C	Geothermal energy is the thermal energy in the Earth's crust which originates from the formation of the planet and from radioactive decay of materials. Geothermal heating, using water from hot springs, for example, are used for bathing at resorts like Goudini and Montagu Spa.