

Name of the Student: _____

Max. Marks : 18 Marks

Time : 18 Minutes

Mark Schemes

Q1.

(a) Radius of orbit = $5 \tan 28.5 + 1 = 3.71 \text{ m}$ ✓ 1

Speed = $2 \times 3.14 \times 3.71/5.2 = 4.49 \text{ ()}$ ✓

For second mark only allow

Use of $\sin 28.5$ gives orbit radius 3.39 m and speed = 4.1 m s^{-1}

Or

Forgets to add 1 giving radius 2.71 and speed 3.27 m s^{-1}

1

(b) Centripetal force = $85 \times 4.49^2/3.71 = 460 \text{ N}$ ✓
470 N if using 4.5 m s^{-1} leads to 1000 N

1

Centripetal force = $T \sin 28.5$ ✓

Allow the following as ecf:

Forgetting to add the 1 m (using $r = 2.71 \text{ m}$) leads to centripetal force = 630 N $T = 1300 \text{ N}$

Using $r = 3.39 \text{ m}$ as ecf from part (e) which leads to

Centripetal force = 510 N giving $T = 1070 \text{ N}$

1

$T = 950 - 970 \text{ N}$ ✓

1

OR

Weight = $85 \times 9.8(1)$ Or 834 N seen ✓

Weight = $T \cos 28.5$ ✓

$T = 950$ (949) (N) ✓

OR

Centripetal force = $85 \times 4.5^2/3.71 = 464 \text{ N}$ ✓

Weight = 834 N ✓

$T = \sqrt{464^2 + 834^2} = 950 - 970 \text{ N}$ ✓

Allow ecf for incorrect weight or centripetal force

Allow the following as ecf:

Forgetting to add the 1 m (using $r = 2.71$ m) leads to

Centripetal force = 630 N, $T = 1050$ N

Using $r = 3.39$ m leads to

Centripetal force = 510 N giving $T = 980$ N

- (c) Vertical (compressive) force **on the pole** increases ✓

1

Increases mass increases weight and hence tension in the rope (for the same angle) ✓

1

Centripetal Force

on the acrobats/masses would be different/not equal

OR

Would be greater on the more massive acrobat (travelling at the same speed/same angle to vertical) ✓

Unbalanced (horizontal) forces/resultant force exists (on the pole) ✓

OR

Unbalanced moments acting (on pole)/resultant torque acting (on pole) ✓

Causing the pole to sway/bend/move/ or tilt/topple the platform toward more massive acrobat ✓

1
Max 3

[8]

Q2.

- (a) (use of $v = 2\pi f \sqrt{a^2 - x^2}$)
 $v_{\max} = 2\pi \times 2.0 \times 2.5 \times 10^{-2}$
 $v_{\max} = 0.314 \text{ m s}^{-1}$ ✓
(use of $E_k = \frac{1}{2}mv^2$)
 $54 \times 10^{-3} = \frac{1}{2}m \times (0.314)^2$
 $m = 1.1 \text{ (kg)}$ ✓

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

$$2.0 \times 2\pi = \sqrt{(k/1.1)} \quad \checkmark$$

$$(k = (4\pi)^2 \times 1.1)$$

$$k = 173 \text{ (172.8)} \quad \checkmark \text{ (N m}^{-1}\text{)}$$

Can

OR

$$5.4 \times 10^{-3} = \frac{1}{2} k (2.5 \times 10^{-2})^2 \quad \checkmark$$

$$k = 173 \text{ (172.8) N m}^{-1} \quad \checkmark$$

If either of these methods used can then find mass from frequency formula or from kinetic energy

OR

$$54 \times 10^{-3} = \frac{1}{2} F \times 2.5 \times 10^{-2}$$

$$F = 4.32$$

$$4.32 = k \times 2.5 \times 10^{-2}$$

$$k = 173 \text{ (N m}^{-1}\text{)}$$

Accept 170 and 172.8 to 174

1
1
1
1

- (b) (use of $f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$)
same mass so $f \propto \sqrt{k}$
thus frequency = $2.0 \times \sqrt{3}$
frequency = 3.5 (3.46) (Hz) ✓

Allow CE from (a) for k or m

1
1

- (c) Two from:

(resonance) peak / maximum amplitude is at a higher frequency ✓
due to higher spring constant ✓

(resonant) peak would be broader ✓
due to damping ✓

amplitude would be lower (at all frequencies) ✓
due to energy losses from the system ✓

First mark in each case for effect

Second mark for reason

2 marks max for effects

2 marks max for reason

Cannot award from sketch graph unless explained

First mark in each pair stand alone

Second mark conditional on first in each pair

1
1
1
1

[10]