



འབྲུག་གི་སློབ་ལཱ་འཛིན་ཆས་རྒྱུགས་དང་བཟླ་ཞིབ་ཆོགས་སྡེ།
Bhutan Council for School Examinations and Assessment
Bhutan Higher Secondary Education Certificate



MARK SCHEME

PHYSICS

Paper II

Maximum Mark: 70

Generic Marking Principles

These generic marking principles must be followed by all markers when assessing candidates' responses. They should be used together with the specific details provided in the mark scheme or the generic level descriptors for each question. Every question paper and its corresponding mark scheme will also adhere to these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in accordance with:

- the specific content of the mark scheme or the generic level descriptions provided for the question,
- the specific skills identified in the mark scheme or descriptors, and
- the standard of performance expected from candidates, as exemplified through standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Only whole marks are to be awarded. No half marks or fractional marks should be given under any circumstances.

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded positively:

- Credit must be given for correct and valid responses, as outlined in the mark scheme.
- Where a candidate's response exceeds the expected content or extends beyond the syllabus in a relevant way, appropriate credit may be awarded, in consultation with the Chief Marker.
- Marks are awarded when the candidate demonstrates clear evidence of knowledge, understanding, or skill.
- Marks must not be deducted for incorrect answers, omissions, or irrelevant material.
- Spelling, punctuation, and grammar should only be considered if explicitly stated in the question's assessment criteria. However, responses must be sufficiently clear in meaning.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently across all scripts, including cases where candidates do not follow specific instructions or where generic level descriptions are applied. For example, if a candidate writes more answers than required or responds in the wrong format, the marker should still assess the response based on the marking scheme. If the marking scheme includes a penalty for not following instructions, it should be applied. If no penalty is mentioned, valid responses should still be credited.

In the case of generic level descriptions such as "basic understanding" or "detailed explanation", all markers must interpret and apply these levels in the same way across all scripts. This helps ensure that every candidate is marked fairly and consistently.

GENERIC MARKING PRINCIPLE 5:

The full range of marks available in the mark scheme must be used where appropriate. However, the actual distribution of marks may depend on the quality of responses observed.

GENERIC MARKING PRINCIPLE 6:

Marks must be awarded strictly based on the criteria and expectations defined in the mark scheme. Judgments should not be influenced by grade thresholds, grade descriptions, or assumptions about overall candidate performance.

Point-Based Marking

Guidance

- DO credit answers which are worded differently from the mark scheme if they clearly convey the same meaning (unless the mark scheme requires a specific term).
- DO credit alternative answers/examples which are not written in the mark scheme if they are correct.
- DO NOT credit answers simply for using a 'key term' unless that is all that is required. (Check for evidence it is understood and not used wrongly.)
- DO NOT credit answers which are obviously self-contradicting or trying to cover all possibilities.
- DO NOT give further credit for what is effectively repetition of a correct point already credited unless the language itself is being tested. This applies equally to 'mirror statements' (i.e. polluted/not polluted).
- DO NOT require spellings to be correct, unless this is part of the test. However, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. Corrasion/Corrosion).

Calculation

- The mark scheme will outline the steps for the most likely correct method(s), including the marks allocated for each step, the correct answer(s), and the marks awarded for the final answer.
- If working or explanation is required to obtain full credit, this will be clearly stated in both the question paper and the mark scheme. In all other cases, a correct final answer should receive full marks even if no supporting working is provided.
- If a candidate applies a valid method that is not specifically included in the mark scheme, equivalent marks should be awarded for achieving equivalent stages of the solution.
- Where a candidate uses an incorrect figure obtained from earlier working, the 'own figure rule' applies. Full marks may still be awarded provided the method used is correct and complete. Additional guidance or exceptions to this principle will be specified in the mark scheme where necessary.

Abbreviations used in the Mark Scheme

/alternative answers for the same marking point underline actual word given must be used by candidate (grammatical variants accepted)
(brackets) the word or phrase in brackets is not required, but sets the context

B marks: These are independent marks, which do not depend on other marks. For a **B** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.

M marks: These are method marks upon which **A** marks later depend. For an **M** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer. If a candidate is not awarded an **M** mark, then the later **A** mark cannot be awarded either.

C marks: These are compensatory marks which can be awarded even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known them. For example, if an equation carries a **C** mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C** mark is awarded.

If a correct answer is given to a numerical question, all of the preceding **C** marks are awarded automatically. It is only necessary to consider each of the **C** marks in turn when the numerical answer is not correct.

A marks: These are answer marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Question 1

Question 1	Answer	Marks	Additional Guidance
a) i.	Y, X and Z OR $Y > X > Z$	B1	
ii.	$\frac{F}{A} = \frac{Ex}{L}$ AND $A = \pi d^2$	B1	
	Rearranged to show that $x = \frac{xL}{AE}$ so that $x \propto \frac{L}{d^2}$	B1	Guidance: this can be awarded if dependence of x on L and d is shown numerically for any pair from X, Y, Z
iii.	Wire Y	B1	
	Because $W = Fx$ and it has the greatest extension x and the same force F	B1	
b) i.	Impulse OR change of momentum	B1	
ii(1)	Correct substitution into $Ft = mv - mu$ $F = \frac{mv - mu}{t}$ $= \frac{1200 \times 20}{0.15}$	C1	Guidance: must see unit only if kN used
	= 160 000 (N) OR 160 kN	A1	
ii (2)	The crumple zone increases the time taken for the car to come to rest	B1	
	rate of change of momentum is less so force (on passengers) is less (reducing risk of injury)	B1	

Question 2

Question 2	Answer	Marks	Additional Guidance
a) i.	Identification of phenomenon as resonance	B1	
	This is because the natural frequency of the third rod is equal/close to f / the driver frequency	B1	
ii.(1)	frequency of ground movements = 2.0 Hz approximately	B1	
	Building B will vibrate with largest amplitude OR will resonate because its natural frequency is close to the frequency of ground movements	B1	
	Buildings A and D will respond with smaller amplitude vibrations OR Building B is most likely to be damaged or collapse	B1	
ii (2)	Damping AND some of the vibration energy is converted to heat and amplitude stays smaller	B1	
b) i.	Electric field strength is the force per unit test charge placed at that point. $E = \frac{F}{q}$	B1	
ii.	Graph is a straight line through the origin so $E \propto \frac{1}{d^2}$	B1	

iii	$E = 9 \times 10^9 \frac{q}{d^2}$ $q = \frac{Ed^2}{9 \times 10^9}$	M1	
	= $1.06 \times 10^{-7} \text{ C}$	A1	

Question 3

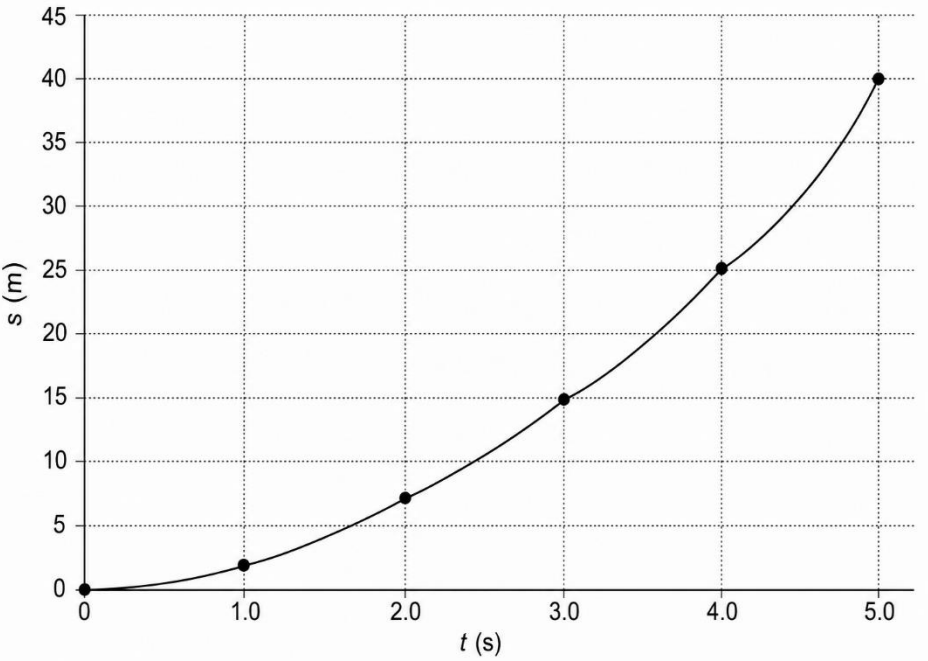
Question 3	Answer	Marks	Additional Guidance
a) i.	A – conductor	B1	
	B – insulator	B1	
	C – semiconductor	B1	
ii	As temperature increases in A (conductor), the atoms in the metal vibrate more. This increases collisions between atoms and electrons and causes heating. Thus, resistivity increases .	B1	
	In C, electrons get enough energy to jump into a conduction band. So more charge carriers are available and resistivity decreases.	B1	
b) i.	1st law: at any junction in the circuit, the total current entering the junction equals the total current leaving the junction.	B1	

	2 nd law: the sum of emfs around a closed circuit loop is equal to the sum of voltage drops	B1	
ii	current in lower parallel branch = $3.0 / 100 = 0.030 \text{ A}$ voltage across 200Ω resistor in lower parallel branch = $0.030 \times 200 = 6.0 \text{ V}$ = voltage across 600Ω resistor	A1	
	current in 600Ω resistor = $6.0 / 600 = 0.010 \text{ A}$ current in 200Ω resistor = $0.030 + 0.010 = 0.040 \text{ A}$ (K1) voltage across 200Ω resistor = $0.040 \times 200 = 8.0 \text{ V}$ (K2)	C1	
	supply voltage = $8.0 + 3.0 + 6.0 = 17 \text{ V}$	A1	

Question 4

Question 4	Answer	Marks	Additional Guidance
a) i.	Reactance is the ratio of peak a.c. voltage to peak a.c. current.	B1	ACCEPT $X = V_p/I_p$ with terms defined.
ii.	$X_L = 2\pi fL$ $X_L = 2\pi(25)(0.50)$ $= 78.55\Omega$	A1	
iii.	$X_L = X_C \text{ or } 2\pi fL = \frac{1}{2\pi fC}$	M1	
	rearranged to give: $C = \frac{1}{(2\pi f)^2 L}$ OR $C = \frac{1}{(100\pi)^2 \times 0.50}$	M1	
	$C = 2.03 \times 10^{-5}$ $\approx 20 \mu\text{F}$	A1 A0	
b) i.	It is the minimum energy needed to remove an electron from the surface of metal.	B1	
ii	$E = hf = 5.30 \text{ J OR } 3.32 \text{ eV}$ Use of photoelectric equation to give max KE: $\text{max KE} = hf - \phi$ AND correct substitution $E = (6.63 \times 10^{-34})(8 \times 10^{14}) - 3.20 \times 10^{-19}$ $\text{max KE} = 2.10 \times 10^{-19} \text{ J}$	C1 C1	

Question 5

Question 5	Answer	Marks	Additional Guidance
a) i.		B1	
	Plots all six data points accurately using suitable scales, with correctly labelled axes (Time, t / s and Displacement, s / m). Draws a smooth curve of best fit passing close to all plotted points.	B1 B1	
ii	Draws a suitable tangent at $t = 2.5 s$ and determines its gradient correctly.	B1	

	Calculation of gradient seen ($\Delta s/\Delta t$) and consistent with line drawn on graph. instantaneous velocity = 8.0 m/s^{-1} (accept $7.5\text{--}8.5 \text{ ms}^{-1}$ depending on the tangent drawn).	M1 A1	
b) i.	The process of splitting a vector into its component vectors (two perpendicular components) whose resultant equals the original vector.	B1	
ii	Horizontal component, $F_x = F \cos\theta$ OR $F_x = 50 \cos 30^\circ$ OR $F_y = F \sin\theta$ OR $F_y = 50 \sin 30^\circ$	C1	1 MARK IF HORIZONTAL AND VERTIAL COMPONENTS REVERSED.
	Horizontal $F_x = 43 \text{ N}$ AND Vertical $F_y = 25 \text{ N}$	A1	
iii	Must see use of Pythagoras's theorem $(43.3^2 + 25^2) = 2474$	C1	
	$\sqrt{2474}=49.7$ which rounds to 50 (N)	A1	

Question 6

Question 6	Answer	Marks	Additional Guidance
a) i.	The time taken for the activity (or number of undecayed nuclei) of a radioactive sample to reduce to half its initial value.	B1	
ii.	$e^{-\lambda t} = \frac{150}{800}$ Substitution into logarithmic equation: $\lambda = -\frac{\ln\left(\frac{150}{800}\right)}{24 \times 3600} = 1.938 \times 10^{-5} \text{ s}^{-1}$ $t_{1/2} = \frac{\ln 2}{\lambda} = 35800 \text{ s} = \mathbf{9.94 \text{ hours}}$ $\approx 10 \text{ hours}$	M1 M1 A1 A0	
iii.	Container is safe if count rate is less than / comparable to background	B1	
	Calculation to support the fact that this occurs after about 7 half lives E.g. $3200 / 2^7 = 25 (<30)$. Safe after about 7 years so engineer's claim is correct	B1	
b) i.	$E = \frac{1}{2} m \omega^2 x_0^2 = \frac{1}{2} m (2\pi f)^2 x_0^2$ correct substitution and calculation: $E = \frac{1}{2} \times 0.20 \times (2\pi \times 2.2)^2 \times 0.050^2 = \mathbf{0.0099 \text{ J}}$	M1 M1	

	$\approx 10 \text{ mJ}$	A0	
ii	Oscillator energy = $\frac{1}{3^2} \times 10 \text{ mJ}$ OR energy transferred to surroundings = $= \frac{8}{9} \times 10 \text{ mJ} = \mathbf{8.9 \text{ mJ}}$	C1 A1	

Question 7

Question 7	Answer	Marks	Additional Guidance
a) i.	$V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$ $V_{\text{rms}} = \frac{340}{\sqrt{2}}$ $V_{\text{rms}} = 240.4 \text{ V } (\approx 240 \text{ V})$	A1	
ii.	$I_{\text{rms}} = \frac{V_{\text{rms}}}{R}$ $I_{\text{rms}} = \frac{240}{110}$ $I_{\text{rms}} = 2.18 \text{ A}$	A1	
iii	$\frac{\pi}{2}$ (or 1.57) OR 90° AND current leads voltage Note: Accept 90° only if the student specifies the unit..	B1	Note: Accept 90° only if the student specifies the unit

iv	Charge is proportional to voltage ($Q = CV$) AND $I = \frac{dQ}{dt}$ At maximum voltage, the gradient of the voltage-time graph ($\frac{dV}{dt}$) is zero, meaning the rate of change of charge is zero, so current must be zero	B1	
b) i.	Recession speed of a galaxy is directly proportional to its distance from the observer (accept $v = H_0 d$, symbols defined)	B1	
ii	$d = \frac{v}{H_0}$ $= 4200/70 = 60 \text{ Mpc}$ $= (60 \times 3.086 \times 10^{22})$ $= 1.85 \times 10^{24} \text{ m}$	C1 A1	
iii	H_0 converted to SI: $70\,000/(3.086 \times 10^{22}) = 2.27 \times 10^{-18} \text{ s}^{-1}$	M1	
	$t = 1/H_0 = 4.41 \times 10^{17} \text{ s} \approx 1.4 \times 10^{10} \text{ years}$	A1	