No. 109/3

EDUCATIONAL QUALITY AND ASSESSMENT PROGRAMME

PHYSICS

Scoring Rubric 2022

South Pacific Form Seven Certificate

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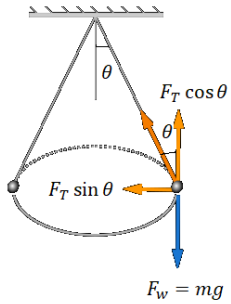
STRAND 1: Demonstrate understanding, by explanation and solving problems, of the physical phenomena, concepts, principles and relationships involved in mechanics.

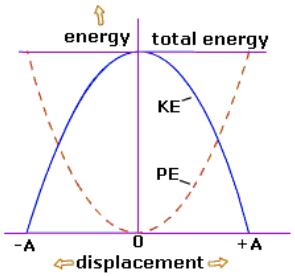
STRAND 1: MECHANICS

1.1 TRANSLATIONAL MOTION

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
1.1a	1	B	B				Incorrect answer
1.1b	2	$c.o.m. = \frac{m_1r_1 + m_2r_2 + m_3r_3 \ldots\ldots}{m_1 + m_2 + m_3 \ldots\ldots}$(i) $= \frac{1\times0+4\times2+2\times5}{1+4+2}$.....(ii) $= \frac{18}{7}$ (iii) $= 2.57\ m\ to\ the\ right$	Steps (i) or (ii) OR 7	Step (iii) OR Correct final answer Or slip in calculation			Incorrect answer
1.1c	1	Momentum of a body is defined as the product of its mass and velocity. OR $p = mv$ OR Quantity of motion of a moving body	Correct definition or anything to that effect.				Incorrect definition
1.1d	2	$v = \frac{p}{m}$.....(i) $= \frac{5.8}{0.58} \ldots\ldots\ldots (ii)$ $v = 10\ ms^{-1}$	Step (i) or 0.58	Correct final answer Or slip in calculation			Incorrect answer
1.1e	3	When two bodies collide, they exert a force F on each other for a short time t and so the momentum of each ball changes. From Newton's 3rd Law, the forces are equal and opposite. Since the forces are equal and opposite, the changes in momentum are equal and opposite. i.e the momentum gained by one ball is equal to the momentum lost by the other ball. Which means when two balls collide, their total momentum remains constant. $\sum momentum_{before} = \sum momentum_{after}$	Mentions when two bodies collide, their momentum changes. (i) OR Newton's 3rd Law states that the forces are equal and opposite (ii)	Mentions both (i) and (ii) or something to that effect	Full explanation with diagrams drawn.		Incorrect answer

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
1.2 CIRCULAR AND ROTATIONAL MOTION							
1.2a	1	C. (III)	C. (III)				Incorrect answer
1.2b	2		**The item had been changed. Thus, any ONE of the arrow diagrams was accepted.** Draws either $F_T\cos\theta$ or $F_T\sin\theta$	**Draws any two correctly**			No additional drawing on the diagram
1.2c	2	$F_y = F_w$.....(i) $F_N \cos\theta = mg$....(ii) $F_N = \frac{1500 \times 10}{\cos 20°}$ $F_N = 15963\ N$.....(ii) $F_x = F_c$ $F_c = F_N \sin\theta$....(iii) $15963 \sin 20° = 5460\ N$...(iv) $F_c = \frac{mv^2}{r}$.....(v) $v = \sqrt{\frac{F_c r}{m}} = \sqrt{\frac{5460 \times 75}{1500}} = 16.52\ ms^{-1}$	Mentions any one of the following: (i), (ii), (iii) or (iv) or (v) OR $v = \sqrt{rgtan\theta}$	Correct answer OR Correct working and 'slip' in calculation			Incorrect answer
1.2d	2	$v = r\omega$.....(i) $= 3 \times 2.8$ $v = 8.4\ ms^{-1}$.....(ii) $L = mvr$.....(iii)	Mentions (i), (ii) or (iii) OR $L = mr^2\omega$	Correct answer OR			Incorrect answer

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
		$= 35 \times 8.4 \times 3$ $= 882\ kgms^{-1}$		Correct working and 'slip' in calculation			
1.2e	2	At the top of the slope, the object has gravitational potential energy. $E_P = mg\Delta h$ ....(i) As the object rolls down the slope, this gravitational potential energy is converted to rotational kinetic energy $(kE)_{rotational}$ and linear kinetic energy $(kE)_{linear}$, assuming that there is negligible heat and sound produced. $E_P = mg\Delta h = kE_{rotational} + kE_{linear}$....(ii)	Mentions anything to the effect of (i) or (ii)	Full description			Invalid conceptual understanding.
1.2f	3	The solid cylinder has an even spread of its mass and has its mass closer to its center giving it a small radius causing a smaller rotational inertia since $I = \frac{1}{2}mr^2$. The hollow cylinder has all its mass far from the centre, causing a radius twice that of the solid cylinder. Hence, $I = mr^2$ so it has a larger rotational inertia. Rotational inertia of an object depends on its mass and the distribution of that mass relative to the axis of rotation.	Mentions on correct idea.	Mentions two or more independent ideas.	Full explanation OR Relates inertia, radius to mass and distribution of mass from the axis of rotation.		Invalid conceptual understanding.
1.3: SIMPLE HARMONIC MOTION							
1.3a	1	$v = \omega\sqrt{A^2 - y^2}$ OR $v = A\omega\cos\omega t$ OR $v = -A\omega\sin\omega t$	Correct answer				Incorrect answer

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
1.3b	1	$v_{max} = \omega A$	Correct answer				Incorrect answer
1.3c	2	$10\ vibrations\ in\ 2s$ $\therefore 5\ vibrations\ in\ 1s \Rightarrow f = 5\ Hz$……(i) $\omega = 2\pi f$ …(ii) $= 2\pi \times 5$….(iii) $\omega = 10\pi = 31.42\ rad\ s^{-1}$….(iv) OR $\omega = \frac{2\pi}{T}$……(v) $= \frac{2\pi}{0.2} = 31.42\ rad\ s^{-1}$	Step (i) or (ii) or 0.2 or (v)	Correct answer OR Correct working with a 'slip' in calculation			Incorrect answer
1.3d	3		One graph correct (with or without label)	Two graphs correct OR three graphs (with or without label)	Got all three graphs correct relative to each other		Invalid conceptual understanding.
1.3e	1	A critically damped oscillation moves as quickly as possible toward equilibrium without oscillating about the equilibrium.	Correct definition or anything to that effect.				Incorrect definition
1.3f	1	Forced vibrations is the vibrations of a body under the action of an external periodic force in which the body vibrates with a frequency equal to the frequency of the external periodic force, other than its natural frequency.	Correct definition or anything to that effect.				Incorrect definition

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: WAVE PROPERTIES

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
2.1a	1	B. Wavelength	B. Wavelength				Incorrect answer
2.1b	1	B. Diffraction	B. Diffraction				Incorrect answer
2.1c	2	$Echo\ heard\ after\ 1\ s$ $\therefore\ time\ taken\ for\ sound\ to\ reach\ sea-bottom\ is\ 0.5\ s$ $Depth\ = d = v \times t$ $= 1500 \times 0.5$ $d = 750\ m$	Correct answer OR Correct working with a 'slip' in calculation				Incorrect answer
2.1d	3	$\left(n - \frac{1}{2}\right)\lambda = \frac{dx}{L}$.....(i) $\left(3 - \frac{1}{2}\right)(590 \times 10^{-9}) = \frac{0.037\times10^{-3}x}{0.55}$(ii) $x = \frac{(2.5)(590\times10^{-9})(0.55)}{(0.037\times10^{-3})}$.....(iii) $x = 0.02\ m\ or\ 2\ cm$	n =3 OR $\lambda = 590 \times 10^{-9}$m OR $d = 0.037 \times 10^{-3} m$	Correct formula (i)	Correct answer OR (iii) Correct working with a 'slip' in calculation		Incorrect answer

Item #	Skill Band	Evidence	Student Response level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
2.2: SOUND WAVES							
2.2a	1	B. Standing wave	B. Standing wave				Incorrect answer
2.2b	1	D. Resonant frequency	D. Resonant frequency				Incorrect answer
2.2c	2	Since frequency, f, is the subject of discussion here. using $v = f\lambda$, $f \propto v \; and \; f \propto \frac{1}{\lambda}$ Changing the length → the shorter the string, the shorter the wavelength, so the frequency is higher, hence a high note. Changing the heaviness of the string → heavier string have a greater mass per metre and the wave speed is lower. Heavier strings produce lower frequency waves, hence lower note. Changing the tension force → the greater the tension force, the faster the wave speed so the higher the frequency thus a high note As such, a guitar has 6 strings with different mass per metre to produce different notes. The tension force on the strings is obtained by turning the tuning pegs and various notes is achieved also by varying the lengths of the strings with the player's fingers.	Mentions one fact.	Mentions two facts.	Includes the relationship between f, wavelength and speed, v. Since frequency, f, is the subject of discussion here. Using $v = f\lambda$, $f \propto v \; and$ $f \propto \frac{1}{\lambda}$	Full explanation by making connection to real life situation.	Invalid conceptual understanding
2.2d	1	$f_b = \lvert f_1 - f_2 \rvert = \lvert 460 - 464 \rvert$ $f_b = 4 \; Hz$	Correct answer OR 'slip' in calculation				Correct answer

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	$I_3 = I_2 + 4$ OR $I_3 - I_2 - 4 = 0$	Correct equation.				Incorrect equation
3.1b	1	$+20 - (5 \times 4) - 10I_1 = 0$ .....(i) $20 - 20 - 10I_1 = 0$ .....(ii) $-10I_1 = 0$ .....(iii)	Any one equation from (i) to (iii)				Incorrect equation
3.1c	3	$C = \frac{k\varepsilon_0 A}{d}$.....(i) $= \frac{(2.5)(8.85\times10^{-12})(0.25)}{(2\times10^{-3})}$ .....(iii) $C = 2.76 \times 10^{-9}\ F$	Step (i) OR (iii) OR 2×10^{-3}	(i)and (iii)	Correct answer OR Correct working with 'slip' in calculation		Incorrect working and answer
3.2: ELECTROMAGNETIC INDUCTION							
3.2	1	To transform voltages from one value to another. To change the voltage supply to an appliance either up (TV) or down (phone charger). To increase transmission voltage from power stations to reduce energy loss by heating effects.	Anything to that effect				Invalid conceptual understanding

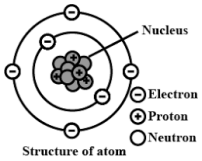
Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
3.3: AC CIRCUITS							
3.3a	3	For low-frequency signals, capacitors offer extremely high resistance. Low frequency signals are blocked while allowing high frequency signals. Capacitive reactance is like resistance. At low frequency, capacitors offer high resistance and current will always take the easy way out	Mentions one fact	Mentions two or more facts	Ability to mention the relationship, f and X_C are inversely proportional to each other. $X_C = \frac{1}{2\pi fC}$ As f↑, X_C ↓ As f↓, X_C ↑		Invalid conceptual understanding
3.3b	2	$X_L = 2\pi fL = 2\pi(50)(0.2) = 63\Omega$....(i) $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(50)(80\times10^{-6})}$ $X_C = 40\Omega$....(ii) $Z = \sqrt{R^2 + (X_L - X_C)^2}$ $= \sqrt{20^2 + (63-40)^2}$ $Z = 30.5\Omega$	Getting step (i) or (ii) or both OR $X_L = 2\pi fL$ OR $X_C = \frac{1}{2\pi fC}$ OR 80×10^{-6}	Correct answer OR Correct substitution OR Correct working with 'slip' in calculation			Incorrect answer

STRAND 4: ATOMIC AND NUCLEAR PHYSICS

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

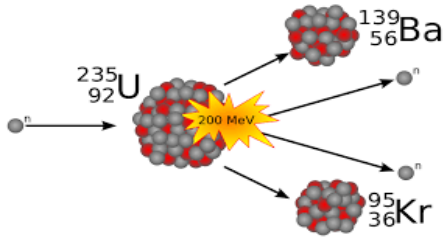
4.1 ATOMIC PHYSICS

Item #	Skill Band	Evidence	Student Response Level				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
4.1a	1	• It failed to explain why electrons could only have certain fixed energy levels • It could not explain some smaller details of the spectrum-Stark Effect • 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. • The Bohr Model is very limited in terms of size. Poor spectral predictions are obtained when larger atoms are in question. • It cannot predict the relative intensities of spectral lines. • It does not explain the Zeeman Effect, when the spectral line is split into several components in the presence of a magnetic field. • The Bohr Model does not account for the fact that accelerating electrons do not emit electromagnetic radiation.	Mentions any one correctly.				Incorrect answer
4.1b	1	Visible light/ ROYGBIV	Correct answer				Incorrect answer

4.1c	2	• Atoms are made of 3 subatomic particles: neutrons, protons and electrons. • 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). • The negatively charged electrons orbit the nucleus. Every atom has the same amount of protons and neutrons, so every atom has a neutral charge. https://www.toppr.com/ask/question/draw-a-labeled-diagram-of-the-structure-of-the-atom/ https://senecalearning.com/en-GB/definitions/atomic-structure/	Mentions one description correctly	Mentions 2 or more descriptions correctly  Structure of atom 			Invalid conceptual understanding
4.1d	3	Spectral emission occurs when an electron transitions, or jumps, from a higher energy state to a lower energy state. The lower energy state is commonly designated as S, and the higher energy state is designated as L. The energy of an emitted photon corresponds to the energy difference between the two states. Because the energy of each state is fixed, the energy difference between them is fixed, and the transition will always produce a photon with the same energy. The spectral lines are grouped into series according to S-values. Lines are named sequentially starting from the longest wavelength/lowest frequency of the series. Jumps from L-values 2, 3, 4,….to S-value 1 is the Lyman series (A) with Ultraviolet its associated part of the spectrum.	Draws one jump correctly (with or without label) Identifies the series correctly. A- Lyman B- Balmer C- Paschen	Mentions the associated S and L-values correctly for each of the three series	Full explanation Mentions their relative associated part of the spectrum		Invalid conceptual understanding

		Jumps from L-values 3, 4, 5….to S-value 2 is the Balmer series (B) with visible light its associated part of the spectrum. Jumps from L-values 4, 5….to S-value 3 is the Paschen series (C) with Infrared its associated part of the spectrum.					

4.2: NUCLEAR PHYSICS							
Item #	**Skill Band**	**Evidence**	**Student Response Level**				
			Unistructural	Multistructural	Relational	Extended Abstract	Weak
4.2a	1	II	Correct answer				Incorrect answer
4.2b	1	I	Correct answer				Incorrect answer
4.2c	2	$^{225}_{89}Ac \rightarrow {}^{221}_{87}Fr + \alpha^{4}_{2}$	Correct complete symbol for alpha	Correct answer			Incorrect answer
4.2d	4	Fission is a nuclear reaction where a large nucleus splits into smaller fragments. When this happens, each fragment has less mass per nucleon. This lost mass is released as energy in the form of kinetic energy and gamma rays. This happens in a controlled way in a nuclear reactor or in the explosion of an atomic bomb. In a fission reaction, one neutron is needed to start the reaction but 2 to 3 neutrons are produced as products. If these neutrons then collide with more nuclei, the number of reactions will suddenly grow very large – a chain reaction will occur.	Defines Fission	Mentions the fuel and the product	Describes the reaction involved with simple diagrams	Mentions the downside of Fission reaction	Invalid conceptual understanding

		In a nuclear reactor, a moving neutron hits Uranium $\left(U_{92}^{235}\right)$ which breaks into Krypton and Barium i.e. $\left(Kr_{36}^{95}\right)$and $\left(Ba_{56}^{139}\right)$ respectively.  https://partiko.app/@rifkan/what-do-you-know-about-nuclear-fission Two main concerns of fission reactions is • Safety-accidents at nuclear power plants have released radiation into the environment, the worst by far, being in 1986 at Chernobyl • Nuclear wastes-highly radioactive products of nuclear reactors often have very long hal-lives. The disposal of these wastes is a major problem, as they must be stored for thousands of years.					

THE END