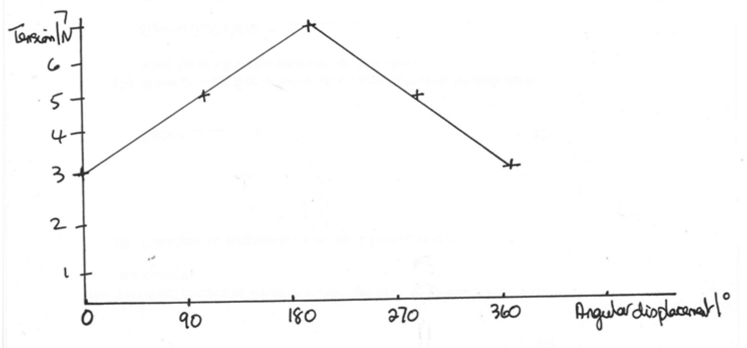
Mechanics II MS2

Question Number	Answer	Mark
1(a)(i)	At B the ball is accelerating **Or** at B the ball is increasing in speed (1) At C ball has zero acceleration (in the absence of friction) **Or** at C the ball has a constant speed (in the absence of friction) **Or** at C the ball is decelerating (due to friction) **Or** at C the speed of the ball decreases (due to friction) (1)	**2**
1(a)(ii)	Use of $F = \Delta p/\Delta t$ (1) F = 23 N (1) Example of calculation $F = \dfrac{(1.5\text{ kg} \times 3.0\text{ m s}^{-1})}{0.2\text{ s}} = 22.5\text{ N}$	**2**
1(b)(i)	Use of $p=mv$ (1) Resolve horizontal components of momentum / velocity (1) Velocity = 1.8 (m s^{-1}) (1) Example of calculation $1.5\text{ kg} \times v = (1.2\text{ kg} \times 1.8\text{ m s}^{-1}) \cos 20 + (1.5\text{ kg} \times 0.7\text{m s}^{-1}) \cos 45$ v=1.8 (m s^{-1})	**3**
1(b)(ii)	Correct calculation of E_k before collision 2.4 - 2.6 (J) (show that value for v gives 3.0 (J)) (ecf value for v from (b)(i)) (1) Correct calculation of E_k after collision 2.3 (J) with comparison (1) Example of calculation E_k (before) = $0.5 \times 1.5\text{ kg} \times (1.8\text{ m s}^{-1})^2 = 2.4$ (J) E_k (after) = $(0.5 \times 1.5 \times 0.7^2) + (0.5 \times 1.2 \times 1.8^2) = 2.3$ (J) E_k (before) > E_k (after)	**2**
	Total for question	**9**

Question Number	Answer	Mark
2(a)	Use of $\omega = \frac{2\pi}{T}$ **Or** Use of $\omega = {}^{\theta}/_{t}$ (1) ω = 1.13×10^{-3} (rad s^{-1}) (1) <u>Example of calculation</u> $\omega = \frac{2\pi \times 15.5}{(24 \times 60 \times 60\ \text{s})}$ = 1.13×10^{-3} (rad s^{-1})	2
(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (although speed is constant) velocity is changing since direction is changing (1) Therefore ISS is accelerating (1) So (by N1/2) there must be a resultant / centripetal force (1)	3
(c)	Use of $F = mr\omega^2$ **Or** $F = \frac{mv^2}{r}$ and $v = r\omega$ **Or** use $F \propto \frac{1}{r^2}$ (1) $F = 3.6 \times 10^6$ N ecf value of *w* from (a) (1) <u>Example of calculation</u> $F = 4.19 \times 10^5\ \text{kg} \times (6.4 \times 10^6\text{m} + 4 \times 10^5\text{m}) \times (1.13 \times 10^{-3}\ \text{rad s}^{-1})^2$ $= 3.6 \times 10^6$ N	2
	Total for question	**7**

Question Number	Answer		Mark
3(a)(i)	Use of $p = mv$ (mass may be left as *m* or justify ignoring mass, e.g. by cancelling) See either × cos 29° or × cos 61° A correct value of momentum for at least one ball, or total, after collision (see 0.036 N s **Or** 0.55 (*m*) **Or** 0.011 (N s) **Or** 0.17 (*m*) **Or** 0.048 (N s) **Or** 0.72(*m*)) Calculated momentum before = calculated momentum after **and** states that momentum is conserved **Or** Calculated momentum before = calculated momentum after **and** states that momentum before = momentum after <u>Example of calculation</u> $p_1 = 0.066 \text{ kg} \times 0.72 \text{ m s}^{-1} = 0.0475 \text{ N s} = 0.048 \text{ N s}$ (2 sf) Components in direction of $u_1 = (0.066 \text{ kg} \times 0.63 \text{ m s}^{-1} \times \cos 29°) + (0.066 \text{ kg} \times 0.35 \text{ m s}^{-1} \times \cos 61°)$ $= 0.0364 \text{ N s} + 0.0112 \text{ N s} = 0.0476 \text{ N s} = 0.048 \text{ N s}$ (2 sf) Momentum before = momentum after, so satisfies principle of conservation of momentum	**(1)** **(1)** **(1)** **(1)**	**4**
3(a)(ii)	Use of $E_k = ½ mv^2$ **Or** $E_k \propto v^2$ Initial E_k = 0.017 (J) (v^2 = 0.52 (m^2 s^{-2})) Calculation of final E_k = 0.017 (J) and statement that E_k conserved (final v^2 = 0.52 (m^2 s^{-2})) <u>Example of calculation</u> $E_k = ½ mv^2$ Before: Ball 1, $E_k = ½ \times 0.066 \text{ kg} \times (0.72 \text{ m s}^{-1})^2 = 0.0171$ J After: Ball 1, $E_k = ½ \times 0.066 \text{ kg} \times (0.63 \text{ m s}^{-1})^2 = 00131$ J Ball 2, $E_k = ½ \times 0.066 \text{ kg} \times (0.35 \text{ m s}^{-1})^2 = 0.0040$ J Total = 0.0171 J, so kinetic energy conserved	**(1)** **(1)** **(1)**	**3**
3(b)(i)	The time intervals between images The scale of the photograph (accept the diameter of the balls)	**(1)** **(1)**	**2**
3(b)(ii)	φ = 45° to 52° Use of graph with their angle to determine total kinetic energy after the collision Statement that it is an inelastic collision **Or** Statement that kinetic energy is not conserved (dependent on candidate attempting MP1 and MP2)	**(1)** **(1)** **(1)**	**3**
	Total for question		**14**

Question Number	Answer		Mark
4(a)	Use of ½ mv^2 and mgh (do not credit use of $v^2 = 2as$ since a not constant, scores 0/2) velocity = 0.77 ($m\ s^{-1}$)	(1) (1)	2
4(b)	Use of mv Correct momentum conservation statement Speed = 0.53 $m\ s^{-1}$ (accept 0.56 $m\ s^{-1}$ from use of show that value) Assumption: no external forces/ no air resistance/ no force on pivot/negligible resistance <u>Example of calculation</u> 320 g × 0.77 $m\ s^{-1}$ = (320 g × v) + (55g × 1.4 $m\ s^{-1}$) Speed of bat = 0.53 $m\ s^{-1}$	(1) (1) (1) (1)	4
4(c)	Use of $E_k = ½ mv^2$ (allow mass in g or kg) Correct calculation of E_k before and after (95, 45, 54 to any power of ten (see below) (If 0.8 $m\ s^{-1}$ and 0.56 $m\ s^{-1}$, values are 102, 50 and 54) Elastic. <u>Example of calculation</u> Before impact E_k bat = ½ 0.320 kg 0.77^2 $(m\ s^{-1})^2$ = 0.095J After impact E_k bat = ½ 0.320 kg 0.53^2 $(m\ s^{-1})^2$ = 0.045 J E_k ball = ½ 0.055 kg 1.4^2 $(m\ s^{-1})^2$ = 0.054 J	(1) (1) (1)	3
4(d)	**Max 2** x measured to nearest cm uncertainty in x gives an uncertainty in GPE / speed (of ball) difficulty of measuring a moving object some energy to sound comments on $E_{(k)}$ after › before relates uncertainty to conclusion made in (c)	 (1) (1) (1) (1) (1) (1)	2
	Total for Question		**11**

Question Number	Answer		Mark
5(a)	Weight acts/pulls (vertically) downwards There must be a component of tension in the vertical direction **Or** refers to Tcos θ with cos θ = 0 when horizontal	**(1)** **(1)**	**2**
5(b)(i)	Use of $mr\omega^2$ (or combining mv^2/r with $v=r\omega$) tension = $mr\omega^2 - mg$ (might be implicit in calculation) Converts cm → m and g → kg Minimum tension = 3.0 N <u>Example of calculation</u> $T_{min} = mr\omega^2 - mg$ T_{min} = 0.204 kg × 0.25 m × (9.90 rad s^{-1})^2 − (0.204 kg × 9.81 N kg^{-1}) T_{min} = 5.0 N − 2.0 N = 3.0 N	**(1)** **(1)** **(1)** **(1)**	**4**
5(b)(ii)	Non zero value of T at 0º Same value at 360 º as at 0º **Single** peak/trough, non-zero, at 180 º (not if horizontal line) Positive gradient from 0º (ignore shape e.g. accept straight or curved between the points) (Anything incorrect after 360 degrees loses MP2) <u>Example of graph</u> (numerical values on T axis not required) 	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question		**10**