



***Scoring  
Rubric  
2019***

**South Pacific  
Form Seven  
Certificate**

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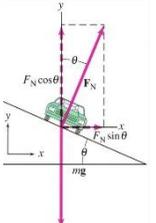
**STRAND 1:** Demonstrate understanding, by explanation and solving problems, of the physical phenomena, concepts, principles and relationships involved in mechanics.

**STRAND 1: MECHANICS**

**1.1: TRANSLATIONAL MOTION**

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
1.1a	2	When the two bodies collide, Jack and Sam will experience equal and opposite momentum changes. At the instant of their collision, they exert equal and opposite forces upon each other as the result of the collision interaction. Like any other collision, total momentum is conserved considering no influence of external forces. As a result, Sam moves off at a lesser speed.	Mentions a fact. Momentum is conserved. Sam moves off at a speed less than $2 \text{ ms}^{-1}$ .	Mentions two facts.			Invalid conceptual understanding.
1.1b	3	$p_{\text{initial}} = p_{\text{final}} \dots \dots \text{(i)}$ $(50 \times 2) + (60 \times 0) = (50 \times 0) + (60 \times v) \dots \text{(ii)}$ $100 + 0 = 0 + 60v$ $100 = 60v \dots \text{(iii)}$ $v = 1.67 \text{ ms}^{-1} \dots \text{(iv)}$	Any expression of the Law of conservation of momentum Steps (i) or (ii)	Getting the correct magnitude of the total initial momentum Steps (iii) or (iv)	Correct final answer Or slip in calculation		Incorrect answer
1.1c	1	For any collision, the total momentum before equals the total momentum after, provided there is no external force acting.	Correct statement or anything to that effect OR Formula $p_{\text{initial}} = p_{\text{final}}$				Invalid statement
1.1d	1	If mass is constant, velocity increases, momentum increases. Thus at a constant mass, momentum increases with increasing velocity.	Correct statement. Directly proportional $p \propto v$				Incorrect statement

Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
1.1e	1	<p>It is the average position of all the mass in a system. OR Point where all mass of a system is concentrated.</p> $x_{cm} = \frac{\sum_{i=1}^N m_i x_i}{M}$	Correct definition or correct formula					Incorrect definition
<b>2: CIRCULAR AND ROTATIONAL MOTION</b>								
1.2a	1	A	Correct answer					Incorrect answer
1.2b	1	f	Correct answer.					Incorrect answer
1.2c	2	$v = \frac{75km}{h} \times \frac{1hour}{3600s} \times \frac{1000m}{1km}$ $v = 20.83 \text{ ms}^{-1}$ $\tan\theta = \frac{v^2}{gr} = \frac{(20.83)^2}{10 \times 32}$ $\theta = 53.6^\circ$	<p>Correct value for <math>v</math></p> <p>OR</p> <p>Identified correct formula</p>	<p>Correct answer</p> <p>OR correct working and 'slip' in calculation</p>				Incorrect answer
1.2d	3	<p>A car (e.g) travelling around a banked curve of <math>\theta</math>, is acted on by two forces:</p> <p>(i) The force of gravity, <math>F_w</math> downwards</p> <p>(ii) The reaction force, <math>F_N</math>, upwards at right angles to the road surface</p>	<p>Mentions one correct relationship</p> <p>OR <math>F_c = \frac{mv^2}{r}</math></p>	<p>Mentions about resolution of force</p> <p>And</p> <p>The vertical component equal to <math>mg</math></p>	Full explanation with or without diagram			Invalid conceptual understanding.

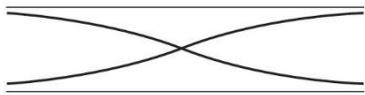
Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
		<p>Resolving <math>F_N</math> into components give <math>F_N \cos \theta</math> and <math>F_N \sin \theta</math>.</p> <p>Now <math>F_N \cos \theta = mg</math>, thus the resultant force is just the horizontal component of <math>F_N</math>, which is <math>F_N \sin \theta</math>.</p> <p>This is the centripetal force, which causes the car to travel on that banked curve at a maximum speed without slipping. i.e.</p> <p><math>F_N \sin \theta = \frac{mv^2}{r}</math> where <math>v</math> is the velocity and <math>\frac{v^2}{r}</math> is the acceleration.</p>  <p><a href="https://slideplayer.com/slide/13324610/">https://slideplayer.com/slide/13324610/</a></p>		<p>OR</p> <p>Diagram</p>			
1.2e	2	$\omega = \frac{45 \text{ rev}}{\text{min}} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{2\pi \text{ rad}}{1 \text{ rev}}$ $\omega = 4.71 \text{ rads}^{-1}$ $v = r\omega$ $= 0.15 \times 4.71$ $v = 0.71 \text{ ms}^{-1}$	<p>Correct value of <math>\omega</math></p> <p>OR</p> <p>Identifies correct formula <math>v = r\omega</math></p> <p>OR <math>1 \text{ rev} = 2\pi \text{ rad}</math></p>	<p>Correct answer</p> <p>OR</p> <p>Correct working and 'slip' in calculation</p>			Incorrect answer
<b>1.3: SIMPLE HARMONIC MOTION (SHM)</b>							

Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
1.3a	1	The displacement in a SHM is given by $y = A \sin \omega t$ where $y$ = displacement (m) $A$ = amplitude (m) $\omega$ = angular frequency ( $\text{rads}^{-1}$ ) $t$ = time (s)	Correct answer  OR Correct formula + any two correct variables  OR $y = A \cos \omega t$					Incorrect answer
1.3b	1	The velocity in a SHM is given by $v = \omega A \cos \omega t$	Correct answer  OR $v = -A\omega \sin \omega t$					Incorrect answer
1.3c	2	$y = 6.8 \sin \left( 4t + \frac{\pi}{4} \right)$ $v = \frac{dy}{dt} = 6.8 \cos \left( 4t + \frac{\pi}{4} \right) (4)$ At t=0 sec; $v = 6.8 \cos \left( 4(0) + \frac{\pi}{4} \right) (4)$ $v = 19.2 \text{ ms}^{-1}$	Shows that $v$ is $\frac{dy}{dt}$  OR $45^\circ$ or $\frac{180^\circ}{4}$  OR $v = \omega A \cos \omega t$	Correct answer  OR Correct working with a 'slip' in calculation				Incorrect answer
1.3d	3	$v = \frac{dy}{dt} = 6.8 \cos \left( 4t + \frac{\pi}{4} \right) (4)$ $a = \frac{dv}{dt} = -27.2 \sin \left( 4t + \frac{\pi}{4} \right) \times 4$ $a = -108.8 \sin \left( 4t + \frac{\pi}{4} \right)$ At t=1 sec; $a = -108.8 \sin \left( 4 + \frac{\pi}{4} \right)$ $a = -82.11 \text{ ms}^{-2}$ $F = ma = 0.5 \times -82.11$ $F = -41.06 \text{ N}$	Shows that $a$ is $\frac{dv}{dt}$ or $y''$  OR $a = -\omega^2 A \cos \omega t$	Correct value for acceleration or 'slip' in calculation or correct formula	Correct answer  OR Correct working with a 'slip' in calculation			

**STRAND 2:** Demonstrate understanding, by explanation and solving problems, of the physical phenomena, concepts, principles and relationships involved in waves.

**STRAND 2: WAVES**

**2.1: STANDING WAVES**

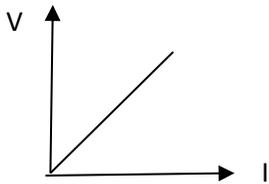
Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
2.1a	1	A standing wave is formed by two travelling waves with the same frequency, wavelength and amplitude travelling in opposite directions.	Correct answer					Incorrect answer
2.2a	2		Partially correct Or has an open pipe	Correct diagram				Incorrect diagram
2.2b	1	C	Correct answer					Incorrect answer
2.2c	2	$\lambda = L = 0.65 \text{ m}$ $v = 330 \text{ ms}^{-1}$ $f = \frac{v}{\lambda} = \frac{330}{0.65} = 507.69$ $\approx 508 \text{ Hz}$	Identified correct value for $\lambda$  Or wave equation in any form	Correct answer or a 'slip' in calculation				Incorrect answer
2.2d	1	Amplitude of a wave is the maximum displacement of the wave from the equilibrium (rest) position.	Correct definition					Incorrect definition

Item #	Skill Band	Evidence	Student Response level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
<b>2.3: DOPPLER EFFECT</b>							
2.3	3	<p>When the source of the sound waves is travelling away from Mike, each time a wave crest is produced the source is further from Mike than when the previous wave crest was produced. This results in the wave crests arriving at Mike's position further apart than they would have been if the source had been stationary. The wavelength has increased. Because the source is gaining speed, the wavelength is continuously increasing and so the frequency is continuously decreasing. Therefore, Mike hears the sound at a lower frequency than the frequency at which it was emitted and the note is continuously getting lower.</p> $f' = f \frac{v_m}{v_m + v_s} = \frac{185 \times 343}{343 + 27}$ $f' \approx 172 \text{ Hz}$	<p>Correct apparent frequency</p> <p>Or mentions that apparent frequency is less</p> <p>Defines Doppler effect</p>	<p>Mentions that as the source moves away, wavelength increases.</p> <p>And</p> <p>Correct apparent frequency</p>	<p>Full explanation and supporting correct calculation</p>		<p>Incorrect answer</p>
2.4	4	<p>Red light has a longer wavelength compared to blue. Longer wavelength causes fringes to be far apart or scattered more.</p> $\lambda \propto x$ <p>If the screen was moved farther away, L increases which causes the fringes to be far apart or scattered more.</p> $L \propto x$ <p>If the distance between the slits was decreased, d decreases. When d</p>	<p>Recognizes the correct formula</p> $n\lambda = \frac{dx}{L}$	<p>One correct effect stating its correct relation to the cause.</p>	<p>Two correct effects stating their correct relation to the causes.</p>	<p>Full explanation</p>	<p>Invalid conceptual understanding</p>

		decreases it will cause the pattern to spread out or scatter or diffract more. $d \propto \frac{1}{x}$					
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### STRAND 3: ELECTRICITY AND ELECTROMAGNETISM

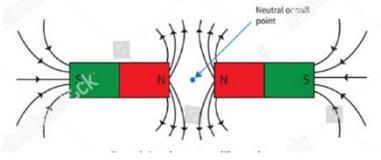
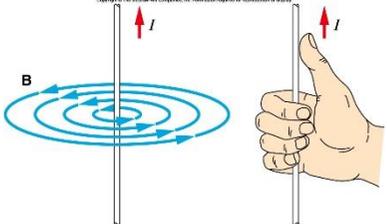
#### 3.1 DC CIRCUITS AND CAPACITANCE

Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
3.1a	1	At any junction, the total current entering the junction equals the total current leaving. OR $\sum I = 0$ OR $\sum I_{entering} = \sum I_{leaving}$	Correct statement.					Incorrect answer
3.1b	1	The current through a conductor is directly proportional to the voltage across it provided the temperature of the conductor is constant. Accept graph 	Correct statement OR $V=IR$ OR $V \propto I$					Incorrect answer
3.1c	2	$R = \frac{V}{I} = \frac{100}{4} = 25 \Omega \dots\dots(i)$ $25 \Omega = R_1 + R_2 + R_3$ $25 \Omega = 10 + 8 + R_3$ $\therefore R_3 = 7\Omega$ -----	Recognizes correct formula (i) OR Arrives at $R_T = 25 \Omega$ ----- or	Correct working and answer. OR 'slip' in calculation				Incorrect working and answer

Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
		OR $100 - (4 \times 10) - (4 \times 8) + x = 0$ . (i) $100 - 40 - 32 = -x$ $x = -28 = -IR = -4 \times R_3$ $R_3 = 7\Omega$	(i) Type equation here. Arrives at -28 V					
3.1d	2	Loop ABCDA $(-4 \times 0.75) + (-2 \times I_1) + 5V = 0$ $-3 - 2I_1 + 5 = 0$ $2 - 2I_1 = 0$ $I_1 = 1 A$	Correct loop equation (i)	Correct loop equation, correct working and correct answer OR 'slip' in calculation				Incorrect working and answer
3.1e	2	$I_1 = 0.75 + I_2$ $1 = 0.75 + I_2$ $I_2 = 1 - 0.75 = 0.25 A$ Loop BCFEB $(-4 \times 0.75) + (I_2 \times 8) + \varepsilon = 0$ $-3 + 8I_2 + \varepsilon = 0$ $-3 + (8 \times 0.25) + \varepsilon = 0$ $-3 + 2 = -\varepsilon$ $-1 = -\varepsilon$ $\therefore \varepsilon = 1 V$	$I_2 = 0.25 A$ OR Correct loop equation (i)	Correct loop equation, correct working and correct answer OR 'slip' in calculation				

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
3.1f	4	<p>A timing circuit controls how long or when something should happen. E.g. a microwave oven has a timer to control how long food is cooked for. A Pelican crossing has a timer, which activates a sequence of traffic lights for a predetermined time when a pedestrian presses a switch.</p> <p>Timer circuits a make use of a capacitor, (preferably an electrolytic capacitor because they have a much larger capacity than non-electrolytic capacitors of the same physical size), a resistor (greater than 1 k<math>\Omega</math> (to minimise the current flowing in the timing circuit) and a 555 Timer.</p> <p>An application of timer that may call for improvement is that on traffic lights. Light changing intervals on busy intersections need to be prolonged to 20s to ease the flow of traffic during peak hours. To do that, we set T= 20s in the formula</p> $T = 1.1 \times R \times C$ $20 = 1.1 \times R \times 100\mu F$ $R = 180 k\Omega$ <p>It is usually easier to find a resistor of different values than a capacitor because there are more of them and variable resistors are very common. Finding a variable capacitor is not so easy and they are very expensive.</p>	General function of a timer.	Mentions how it works, the use of 555 Timer, R (greater than 1 k $\Omega$ and an electrolytic C.	General function of a timer.  Mentions how it works and the relationship between R and C and T	Improvement to existing applications- valid applications	Invalid conceptual understanding

## 3.2: ELECTROMAGNETIC INDUCTION

Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
3.2a	1	It is a region in space where a magnetic material experiences a magnetic force.	Correct answer					Incorrect answer
3.2b	1	 <a href="https://www.freeart.com/artwork/art-print/magnetic-field-of-a-bar-magnet_fa12786638.html">https://www.freeart.com/artwork/art-print/magnetic-field-of-a-bar-magnet_fa12786638.html</a>	Draws correct pattern and correct direction.					Incorrect pattern or incorrect direction
3.2c	1	 <a href="https://physics.stackexchange.com/questions/162800/magnetic-field-direction-a-single-one-on-a-current-carrying-wire">https://physics.stackexchange.com/questions/162800/magnetic-field-direction-a-single-one-on-a-current-carrying-wire</a>	Draws correct pattern and correct direction.					Incorrect pattern or incorrect direction

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
3.2d	3	<p>When the bar magnet is moved towards the coil, the flux through the coil increases, and an induced current flows in the coil. The induced current in the coil produces its own magnetic field, which according to Lenz's Law will oppose the cause, the change in magnetic flux. The induced current in the coil creates a North pole to try to repel the North pole coming in. Hence, the current in the coil flows away from me, using the Right Hand Grip Rule.</p> <p>When the bar magnet is moved away from the coil, the flux through the coil decreases, and an induced current flows in the coil. The induced current in the coil produces its own magnetic field, which according to Lenz's Law will oppose the cause, the change in magnetic flux. The induced current in the coil creates a South pole to try to attract the North pole coming out. Hence, the current in the coil flows towards me, using the Right Hand Grip Rule.</p>	<p>Mentions there is a change in flux when the magnet moves in/out of the coil.</p> <p>Mentions that Current or voltage is induced</p>	<p>Mentions that the induced current in the coil produces its own magnetic field thus opposes the cause.</p> <p>Mentions correct production of North/ South pole.</p> <p>Mentions polarity changes on the closer end of coil</p>	Full explanation		Invalid conceptual understanding
3.2e	3	<p>A transformer consists of two coils: the primary and the secondary coil. A changing voltage applied across the primary coil, produces a changing magnetic flux along its core. The core is made of soft iron, a magnetically soft substance that guides the magnetic flux into the secondary coil. This induces voltage in the secondary coil. The continuous loop of iron makes the flux produced by the primary coil link the secondary coil.</p> <p>The continuous iron core is laminated and each layer is insulated from the ones above and below. This is done to minimise eddy currents.</p>	<p>Mentions the components of a transformer; primary coil, secondary coil and iron core</p> <p>Any associated formulae</p> $\frac{V_S}{V_P} = \frac{N_S}{N_P}$ $V_P I_P = V_S I_S$	<p>Two facts stated and the correct components.</p> <p>Mention that transformers operate only in AC circuits</p>	Full explanation		Invalid conceptual understanding

**STRAND 4:** Demonstrate understanding, by explanation and solving problems, of the physical phenomena, concepts, principles and relationships involved in atomic and nuclear physics.

**STRAND 4: ATOMIC AND NUCLEAR PHYSICS**

**RADIOACTIVITY**

Item #	Skill Band	Evidence	Student Response Level					
			Unistructural	Multistructural	Relational	Extended Abstract	Weak	
4.1a	1	<p>According to Bohr's one-dimensional model, this is the number of an energy level of an electron in an atom.</p> <p>According to Schrodinger's 3-D model, this is a 3 coordinate number to describe the orbitals in which the electron can be found: <math>n, l, m</math>; principal, angular and magnetic quantum numbers.</p>	Mentions either one correctly.					Incorrect answer
4.1b	1	<ul style="list-style-type: none"> <li>• It failed to explain why electrons could only have certain fixed energy levels</li> <li>• It could not explain some smaller details of the spectrum</li> <li>• It is in violation of the Heisenberg Uncertainty Principle. The Bohr Model considers electrons to have both a known radius and orbit, which is impossible according to Heisenberg.</li> <li>• The Bohr Model is very limited in terms of size. Poor spectral predictions are obtained when larger atoms are in question.</li> <li>• It cannot predict the relative intensities of spectral lines.</li> <li>• It does not explain the Zeeman Effect, when the spectral line is split into several components in the presence of a magnetic field.</li> <li>• The Bohr Model does not account for the fact that accelerating electrons do not emit electromagnetic radiation.</li> </ul>	Mentions any one correctly.					Incorrect answer

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
4.1c	2	<ul style="list-style-type: none"> <li>Atoms are made of 3 subatomic particles: neutrons, protons and electrons.</li> <li>The centre of an atom is called the nucleus and contains the protons (which are positively charged) and neutrons, which are neutral (have no charge).</li> <li>The negatively charged electrons orbit the nucleus.</li> <li>Every atom has the same amount of protons and neutrons, so every atom has a neutral charge.</li> </ul>	Mentions one description correctly	Mentions 2 or more descriptions correctly			Incorrect answer
4.1d	3	Bohr was the first to incorporate quantization into the electronic structure of the Hydrogen atom. He suggested that the energy of the orbiting electron must be quantized, i.e. have only specific, discrete values. This means when excited electrons fall back to lower energy levels, the energy they lose- and hence emit as EM radiation- also has very specific values. As the frequency of the emitted EM radiation depends on its energy, only very specific frequencies are emitted. Each different frequency produces a spectral line.	Any one idea mentioned correctly.	Any two ideas mentioned correctly. $n = \infty$ , energy level at which the electron is no longer bound to the atom, the atom has become an ion. The $E=0$ Lower energy levels, $E$ is negative. First energy level is $n = 1$ , ground state energy level. An electron in ground state is most tightly bound within the atom.	Full explanation		Incorrect answer
4.1e	4	Fusion is the combining of two light atomic nuclei. Practically, fusion energy generation use nuclei of Deuterium and Tritium, which are easily obtainable. Deuterium is in normal hydrogen or sea water. Deuterium and Tritium are isotopes of hydrogen, both positively charged, thus great amount of energy is needed to overcome the repulsive forces. The reaction is exothermic releasing neutrons and electrons. Gas from Deuterium and Tritium is heated to a very high	Defines fusion	Mentions raw materials  Mentions that great amount of energy is needed to overcome repulsive forces	Shows some understanding of the process involved, availability of raw materials, and the danger of containing the plasma	Full explanation  Mentions advantage of fusion power generation	Invalid conceptual understanding

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
		<p>temperature (100 M degrees C). This is achieved through magnetic confinement where the hot gas (plasma) is controlled in toroidal chambers magnetic coils so that it does not touch anything else. Plasma is contained in a “magnetic bottle”.</p> <p>There is a great energy loss from the plasma in the form of microwaves, X-rays, UV radiation and heat. Workers need to wear protective clothing to keep from exposure. The advantage of fusion power generation s that:</p> <ul style="list-style-type: none"> <li>• No nuclear weapon material is produced</li> <li>• Radioactive waste is a minimal</li> </ul>					