**ACEITEKA MOCK EXAMINATIONS 2024, UCE PHYSICS P535/1, SCORING GUIDE**

| Item | Expected response | Points |
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| 1. | **Operation of a nuclear reactor.**<br>-The reactor core is loaded with fuel rods containing pellets of uranium (U-235). These rods are assembled into fuel assemblies. ✓<br>-Control rods made of neutron-absorbing materials such as boron or cadmium are placed among the fuel rods to manage the rate of the fission reaction. ✓<br>-A neutron source initiates the nuclear fission process by bombarding the fuel rods with neutrons. ✓<br>-When a U-235 nucleus absorbs a neutron, it becomes unstable and splits into two smaller nuclei (fission fragments), releasing a large amount of energy in the form of heat and additional neutrons. ✓<br>-This heat is used to produce steam, which drives turbines connected to generators to produce electricity. ✓<br>**How energy is produced in a control way.**<br>-In a nuclear reactor the energy production is controlled so that the heat energy is released over a longer period of time. This prevents explosion. ✓<br>**Background radiations**<br>-Background radiation is low-level ionising radiation that is produced all the time. We are exposed to it from various sources like the sun, soil, and even certain foods. ✓<br>- Nuclear power plants contribute very little to this background radiation. ✓<br>**Radioactive waste with long half-lives.**<br>-Radioactive waste products with long half life produce in a nuclear reactor present a serious problem for a long period of time. ✓<br>-They are therefore sealed (closed) in containers which are then buried deep underground. ✓<br>**Benefits of nuclear energy.**<br>-Low carbon emissions ✓<br>-High energy density ✓<br>-Reduces dependence on fossil fuels ✓<br>-Reliability (not weather dependent). ✓<br>**Any two points**<br>1. 16pts<br>2. 16pts<br>3. 14pts<br>4. 13pts<br>5. 11pts<br>6. 12pts<br>7. 16pts | 05pts<br>01pt<br>02pts<br>02pts<br>02pts<br>Tot=16pts |

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| 2. | **(a) How the sun produce energy**<br>The Sun produces energy through a process called nuclear fusion. In its core, hydrogen atoms are fused together under extreme pressure and temperature to form helium atoms. This fusion process releases a large amount of energy in the form of light and heat, which travels through space and reaches Earth. This energy is important for life on our planet<br><br>**(b) The variation in colour and brightness of stars in the milky way in terms of their size and distance from earth**<br>**-Colour:** The colour of a star indicates its temperature. Hotter stars appear blue or white, while cooler stars appear red or orange. Medium-temperature stars, like our Sun, appear yellow.<br>**-Brightness:** A star's brightness, or how bright it appears to us, is influenced by its size and distance from Earth. Larger stars can produce more light and appear brighter if they are closer to us. Conversely, smaller stars or those further away appear dimmer.<br>**(c) The different stages in the life cycle of a star**<br>**-Nebula:** Stars begin as clouds of gas and dust called nebulas.<br>Protostar: Gravity pulls the gas and dust together, forming a protostar.<br>**-Main sequence:** The star enters the main sequence phase, where it spends most of its life fusing hydrogen into helium, like our Sun.<br>**-Red giant/supergiant:** When the hydrogen runs out, the star expands into a red giant (for medium-sized stars) or supergiant (for massive stars).<br>**-White dwarf:** After shedding its outer layers, a medium-sized star's core remains as a white dwarf.<br>**-Neutron star or black hole:** A massive star can explode in a supernova, leaving behind a dense neutron star or collapsing into a black hole.<br>**(d) The purpose of the international space station (ISS) and its role in space exploration**<br>-**Scientific research:** Conducting experiments in microgravity that are not possible on Earth, leading to advances in science and technology. | 03pts<br><br>03pts<br><br>03pts<br><br>05pts |

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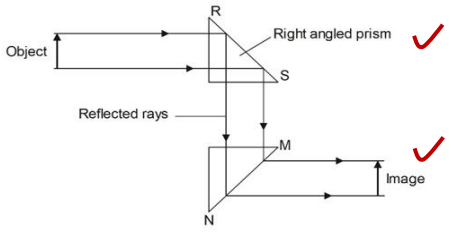
| 2. | -**International cooperation**: Serving as a symbol of international collaboration, with contributions from space agencies like NASA, ESA, Roscosmos, JAXA, and CSA. ✓ Any two points<br>-**Space exploration:** Testing new technologies and conducting research that will help in future space missions to the Moon, Mars, and beyond. ✓<br>**Education and inspiration:** Providing educational opportunities and inspiring the next generation of scientists and engineers. ✓ | 02pts<br><br>Tot=16pts |
| 3. | **(a) Choose between a mirror and a glass prism for the design of the simple instrument. Explain your choice with reasons and use a diagram to illustrate the design and operation of the simple instrument.**<br>The use of prisms is preferred to plane mirror in a periscope because;<br>-Prisms produce clear image ✓ Any one point<br>-Prisms do not tarnish and deteriorate as mirror. ✓<br>**Operation of a prism periscope.**<br>  <br><br>Correct diagram with any two correctly labelled parts<br>Light from a distant object meets the surface RS at $45^0$ ✓ so light is totally internally reflected ✓ downwards. The reflected light is incident to the surface MN where it is totally internally reflected to give the emergent light to the observer. ✓<br>**(b) Suitability of the laser**<br>Given;<br>Using $v = \lambda f$ , ✓<br>$f = \frac{v}{\lambda}$<br>$= \frac{3 \times 10^8}{532 \times 10^{-9}}$ ✓<br>$= 5.64 \times 10^{14} Hz$ ✓<br>**Advise:** Since the frequency $5.64 \times 10^{14} Hz$ of the laser s less than $6 \times 10^{14} Hz$ , itis suitable for the security system based on the given criteria. ✓ | 01pt<br><br>02pts<br><br>03pts<br><br>04pts |

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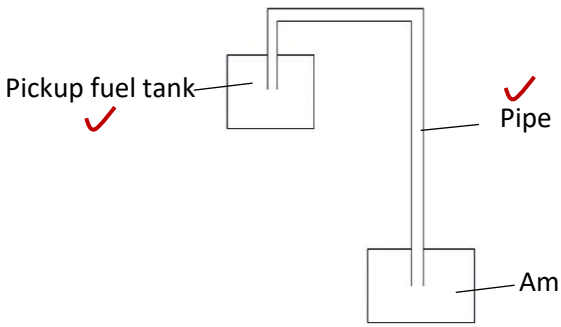
| 3. | **Differences between light from a regular light bulb and a laser**<br>**<u>Light from a regular light bulb</u>**<br>**-Nature:** Emits light in all directions. ✓<br>**-Wavelength:** Consists of a wide range of wavelengths (broad spectrum).✓<br>**-Coherence:** Light waves are not coherent; they are out of phase.<br>**-Divergence:** Light spreads out quickly. ✓<br>**<u>While for Laser Light</u>**<br>**-Nature:** Emits light in a specific direction. ✓<br>**-Wavelength:** Consists of a single wavelength (monochromatic).<br>**-Coherence:** Light waves are coherent; they are in phase.✓<br>**-Divergence:** Light spreads out very little, maintaining a narrow beam. ✓<br>Any two differences | 04pts<br><br>Tot=14pts |
| 4. | **(a) how the driver can get fuel using a pipe from the pick-up truck to his tank.**<br>  <br><br>Correct diagram with any two correctly labelled parts<br>-Insert one end of the pipe into the pickup truck's fuel tank. ✓<br>-Ensure the other end of the pipe is lower than the pickup truck's fuel tank to create a siphoning effect.✓<br>-Suck on the lower end of the pipe to start the flow of fuel until fuel starts to flow out. ✓<br>-Quickly insert the lower end of the pipe into the ambulance's fuel tank to allow the fuel to continue flowing. ✓<br>**(b) Minimum speed,**<br>$\text{Speed} = \frac{\text{distance}}{\text{time}}$ ✓<br>$= \frac{150}{3}$ ✓<br>$= 50\text{kmh}^{-1}$ ✓<br>**Advice:**<br>-The driver needs to maintain a minimum average speed of ✓ $50kmh^{-1}$ to ensure the medicine remains properly refrigerated upon arrival. | 02pts<br><br>04pts<br><br>04pts |

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| 4. | **(c) Establishing whether there is enough energy to maintain the refrigerator's internal temperature if the refrigerator's power rating is 50 W.**<br><br>Total energy required=Power×Time ✓<br>$= 50 \times 3 \times 3600 = 540{,}000J$ ✓<br>**Advise:**<br>-Given that the amount of thermal energy required to maintain the refrigerator's internal temperature should be higher than 450,000 J, and the total energy required is 540,000 J, there is enough energy to maintain the refrigerator's internal temperature. ✓ | 03pts<br><br>Tot=13pts |
| 5. | **(a) Guiding the police on whether the pickup was speeding.**<br><br>Using the law of conservation of momentum, we can determine the velocity of the car traveling northward before the collision.<br>$m_1u_1 + m_2u_2 = (m_1 + m_2)v,$ ✓<br>$(2000 \times u_1) - (1800 \times 19.44) = (2000 + 1800) \times 9.72$<br>$(2000 \times u_1) - 34992 = 36936$<br>$(2000 \times u_1) = 36936 + 34992$ ✓<br>$(2000 \times u_1) = 71928$<br>$u_1 = \frac{71928}{2000}$<br>$u_1 = 35.964ms^{-1}$<br>$= 129.47kmh^{-1}$ ✓<br>**Adise:** The pick up was travelling at $129.47kmh^{-1}$ which is beyond $70kmh^{-1}$ hence the pickup was speeding. ✓<br><br>**(b) Advise the driver who was not putting on the seat belt on the how it can safeguard his live**<br>-When a car is moving, both the car and its occupants are traveling at the same speed. ✓<br>-Due to inertia, if the car suddenly stops (e.g., due to a collision), the bodies of the occupants will tend to continue moving forward at the same speed. ✓<br>-Upon a sudden stop, the seat belt applies a force to the occupants' bodies, decelerating them gradually and safely, preventing them from continuing to move forward and hitting the interior parts of the vehicle or being thrown out of the car. This prevents injuries or death. ✓ | 04pts<br><br>03pts |

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| 5. | **(c) Assisting the police to get the correct tyre temperature.**<br>$\theta = \frac{L_\theta - L_0}{L_{100} - L_0} \times 100^0C$ ✓<br>$= \frac{40 - 10}{80 - 10} \times 100^0C$ ✓<br>$= \frac{30}{70} \times 100^0C$<br>$= 42.86^0C$ ✓<br>-The correct tyre temperature is approximately $42.86^0C$ ✓ | 04pts<br><br>Tot=11pts |
| 6. | **(a) How installing a lightening will protect his building**<br>-During a thunderstorm, the sharp points near the ground becomes highly charged.✓<br>-The lightning rod, being a pointed conductor, has high concentration of positive charge around it. ✓<br>-This ionizes the air around the lightning rod, making it more conductive and creating an easy path for the lightning to follow. ✓<br>-In case of a spark jump (lightning strike), it is safely conductor to the ground through the copper plate. ✓<br>-Without a lightning conductor, a lightning strike could directly hit the building, causing fire or significant damage to the structure.✓<br>**(b) Whether the newly bought transformer is suitable for the building's needs**<br>Efficiency $= 80\% = 0.80$<br>Input Power $= 60\text{W}$<br>Efficiency $= \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$ ✓<br>Output Power = Efficiency × Input Power<br>Output Power $= 0.80 \times 60\text{W} = 48\text{W}$ ✓✓<br>**OR**<br>$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ ✓<br>$\frac{v_s}{240} = \frac{300}{200}$ ✓<br>$v_s = 360\text{V}$ ✓<br>Since, $V_s > V_p$ and<br>$P \propto V$ ✓<br>**-Advise:** The newly bought transformer has an output power of 48W, which is less than the required 80W. Therefore, the new transformer is not suitable for the building's needs as it will not provide adequate power for the electrical system ✓ | 05pts<br><br>04pts |

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| 6. | **(c) The dangers associated with delaying the replacement of the fuse and the re-establishment of a proper earth connection.**<br>-Under normal operating conditions, the electrical current flowing through the circuit is within the safe limits.<br>-The fuse element is designed to carry this current without overheating or melting. ✓<br>-If the current exceeds the safe limit due to a fault such as a short circuit or overload, the fuse element heats up. ✓<br>-The excessive current causes the fuse element to reach its melting point and melt ✓<br>-When the fuse element melts, it breaks the electrical circuit, interrupting the flow of current. This stops the excessive current from continuing to flow, preventing potential damage or hazards. ✓ | 03pts<br><br>Tot=12pts |
| 7. | **(a) Total power**<br>Total Energy $(Wh) = (5W \times 12 \times 12\ hours) + (65W \times 24\ hours) + (3000W \times 5\ hours)$ ✓<br>$= 720\ Wh + 1560\ Wh + 15000\ Wh$ ✓<br>$= 17280\ Wh$<br>$= 17.28\ kWh$ ✓<br><br>**(b) choosing a suitable generator for his business needs and explaining the operation of the chosen generator with a labelled diagram.**<br><br>**Advantages of alternating current (a.c.) over direct current (d.c.).**<br>- A.c. can be produced in large quantities unlike d.c. ✓<br>-A.c. can be stepped up or stepped down, allowing us to use the required amount, this is not possible with d.c. ✓<br>- Power losses due to a.c. can easily be minimised (i.e. by stepping up voltage). ✓<br>- A.c. is cheaper to generate compared to d.c. considering what is needed to produce them. ✓<br>Any two points | 03pts<br><br>02pts |

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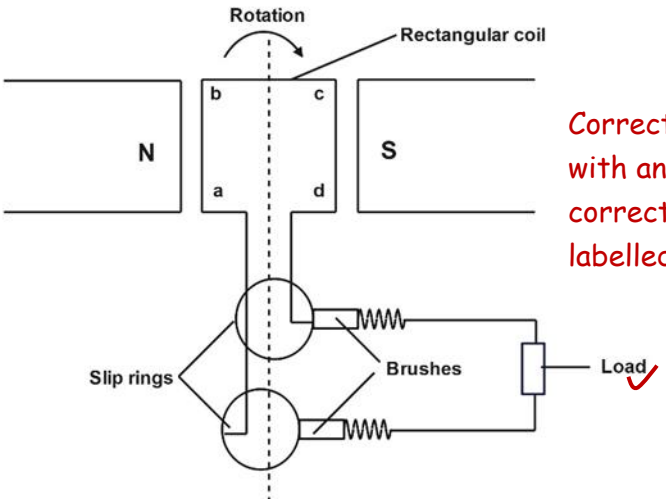
| 7. | **Operation of an A.C generator**<br>  <br><br>Correct diagram with any 1 correctly labelled part<br>-The simplest alternating current (A.C) generator consists of a rectangular coil between the poles of a C-shaped magnet. The ends of the coil are joined to two slip rings on the axle and against which carbon brushes press.<br>-When the coil is rotated it cuts the field lines and a voltage is induced in it. As the coil moves through the vertical position with ab uppermost, ab and cd are moving along the lines and no cutting occurs. The induced voltage is zero.<br>-During the first quarter rotation, the p.d. increases to a maximum when the coil is horizontal. Sides ab and dc are then cutting the lines at the greatest rate.<br>-In the second quarter rotation the p.d. decreases again and is zero when the coil is vertical with dc uppermost. After this, the direction of the p.d. reverses because, during the next half rotation, the motion of ab is directed upwards and dc downwards.<br>-An alternating voltage is generated which acts first in one direction and then the other; it causes alternating current (A.C) to flow in a circuit connected to the brushes.<br>**(c) Colour codes**<br>**-Live (Hot) Wire:** Brown (or Red)<br>**-Neutral Wire:** Blue (or Black)<br>**-Earth (Ground) Wire:** Green/Yellow stripes<br>**(d) Energy saving tips**<br>-Use energy-efficient devices and practices.<br>-Maintain equipment regularly.<br>-Control the usage of high-energy appliances.<br>Any two points<br>.....**The end**..... | 01pt<br>05pts<br>03pts<br>02pts<br>Tot=16pts |