Anderson Serangoon Junior College 2023 H2 Physics Promo P2 Mark Scheme

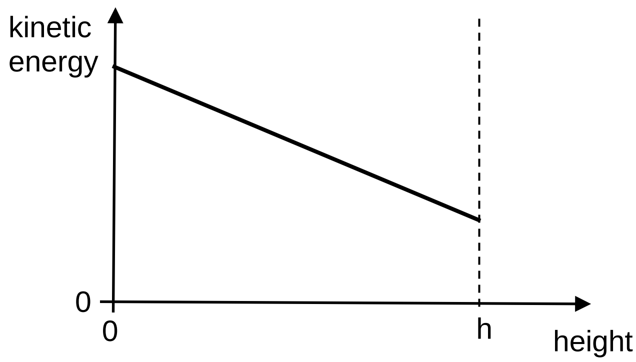
Paper 2 (80 marks) **E – Easy, A – Average, D – Difficult**

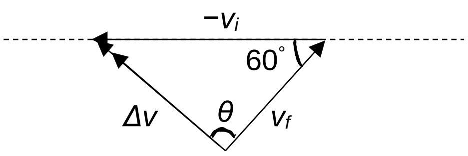
ECF	Error carried forward	**SF**	Significant figures error	**M0**	No A marks awarded
AE	Arithmetic error	**BOD**	Benefit of doubt	**^**	More is needed in answer
POT	Power of ten error	**CON**	Contradictory response	**XP**	Wrong physics
TE	Transcription error	**IR**	Irrelevant (part) response		

Table of Specifications (Paper 2)

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**	**%**
Easy	**2**	**1**	**2**	**0**	**2**	**4**	**0**	**1**	**3**	**15**	**18.75**
Average	**5**	**5**	**5**	**10**	**5**	**6**	**5**	**7**	**5**	**53**	**66.25**
Difficult	**3**	**2**	**2**	**2**	**3**	**0**	**0**	**0**	**0**	**12**	**15.00**
Marks	**10**	**8**	**9**	**12**	**10**	**10**	**5**	**8**	**8**	**80**	**100.0**

1a	Work done (against frictional force) =loss in GPE – gain in KE 52 × (distance moved) = 330×(4.0 – 1.1) – 540 distance moved = 8.019 = 8.0 m *<u>Examiner's comments:</u>* *Most students get this correct. Some students applied Conservation of Energy wrongly, e.g loss in GPE = gain in KE + <u>friction</u>+ work done. Students should also note that there is gain in GPE when the child moves from the lowest point to Y and the loss in GPE is mg(4.0 -1.1).*	**A**	 C1 A1
1bi	$E_k = ½mv^2$ $540 = ½ × (330/9.81) × v^2$ $v = 5.67 = 5.7$ m s^{-1} *<u>Examiner's comments:</u>* *Generally well done except some students made careless mistakes in substitution, using wrong value (330) for m.*	**E**	 A1
1bii	Speed at point Z = horizontal component of velocity at point Y = 5.67 × cos 41° = 4.279 = 4.3 m s^{-1} *<u>Examiner's comments:</u>* *Some students did not show pre-rounded value of 4.279 m s^{-1}.*	**A**	 M1 A0
1biii	At point P, horizontal velocity, v_x, is constant at 4.3 m s^{-1} $\tan 48^o = \frac{v_y}{4.3}$ $v_y = 4.776$ m s^{-1} = 4.78 m s^{-1} Taking downwards as positive, $v_y{}^2 = u_y{}^2 + 2a_y s_y$ $(4.78)^2 = (-5.67 sin 41^o)^2 + 2 \times 9.81 \times s_y$ $s_y = 0.459 = 0.46$ m	**D**	 C1 C1 A1

	Examiner's comments: *Most students found this question challenging.* *Many students using $v^2 = u^2+2as$ and substituted the incorrect initial and final velocities (swopped speed and vertical velocity).* *Students failed to apply the common approach to solving projectile motion problem (considering the motion separately in x and y directions and show clear workings using symbols and subscripts).* *Some students applied Conservation of Energy but calculated the height wrongly (either from Y to Z or from Z to P).*		
1biv	 Line with a negative gradient starting from a non-zero value kinetic energy when the vertical height is zero, and the straight line ends at a non-zero value of kinetic energy when the vertical height is h. *Examiner's comments:* *This part was poorly done. Many students failed to note that loss in KE = gain in GPE, and gain GPE is proportional to height, hence the graph is a straight line.*	**A**	A1
1c	With a large splash, a large part of the kinetic energy of the child is transferred to the kinetic energy of the splashed water, as well as sound energy. This leaves the child with a small kinetic energy to do work against the pool water's resistive force when he enters the pool. Hence, the child will be slowed down in a shorter distance when it enters the pool with a large splash. *Examiner's comments:* *This part was poorly done. Some students mentioned that large splash causes larger resistive forces from water. The majority who mentioned energy did not refer to the energy forms that were involved in the two cases. There were many vague descriptions that more energy was been lost by the child when it made a splash, did not mention the KE of the child to the KE or GPE of the water. Many students did not mention when the child enters the pool, work is done against water's resistive force.*	**D**	M1 M1 A0
2ai	Total initial momentum = $mu_A + mu_B = m\ (500 + 0) = 500m$ *Examiner's comments:* *This part was well done by most candidates. However, some candidates were penalized when they used terms such as m_A (instead of using m)*	**E**	A1
2aii1	$mv_A \cos 60° + mv_B \cos 30° = mv_A\ (0.50) + mv_B\ (0.87)$ *Examiner's comments:* *This part was well done by most candidates. However, some candidates were penalized when they did not include the mass in their expression.*	**A**	A1

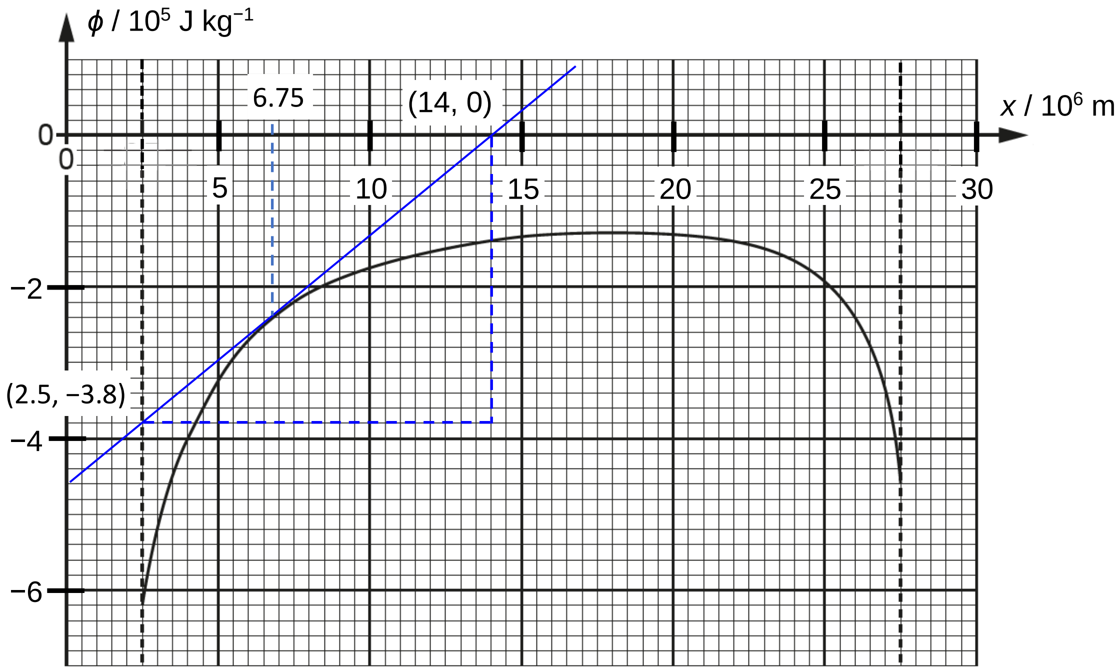
2aii2	(Taking upwards as positive) $mv_A \sin 60° - mv_B \sin 30° = mv_A (0.87) - mv_B (0.50)$ Or (Taking downwards as positive) $mv_B \sin 30° - mv_A \sin 60° = mv_B (0.50) - mv_A (0.87)$ Or $mv_A \sin 60° + mv_B \sin 30° = mv_A (0.87) + mv_B (0.50)$ *<u>Examiner's comments:</u>* *This part was well done by most candidates. However, some candidates were penalized when they did not include the mass in their expression.*	**A**	A1
2aiii	By Conservation of Linear Momentum, $500m = mv_A (0.50) + mv_B (0.87)$ $500 = v_A (0.50) + v_B (0.87)$ and $0 = mv_A (0.87) - mv_B (0.50)$ $v_A (0.87) = v_B (0.50)$ Solving the two equations for v_A, $v_A = 250 \text{ m s}^{-1}$ *<u>Examiner's comments:</u>* *This part was poorly done as many candidates did not know how to make use of the momentums in the 2 directions. Common mistakes include equating 500m to the sum of the final momentums in the x and y directions. Candidates should realize that vectors in different directions cannot be added up without considering their directions.*	**D**	 M1 M1 A0
2b	$\Delta v = v_f - v_i = v_f + (-v_i)$  $\Delta v = \sqrt{v_f^2 + v_i^2 - 2v_f v_i \cos 60°}$ $\Delta v = \sqrt{250^2 + 500^2 - 2(250)(500)\cos 60°}$ = 433 ≈ 430 m s−1 $v_i = \sqrt{v_f^2 + \Delta v^2 - 2v_f \Delta v \cos\theta}$ $500 = \sqrt{250^2 + 433^2 - 2(250)(433)\cos\theta}$ θ = 90° Or use sine rule $\frac{\sin\theta}{500} = \frac{\sin 60°}{430}$ $\theta = 90°$	**A**	 M1 A1 A1

[Turn Over

	<u>*Examiner's comments:*</u> *Despite being tested on the same concept on other occasions, many candidates are still unsure of how to determine the change in vectors (when the vectors are in different directions). Also, candidates should note that they should not include the negative sign when applying the cosine rule. Others were penalized when they made assumptions in their working (e.g. assuming that the vector triangle is a right-angled triangle without proving it). Candidates should draw clear and well-labelled vector diagrams. Similar to the earlier part, candidates should realize that vectors in different directions cannot be added up/subtracted without considering their directions.*		
3a	Moment = 0.30 x 0.29 cos 40° = 0.067 N <u>*Examiner's comments:*</u> *Generally well done. Students who are unable to get full credit usually had difficulties manipulating the angles and resolving vectors properly despite it being a rather straightforward scenario. They are encouraged to revise and practice how to resolve vectors correctly as this is a critical skill in the study of Physics. A small number of students did not get full credit due to rounding error.* *E1 – resolve perpendicular distance wrongly, i.e. using 0.29 sin 40°* *E2 - resolve weight wrongly, e.g. F = mg / sin 50°* *E3 – manipulated angles wrongly, e.g. sum of angles = 100° for right angle*	**E**	C1 A1
3bi	Volume of sphere = $\frac{4}{3}\times\pi\times(0.0480)^3$ Upthrust = $\rho gV = 1000\times 9.81\times\frac{4}{3}\times\pi\times(0.0480)^3\times 0.26 = 1.1816$ ≈ 1.18 N <u>*Examiner's comments:*</u> *Generally well done. Students need to show all steps clearly, especially substitutions and pre-rounded value to score full credit.* *E1 – did not show pre-rounded value of 1.186 N* *E2 – wrong formula for volume of sphere*	**A**	 M1 A0
3bii	Taking moments about P, Sum of clockwise moment = sum of anticlockwise moment 1.18 x 0.29 = 0.30 x 0.29 + *F* x 0.017 *F* = 15 N <u>*Examiner's comments:*</u> *Even though the question asks for force on the spring by the rod, students need to consider the free-body diagram of the rod-sphere system (and not the spring!) when applying Principle of Moment about point P. This implies that the force F in their equation should give rise to an anti-clockwise moment about point P. Students who equate this moment due to F as clockwise moment will gain no credit due to wrong Physics. Many students overlooked the anti-clockwise moment due to weight of sphere or the clockwise moment due to upthrust. It is heartening to see some students doing complete analysis to include Newton's 3rd Law, showing excellent understanding of the forces.* *E1 – multiply or divide 0.30 N by 9.81 m s^{-1}* *E2 – did not include moment due to upthrust or weight* *E3 – equating moment due to F as clockwise moment*	 **A**	 C1 A1

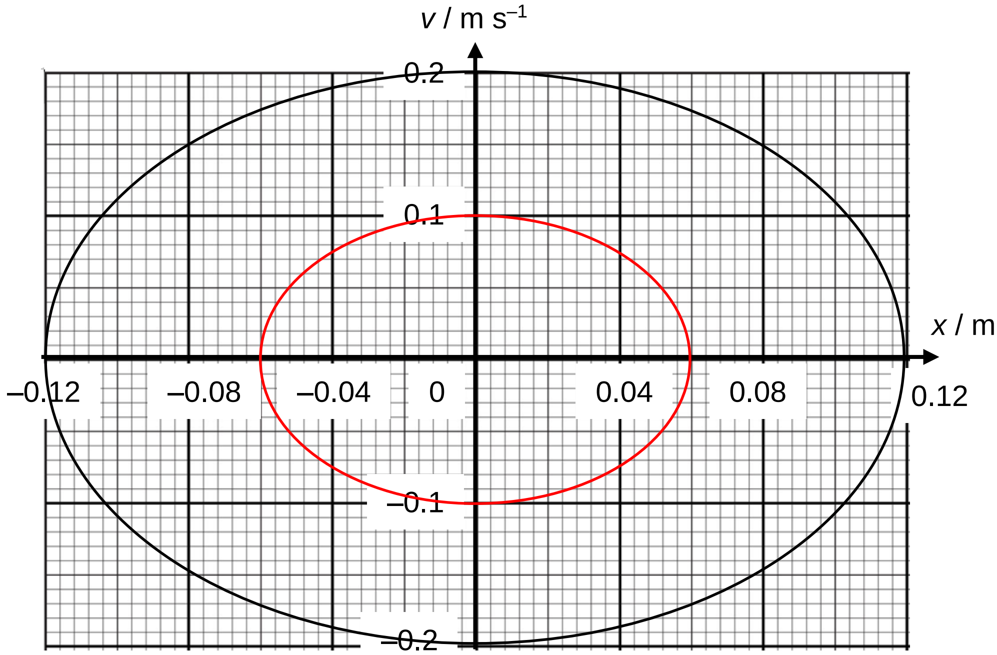
3biii	From Fig. 3.3, when F = 15 N, x = 7.1 mm EPE stored = area under graph = $\frac{1}{2}\times 15\times 7.1\times 10^{-3}$ = 0.053 J <u>*Examiner's comments:*</u> *Many students, including those who correctly calculated the force F in previous part, used the wrong value for compression in their calculation of EPE stored, and ended up with the wrong area under the graph. This suggests that they do not have a complete understanding of the equilibrium position in Fig. 3.2. Many carelessly overlooked the unit for compression, ending up with power of ten error, hence not gaining full credit.*	**A**	C1 A1
3c	Work done by upthrust is the <u>sum of the gain in gravitational potential energy of the sphere and elastic potential energy of the spring</u> hence <u>not equal</u>. <u>*Examiner's comments:*</u> *This part proved difficult for many students who could not identify the correct energy conversion in the system from the position in Fig. 3.1 to Fig. 3.2. While some identified the change in position of the sphere (which leads to its gain in gravitational potential energy), explanations are usually lengthy yet lacking in terms of supporting using Physics concepts. Students should use work / energy to explain rather than analyzing the forces involved. Some attempted to calculate the work done by upthrust without realizing that upthrust is not constant in this case.* *E1 – calculate work done by upthrust and compare with 3biii. Incorrect because upthrust is not constant at 1.18 N.* *E2 – included change in kinetic energy in explanation. While the sphere had KE during its movement from initial to final position, it eventually slowed down, lost the same amount of KE and settled with zero KE in Fig. 3.2, i.e. not moving. Hence final KE = initial KE = zero.*	**D**	M1 A1
4ai	(Since ball travels in a horizontal plane, there is zero net force in the vertical direction) $W = R \sin\theta$ (equation 1) $F = R \cos\theta$ (equation 2) Equation 1 divided by equation 2, $W = F \tan\theta$ <u>*Examiner's comments:*</u> *Some candidates did not realise that R cos θ provides centripetal force F. Some candidates did not resolve R into perpendicular components in their derivation and hence did not receive any credit.*	**A**	M1 M1 A0
4aii	<u>Provides</u> the centripetal force <u>*Examiner's comments:*</u> *This part was well done.*	**A**	B1
4aiii	$F = \frac{mv^2}{r}$ and $W = mg$ From $W = F \tan\theta$, $mg = \frac{mv^2}{r}\tan\theta$	**A**	C1

	$v=\sqrt{\dfrac{rg}{\tan\theta}}$ $v=\sqrt{\dfrac{(14\times10^{-2})(9.81)}{\tan 28^\circ}}$ $=1.61$ $=1.6\text{ m s}^{-1}$ *<u>Examiner's comments:</u>* *Some candidates did not convert the radius in cm into m (POT – power of ten error).*		C1 A1
4aiv	The <u>resultant force</u> is <u>perpendicular</u> to the <u>velocity</u>. *Either* <u>No work is done by the force</u>, and hence there is no change in kinetic energy. *Or* Acceleration is perpendicular to velocity, causing <u>velocity to change direction but not magnitude</u>, and since KE is ½ mv^2, KE is unchanged. *<u>Examiner's comments:</u>* *Many candidates did not explain the resultant force is perpendicular to the velocity. Some candidates explained that "the velocity does not change" or "the velocity is constant" which is an incorrect concept because the direction of velocity changes.*	**D**	B1 B1
4bi	By Conservation of Energy, Total initial energy at X = Total (final) energy at Y $\left.\begin{array}{l}\frac{1}{2}mu^2=\frac{1}{2}mv^2+mgh\\ \frac{1}{2}u^2=\frac{1}{2}v^2+gh\\ \frac{1}{2}(3.7)^2=\frac{1}{2}v^2+(9.81)(0.40)\end{array}\right\\}$ v = 2.42 m s^{-1} Using Newton's Second Law, When the ball just remain in contact with the track, normal contact force by track on ball = 0 N. $mg=\dfrac{mv^2}{r}\Rightarrow v_{\min}=\sqrt{rg}=1.4\text{ m s}^{-1}$ Actual speed of ball at Y is larger than minimum speed to complete the vertical circle without falling off the track, so ball is in contact with track. *<u>Examiner's comments:</u>* *This part was not well done. Many candidates used the given velocity at X to determine the normal contact force at Y, which is incorrect, because the velocity at Y is not the same as the velocity at X. Some candidates thought that the radius of the circle was 0.40 m, it should be 0.20 m.*	**A**	C1 C1 A1

4bii	<u>Acceleration / velocity at Y / minimum speed</u> to keep the ball in contact with the loop at Y is independent of mass, so makes no difference. *<u>Examiner's comments:</u>* *Some candidates explained that "it is independent of mass" or "the equation is independent of mass" without explaining clearly what "it" or "the equation" is.*	**A**	B1
5a	Gravitational field is a <u>region of space</u> where a <u>mass</u> experiences a force. The <u>direction of the field is the direction of the force</u> on the mass. *<u>Examiner's comments:</u>* In this question, the words "gravitational field" are both in italics, therefore students must not reuse the word "field" as part of the explanation. Proper phrasing of the answer is necessary to gain full credit here. **E1** use object/ body/ particle instead of mass	**E**	B1 B1
5b	Since <u>gravitational forces are attractive</u> and gravitational <u>potential</u> is taken to be <u>zero at infinity</u>, the <u>work done by the external agent</u> on the point mass moving it <u>from infinity</u> to the point in the field <u>is negative</u>. Thus, gravitational potential is negative. *<u>Examiner's comments:</u>* This part was quite poorly done by students and many misconceptions were surfaced from the answers written. Some students are confused about the various terms (gravitational force, gravitational field, gravitational potential and gravitational potential energy) and used them interchangeably. Quite a significant number thought that gravitational potential is a vector or stated that "potential is opposite in direction to field/force" which gives the impression that gravitational potential has direction.	**A**	B1 B1 A0
5ci	 Since $g = -\frac{d\phi}{dx}$, the negative of the gradient of tangent to ϕ−x graph at a particular x gives the gravitational field strength.	**A**	

	At $x = 6.75 \times 10^6$ m, gradient = $\frac{[0-(-3.8)]\times 10^5}{(14-2.5)\times 10^6}$ = 0.0330435 Hence, $g = -0.0330435$ where the "−" sign here represents the direction of g, that is, in the negative x direction / towards the centre of the planet. magnitude of gravitational force = mg = 3.97 × 0.0330435 = 0.131 N [value 0.127 ≤ gravitational force ≤ 0.140] direction: towards (the centre of) the planet / to the left (BOD) *Examiner's comments:* Many students used the formula for gravitational potential, $-\frac{GM}{r^2}$, to solve this part but did not realise/understand that the formula applies only for the gravitational potential due a single object. In this context, the gravitational potential, ϕ, is due to the system of planet and moon. For others who realized that a tangent to the graph is needed, quite a few gave the wrong relationship, thinking that $F = -\frac{d\phi}{dx}$. Many had power of ten (POT) error as they did not read the axes of the graph. Quite a few had issues with reading the coordinates correctly. To achieve full credit for determining the magnitude of gravitational force, the line drawn has to be tangential to the graph, hence an accuracy mark was deducted from answers that fall out of the range indicated in the above answer. **E1** use $\phi = -\frac{GM}{r}$ **E2** use $F = -\frac{d\phi}{dx}$		M1 A1 B1
5cii	From Fig. 5.2, the gravitational potential is -2.4×10^5 J kg^{-1} when $x = 6.75 \times 10^6$ m. For the rock to travel off into space (or escape from the field of the planet and moon), it must reach infinite distance with minimum kinetic energy of zero and its total energy would be zero. **Either** Let v_{min} be the escape speed of the rock when $x = 6.75 \times 10^6$ m. Hence, by conservation of energy, total energy at 6.75×10^6 m = total energy at infinite distance $\frac{1}{2} m v_{min}^2 + m\phi = 0$ $v_{min}^2 = -2\phi$ $v_{min} = \sqrt{-2(-2.4 \times 10^5)}$ = 692.82 m s^{-1} Since the speed of the rock is less than the escape speed, the rock will not travel off into space. **OR** Total energy of the rock = $\frac{1}{2} m v^2 + m\phi$ = 3.97 × [½ × 550^2 + (−2.4 × 10^5)] = −352,337.5 J	**D**	 B1 M1 A1 M1

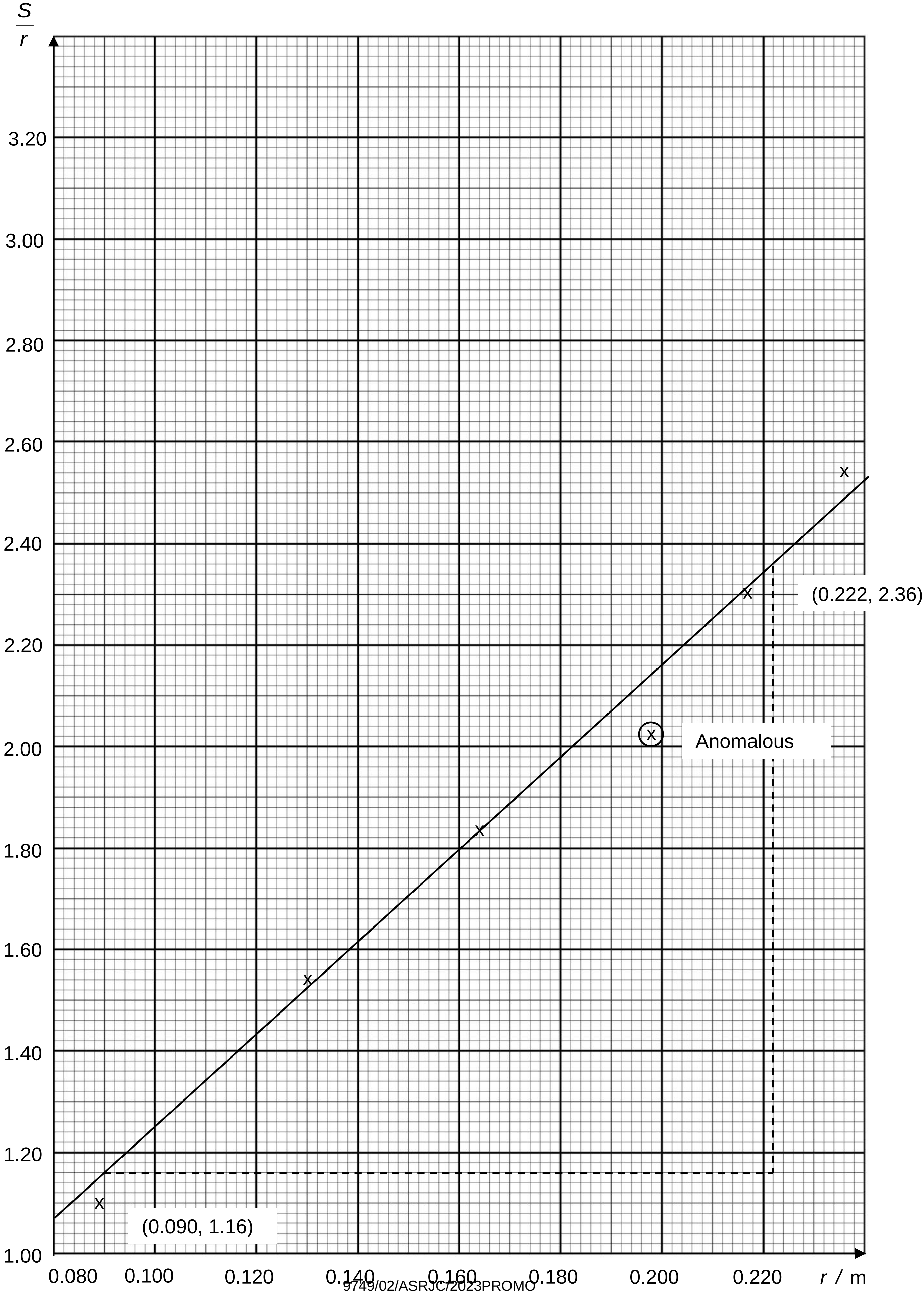
	Since total energy of the rock is less than zero, the rock will not travel off into space. *Examiner's comments:* Students are advised to interpret whether the context is about a body orbiting or moving away from another body before attempting to solve the question. In this case, "travel off into space" means that the rock leaves the gravitational field of the planet−moon system, that is, this is an escape speed context. The physics concepts required here are Conservation of Energy and that total energy of the rock must be minimally zero at infinity for it to escape into space. Many students who went straight into using equations without explaining the physics concept required here get little or no credit, even though the final "answer" is the same. Students who used gravitational potential energy as $-\frac{GMm}{r}$ in their equation or memorized the escape speed formula also get no credit as this expression is not applicable to this planet−moon system context. **E1** use $GPE = -\frac{GMm}{r}$ or $v_e = \sqrt{\frac{2GM}{R_e}}$ **E2** use $\frac{GMm}{r^2} = \frac{mv^2}{r}$		A1
6a	$a = -\omega^2 x$ a = acceleration, x = displacement <u>from equilibrium position</u> and ω = angular frequency *Examiner's comments:* Most students correctly answered this part. A significant number of students incorrectly mentioned angular "velocity" instead of "frequency". Many students did not answer the question when they stated the definition of simple harmonic motion (SHM).	**E**	M1 A1
6bi	$v_0 = \omega x_0$ $\omega = \frac{v_0}{x_0} = \frac{0.20}{0.12}$ $= 1.6667$ $= 1.7 \text{ rad s}^{-1}$ *Examiner's comments:* This was generally well answered. Some students may not have realized that it was easier to use the maximum values of amplitude and velocity (and instead used other values of displacement and velocity).	**A**	M1 M1 A0
6bii	$E_{p,\max} = E_{k,\max} = \frac{1}{2}Mv_0^2$ $0.050 = \frac{1}{2} \times M \times 0.20^2$ $M = 2.5 \text{ kg}$ *Examiner's comments:* This question was generally well answered.	**A**	C1 A1
6ci	Loss of (total) energy (of system) / dissipation of (total) energy (of system) <u>with time</u> due to resistive forces	**E**	B1 B1

	<u>Examiner's comments:</u> Some answers reflected the misconception that "damping" is a "force", when it should be the "loss of total energy…". A "decrease in amplitude of oscillation" does not answer the question because it is an observation that does not explain the concept of loss of energy behind the decrease in amplitude.		
6cii	When x_0 = 0.06 m, $v_0 = \omega x_0$ = 1.7 x 0.06 = 0.10 m s^{-1} Closed ellipse surrounding the origin with maximum x at ± 0.060 m passing through v = 0 maximum velocity shown as ± 0.10 m s^{-1} passing through x = 0  *<u>Examiner's comments:</u>* A significant number of students drew the correct ellipse. Candidates need to draw the curves more accurately.	**A**	B1 B1
7a	Particle A is instantaneously at rest, and particle B is moving downwards. *<u>Examiner's comments:</u>* *It is surprising that many candidates get the directions for particle A wrong. Many candidates did not read the question carefully and jumped to sketching the wave a moment later assuming the wave moves to the right. There are some nonsensical responses of the particles moving left or right showing lack of understanding of a transverse wave.*	**A**	B1
7b	Period, T = 15/1.5 = 10 s, and λ = 0.18 m Speed of wave = $f\,\lambda$ = (1/T)(0.18) = (1/10)(0.18) = 0.018 m s^{-1}	**A**	C1 A1

	Examiner's comments: *Some candidates mixed up frequency with period while some forgot to convert cm to m in the calculation. There are a significant number of candidates finding it difficult to determine the period and just read off to 10,5 s.*		
7c	phase difference, $\Delta\phi = \frac{\Delta x}{\lambda} \times 2\pi$ $= \frac{0.06}{0.18} \times 2\pi$ $= 2.09$ rad *Examiner's comments:* *This part is mostly well done. There a few candidates who treated P and Q as particles rather than waves. Candidates need to know that the final answer must be expressed in decimal.*	**A**	C1 A1
8ai	constant phase difference, between (two) waves *Examiner's comments:* *Majority of students were able to recall the correct definition.*	**E**	B1
8aii	The two coherent waves from the slits arrive/meet/overlap/superpose at P_1 with path difference is either λ or $n\lambda$, OR phase difference is 360° or n × 360° or n2π rad *Examiner's comments:* *Most students can explain how the two waves arrive at P_1 in-phase leading to constructive interference. However, they usually miss out on the path / phase difference leading to constructive interference, hence not getting full credit. In this scenario, the path difference at P_1 cannot be zero (it must be at least λ), because point P_1 is not equidistant from the two slits. Likewise the phase difference cannot be zero (it must be minimally 360°).* *E1 – did not state the condition for path / phase difference.*	**A**	B1 B1
8aiii	$x = \lambda D / a$ $= (630 \times 10^{-9} \times 1.5) / 0.45 \times 10^{-3}$ $= 2.1 \times 10^{-3}$ m *Examiner's comments:* *Well done! A small group of students had power of ten error.*	**A**	C1 A1
8b	no change to separation/fringe width no change to dark fringes/dark fringes remain dark bright fringes are brighter/more intense *Examiner's comments:* *Majority can identify that bright fringes will become brighter. However, quite a number stated that dark fringes will also become brighter. Explanation using contrast gains no credit as it is only complete when changes, if any to both bright and dark fringes have been discussed. Many did not discuss about fringe separation / width hence could not gain full credit.*	**A**	B1 B1 B1

9a	<table><tr><td>S / m</td><td>r_1 / m</td><td>r_2 / m</td><td>$r = \frac{r_1 + r_2}{2}$ r / m</td><td>$\frac{S}{r}$</td></tr><tr><td>0.200</td><td>0.129</td><td>0.131</td><td>**0.130**</td><td>**1.54**</td></tr><tr><td>0.100</td><td>0.090</td><td>0.088</td><td>**0.089**</td><td>**1.1**</td></tr></table> 1 m for correct calculation and s.f. *<u>Examiner's comments:</u>* *This part is badly done and the most common mistake is leaving the answer in the last row in 3 sf instead of 2 sf when the lowest sf of the raw data is 2 sf.*	**E**	B1
9b	2 points plotted correctly accurate to half a small square. Straight line of best fit – judge by scatter of points about the candidate's line. There must be a fair scatter of points either side of the line. *<u>Examiner's comments:</u>* *A number of candidates were not careful in plotting and some did not plot to half a small square accuracy. There are some best fit lines that are obviously unbalanced when we look at each half of the line. The best fit line is not assessed if there are less than 5 valid points, the anomalous points identified by candidates will be left out when assessing the best fit line.*	**E**	B1 B1
9c	Anomalous data/results, if any, must be identified. Appropriate justification must be given. Otherwise, comment on absence of anomalous data. e.g.: The point (x, y) is an anomalous point because it is far/further away from the best fit line as compared to the other points. OR There is no anomalous data as all points plotted are close to the best fit line. *<u>Examiner's comments:</u>* *There are a significant number of candidates who still cite creative reasons blaming either the apparatus or the experimenter for the anomalous results. A few candidates thought any point not touching the line is anomalous thus jeopardizing their best fit line assessment. Candidates should not use "further/furthest" in their answer as this suggests a comparison which will be valid for all graphs thus suggesting that every graph has an anomalous point.*	**A**	A1
9d	Gradient – the hypotenuse of the triangle must be greater than half the length of the drawn line. Read-offs must be accurate to half a small square. Check for $\Delta y/\Delta x$ (i.e. do not allow $\Delta x/\Delta y$). y-intercept – must be determined from $y = mx + c$ using a point on the line. $gradient = \frac{2.36 - 1.16}{0.222 - 0.090} = 9.09$ Subst (0.090, 1.16) into $y = mx + c$,	**A**	B1 B1

	$1.16 = (9.09)(0.090) + c$ $\therefore c = 0.342$ *<u>Examiner's comments:</u>* *Most candidates are still reading off the intercept despite false origin. Some gradient triangles are smaller than half the line drawn and some gradient coordinates are not read accurate to half a small square. A small minority use change in x over change in y.*		
9e	Values of P and Q calculated correctly with units of m s^{-1}. $S = \frac{P}{Q}r + \frac{k}{Q^2}r^2$ $\frac{S}{r} = \frac{k}{Q^2}r + \frac{P}{Q}$ Since $k = 4.9$ m s^{-2} $\frac{k}{Q^2} = gradient$ $Q = \sqrt{\frac{k}{gradient}}$ $= \sqrt{\frac{4.9}{9.09}}$ $= 0.734 \text{ m s}^{-1}$ $\frac{P}{Q} = \text{y-intercept}$ $P = 0.342 \times 0.734$ $= 0.251 \text{ m s}^{-1}$ *<u>Examiner's comments:</u>* *The most common mistake is omitting the units of P and Q. Some candidates have difficulty manipulating the equation and some forgot to take square root for Q.*	**A**	B1 B1



$\frac{S}{r}$
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.080
0.100
0.120
0.140
0.160
0.180
0.200
0.220
r / m
(0.222, 2.36)
Anomalous
(0.090, 1.16)