**Level 3 Physics SHM Review Sheet – ANSWERS**

1. SHM phasors and graphs for mass on a spring STARTING from equilibrium moving UPWARDS.

* ?1 = equilibrium (where mass would be stationary). Vmax happens here. a = 0 and y = 0 here as well.
* ?2 is the top of the SHM motion where y = A, v = 0 and amax is downwards.
* ?3 is the bottom of the SHM motion where y = -A, v = 0 and amax is upwards.
* Linear acceleration is always towards equilibrium and always proportional to displacement.
* ?4 is the angular velocity of all 3 phasors which can be found with 
* The 1st phasor is for the displacement. Radius of circle = amplitude (A) of motion. The arrow points RIGHT to show location at equilibrium and moving upwards.
* Time for each phasor = period of motion (T)
* The 1st phasor makes a sine wave of height A and wavelength = period T
* The 2nd phasor is for the linear velocity of the mass. Radius = vmax = ωA. The arrow points upwards showing max velocity upwards at this location (equilibrium).
* The 2nd phasor makes a cosine graph of height ωA and wavelength = period T.
* The 3rd pasor is for the linear acceleration of the mass. Radius = amax = ω2 A. The arrow points LEFT to show zero acceleration and that it will be negative just after leaving equilibrium.
* The 3rd phasor makes a negative sine wave of height ω2 A and wavelength = period T.
* The 3 equations  ** and **can be used for THIS situation but the calculator MUST be in RADIAN MODE.

2. Pendulum under SHM with forces drawn.

* ?1 = tension up the string. This changes while the mass swings but is only drawn at the left or right edge. At the centre the tension helps to create the centripetal force.
* ?2 = weight (mg)
* ?3 = net force which is 90° to the string (and tension)
* ?4 = the angle at the max amplitude from vertical
* ?5 = the horizontal amplitude of motion (A)
* ?6 = the force triangle made of these 3 forces. The angle in the triangle is between the tension and weight is the SAME as the angle between the string and the vertical.
* Since the 3 forces are linked by the angle we can find forces by sine, cosine or tangent.
* The hypotenuse in this triangle is always the weight force.

3. A phasor diagram for SHM showing how long a mass is MORE THAN 12cm from equilibrium in one complete cycle.

* The amplitude of this motion is 14cm (radius of the circle). The period of motion is 2.5s (given).
* Using  we get θ = 31°
* There are FOUR of these angles so total angle = 124°
* Using  we can get t = = 0.86s

4. Graph of displacement vs time for DAMPED SHM for 3 complete cycles of motion

* ?1 = displacement axis (m)
* ?2 = staring displacement BELOW equilibrium (mass on spring pulled down and let go)
* ?3 = period of oscillation (T)
* ?4 = 2nd period of oscillation (same as 1st)
* ?5 = 3rd period of oscillation (same as 1st 2)
* The amplitude of motion shrinks as energy of the system is lost to heat through friction but the period and frequency of motion does NOT change.

Simple Harmonic Motion Revision Questions ANSWERS

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| ONE  (a) |  | 2Correct answer |  |  |
| (b) |  | 2Correct answer |  |  |
| (c) |  | 2Correct answer |  |  |
| (d) |  | 2Correct answer |  |  |
| (e) | At the end points, or positions of maximum displacement | 1 Correct answer |  |  |
| (f) | When the bouncinette is depressed more than 17cm the net acceleration it applies to the baby exceeds that of ‘g’ (9.8). This will result in the baby still moving upward as it moves through an amplitude of + 15cm. If the baby is not well secured there is the potential for him to be catapulted out of the bouncinette and the baby will go into ‘freefall’. | 2 Calculation of acceleration as a value greater than 9.8 ms-2 (11 ms-2) | 1concept of baby’s acceleration exceeding ‘g’ and resultant ‘catapult’ motion. | 1Correct answer clearly expressed. |
| TWO  (g) | Recognition that angle between the two phasors for this scenario will be 60° by use of sinθ =3.75/7.5 = 30o  60° = 1/6 th circumference.  Hence the time between A and B is 1/6 th a period = 0.78s ÷ 6 = 0.13s (2 s.f.)  Alternatively, *y = A*sin*t* can be used to determine tA (-0.0649s) and tB (0.0649s) and the difference obtained (0.13s) . | 2Attempt to use reference circle to get angle.  OR  Unsuccessful attempt  to use the equation  y = A sinωt | 2recognition of relationship between phasor position and time elapse. | 2Correct answer, linking 1/6 th circumference to 1/6 th period and then calculation of time. |

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| TWO  (a) | x =  = 3.51 m |  | 2 correct working and answer |  |
| (b) | Length to O = 3.51 + 5.08 = 8.59 m | 2 correct answer |  |  |
| (c) | ⇔  = 2π √ 74.4  208  = 3.76 s | 2 correct working to get correct answer |  |  |
| (d) | and  thus    amax = ω2A = 1.672 x 3.21  = 8.97 ms-2 (8.95 – 8.97) |  | 2 correctly gets **ω** but not **a**max. | 2 correct working and answer |
| (e) | At the extremities of this motion | 1 correct answer. |  |  |
| (f) | This is slightly less than “1g”. It would feel like he was being stopped by a force that would feel slightly less than holding his own weight up – not particularly uncomfortable compared to the several “g’s” that fighter pilot and astronaut trainees are tested as being tolerant to. |  | 1 comments about “g’s” or comparing to weight leading to reasonable comment. | 1 well reasoned case |
| (g) | It means that the amplitude of the oscillation is made to die away to zero over 5 periods. To achieve this the design of the structure of this rope must dissipate energy out to the environment. | 1 states what damping in 5 oscillations is. | 1 correct description and explanation of needing to dissipate energy to environment. |  |

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| THREE  (a) (i) | In SHM the displacement and acceleration are directly proportional but opposite in direction. | 1 proportional AND opposite direction |  |  |
| (a) (ii) |  | 2 Correct working |  |  |
| (b) | Angular frequency unit is **rad s–1**. | 1 Correct unit |  |  |
| (c) |  | 2 Correct working and answer. |  |  |
| (d) |  | 2 Correct working and answer. |  |  |
| (e) | Vmax = 48ms–1.  T = 0.0071s. | 1 Correct shape. | 1 Correct shape AND data values. |  |
| (f) |  | 2 Correct working and answer. |  |  |