

Name of the Student: _____

Max. Marks : 20 Marks

Time : 20 Minutes

Mark Schemes

Q1.

- (a) Equates resultant force to ma

and shows a proportional to y , as $A\rho mg$ are all constant ✓

In MP1:

Condone upthrust/buoyancy force for resultant force

$$F = ma = -A\rho y g$$

$$\rho = \frac{-A\rho y g}{m}$$

Condone missing minus signs in MP1.

Minus sign included and explained:

(restoring) force/acceleration directed to centre of oscillation ✓

(hence SHM)

In MP2:

Minus because force/acceleration is in opposite direction to y OWTTE

2

- (b) $(T = 2\pi/\omega)$ so $\omega = \sqrt{\frac{g}{l}}$ ✓ ($= 10.74 \text{ rad s}^{-1}$)

$$(a_{\max} = -\omega^2 y_{\max} = \frac{g}{l} \times y_{\max} = (9.81 \div 0.085) \times 0.005)$$

Alternative for MP1:

calculates time (0.58(5) s) AND then uses ω from this time

0.58 (m s^{-2}) ✓ from some correct working

MP2 for correct calculation of acceleration.

2

- (c) Idea that (at resonance) frequency of forced vibrations equals natural/resonant frequency $_1$ ✓

Idea that amplitude (of vibrations/oscillations) is at a maximum $_2$ ✓

Accept fully labelled graph of amplitude vs driving frequency with resonance frequency clearly labelled $_1$ ✓ and an amplitude peak. $_2$ ✓

Condone 'wave frequency' for 'driving frequency'

Ignore references to phase

2

(d) stopped: wave frequency ($= \frac{v}{\lambda}$) = 0.12 Hz $_1$ ✓

moving: when ship continues at 8 m s^{-1} , forcing frequency will be further from resonant frequency $_2$ ✓

Moving option is better with reason,

eg for stopped option wave/forcing frequency very close to natural frequency, (so amplitude of oscillations will be high)

OR

for moving option resonance does not occur $_3$ ✓

$_1$ ✓ is for calculation of (driving) frequency when stopped. Condone reference to 'frequency of waves'.

If no reference to ship being stopped, evidence can come from the substitution. Reject simple "0.12 (Hz)"

$_2$ ✓ is for a relevant comment about the moving situation

OR

calculation of forcing frequency with the ship moving (giving 0.05 Hz)

For $_2$ ✓ accept incorrect calculation from adding speeds provided comment that this frequency is further from resonant frequency.

$_3$ ✓ is for statement of why moving is the better option

Allow answer for $_3$ ✓ that mentions that damping will be highly likely, so amplitudes may not reach high enough values to prevent operation

3

[9]

Q2.

(a) Use of time = angle / angular speed ✓

To get 3.5 (s) ✓

Alternative for MP1: Accept distance ÷ speed when circumference has been calculated.

Accept answers that round to 3.49

2

(b) Arrow towards centre of turntable. ✓

1

(c) Use of $F = mr\omega^2$ ✓

OR

determination of centripetal acceleration and then $F = ma$ ✓

To give 0.097 N ✓

Shown by substitution.

Condone use of diameter or radius halved in MP1.

Accept negative answer.

Calculator value: 0.0972

2

- (d) States block is (constantly) changing direction ✓

Uses appropriate Newton law of motion to link evidence (to show that a force acts) ✓

Alternative 1

Block constantly changing direction (at constant speed) ✓

Uses N1 to show that a force must apply ✓

Alternative 2

Changing direction shows (centripetal) acceleration ✓

Uses N2 to show that a force must apply ✓

Reference can be to the name of the law or to a description of what the law says.

Condone lack of “resultant force” in N1 and N2.

Use of “changing velocity” without reference to direction is not enough for MP1.

2

- (e) Use of pendulum equation by substitution or manipulation ✓

To give 1.55 m ✓

Allow 2+ sf

Allow answer that rounds to 1.55

Use of $g = 10 \text{ N kg}^{-1}$ gives 1.58 – do not allow for MP2

2

- (f) *Amplitude* – the pendulum shadow amplitude becomes less than the block shadow amplitude ✓

Phase – time period decreases/changes OR frequency increases/changes (as pendulum amplitude gets less) therefore phase changes ✓

Must see a comparison for MP1

Condone:

the time periods/ frequencies remain identical therefore the shadows remain in phase

2

[11]