

Mark schemes

1

(a) $\mathbf{r} = \int \mathbf{v} \, dt$

M1 for at least one term correct

M1

$$= (t^4 - 6t^2 + 3t)\mathbf{i} + 5t\mathbf{j} + 4t^2\mathbf{k} + \mathbf{c}$$

m1 for + c

A1m1

When $t = 0$, $\mathbf{r} = -5\mathbf{i} + 6\mathbf{k} \therefore \mathbf{c} = -5\mathbf{i} + 6\mathbf{k}$

$$\therefore \mathbf{r} = (t^4 - 6t^2 + 3t - 5)\mathbf{i} + 5t\mathbf{j} + (6 + 4t^2)\mathbf{k}$$

A1

4

(b) $\mathbf{a} = (12t^2 - 12)\mathbf{i} + 8\mathbf{k}$

M1 for either component

M1A1

2

(c) Magnitude is $\left\{ (12t^2 - 12)^2 + 64 \right\}^{\frac{1}{2}}$

M1A1F

2

(d) Magnitude is a minimum when $12t^2 - 12$ is zero

M1 for correct differentiation of correct expression in (c)

M1

ie when $t = 1$

A1

2

- (e) Minimum acceleration is 8

Using $F = ma$,

a could be a vector

M1

$$F = 7 \times 8 = 56$$

CAO

A1

2

[12]

2

- (a) Symmetry

E1

1

- (b) Moments about AB :

$$300\sigma \cdot 15 + 100\sigma \cdot 5 + 300\sigma \cdot 15 = 700\sigma \cdot x$$

(condone lack of σ .)

M1 needs correct total marks

$$x = \frac{9500}{700}$$

M1A1

$$= \frac{95}{7} \text{ or } 13.6 \text{ cm}$$

A1

3



- (c) Distance from HG is 16.4 cm

B1

$$\tan \theta = \frac{15}{16.42857}$$

Seeing both 15, 16.4 and tan

M1

$$= 0.913043$$

$$\theta = 42.3974^\circ$$

A1

$$\theta = 42^\circ$$

[48° probably B1, M1]

NB $\frac{13.6}{15}$ etc $\Rightarrow 42^\circ$ no marks

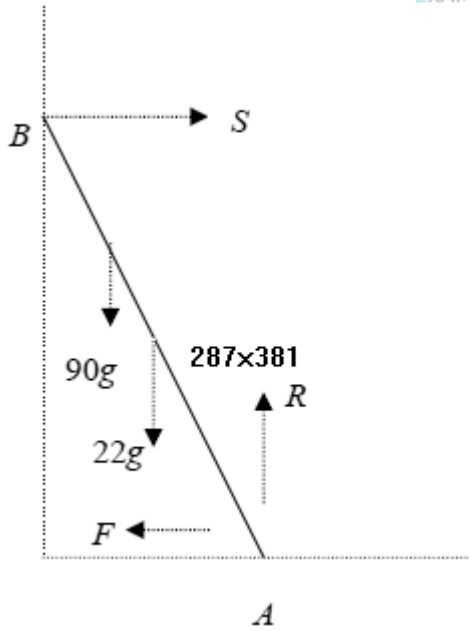
A1

4

[8]

3

(a)



Resolve vertically:

$$R = 22g + 90g$$

$$= 112g$$

B1

Using $F = \mu R$:

M1

$$F = 0.6R$$

$$F = 0.6 \times 112g$$

Needs $0.6 \times 112g$ or 0.6×1097.6

NOT 0.6×1097 unless 658.56 seen

A1

$$= 67.2g \text{ or } 658.56$$

$$F = 659 \text{ N}$$

AG (659 must be shown from correct working)

A1

(b) Resolve horizontally: $S = F$

B1

Moments about A:

$$90g \times 5 \times \cos \theta + 22g \times 3 \times \cos \theta$$

M1 (one term, force $\times$ distance $\times$ cos or sin)

M1A1

$$= 67.2g \times 6 \times \sin \theta$$

A1

$$450g + 66g = 403.2g \tan \theta$$

$$\tan \theta = \frac{516}{403.2}$$

$$\theta = 52.0^\circ$$

accept 52

Alternative: or moments about B:

M1 A2, 1 or 0 for four-term moment equation

+ M1 for rearranging etc (dep on 4 term)

+ A1 for answer

A1

5

[9]

4

(a) $\mathbf{a} = \frac{dv}{dt}$

$$\mathbf{a} = -8e^{-2t} \mathbf{i} + (6 - 6t)\mathbf{j}$$

M1: Differentiating with either of the two components correct. Do not need to see $\mathbf{i}$ or $\mathbf{j}$.

A1: Correct $\mathbf{i}$ component.

A1: Correct $\mathbf{j}$ component.

M1

A1

A1

3



- (b) (i) Using $F = ma$

$$F = 5 \times \{-8e^{-2t} \mathbf{i} + (6 - 6t)\mathbf{j}\}$$

$$= -40e^{-2t} \mathbf{i} + (30 - 30t)\mathbf{j}$$

M1: Multiplying their acceleration by 5, even if not a vector.

A1: Correct expression.

M1

A1

2

- (ii) Magnitude of F is

$$\{(-40)^2 + (30)^2\}^{\frac{1}{2}}$$

M1: Finding magnitude from two non-zero terms. Must add terms and square root. Condone $\{(40)^2 + (30)^2\}^{\frac{1}{2}}$

M1

$$= 50$$

A1: Correct answer only.

In this part, condone lack of negative signs in expression for force in (b) (i).

A1

2

- (c) When F acts due west, j component is zero

$$30 - 30t = 0$$

M1: Putting j component equal to zero.

M1

$$t = 1$$

A1: Correct time.

A1

2



(d) $\mathbf{r} = -2e^{-2t} \mathbf{i} + (3t^2 - t^3) \mathbf{j} + \mathbf{c}$

M1: Integration with either of the two components correct.

Do not need to see $\mathbf{i}$ or $\mathbf{j}$.

A1: Correct $\mathbf{i}$ component.

A1: Correct $\mathbf{j}$ component.

Condone lack of $+ \mathbf{c}$

M1

A1

A1

When $t = 0$, $\mathbf{r} = 6\mathbf{i} + 5\mathbf{j} \therefore \mathbf{c} = 8\mathbf{i} + 5\mathbf{j}$

dM1: Finding $\mathbf{c}$ using $6\mathbf{i} + 5\mathbf{j}$ and $e^0 = 1$.

dM1

$\therefore \mathbf{r} = (8 - 2e^{-2t}) \mathbf{i} + (5 + \frac{1}{4}t^4 - t^3) \mathbf{j}$

A1: Correct position vector.

A1

5

[14]

5

(a) $0^2 = (30 \sin 35^\circ)^2 + 2 \times (-9.8)s$

M1: Equation to find the max height, with $v = 0$

M1

A1: Correct equation

A1

M1: Solving for the height

M1

$s = \frac{(30 \sin 35^\circ)^2}{2 \times 9.8} = 15.1 \text{ m}$

A1: Correct height

A1

4

(b) $28^2 = (30 \cos 35^\circ)^2 + v_y^2$

M1: Equation to find vertical component

M1

A1: Correct equation

A1

$$v_y = \sqrt{28^2 - (30 \cos 35^\circ)^2}$$

M1: Solving equation

M1

$$= 13.4198 = 13.4 \text{ m s}^{-1} \quad \mathbf{AG}$$

A1: Correct speed from correct working.

A1

4

(c) $\tan \theta = \frac{13.4}{30 \cos 35^\circ}$

M1: Expression to find the angle.

M1

$$\theta = 28.6^\circ$$

A1: Correct angle.

A1

2

[10]

6

- (a) Using power = force $\times$ velocity
 Power = $(30 \times 48) \times 48$

M1

$$= 69120 \text{ watts}$$

AG

A1

2

- (b) When speed is 40 m s^{-1} ,
max force exerted is $\frac{69120}{40}$
 $= 1728 \text{ N}$

B1

Accelerating force is '1728' – 1200 N

M1

Using $F = ma$:
 $528 = 1200a$

m1

$a = 0.44 \text{ m s}^{-2}$

A1

4



- (c) Force exerted by engine is $\frac{69120}{v}$

B1

Force exerted by the engine

$$= 30v - mg \sin 3$$

(Use of $\cos 3$ delete A1, A1 of 3 A terms)

M1

$$30v - 615.47(\text{or } 1200g \sin 3) = \frac{69120}{v}$$

A2 All terms correct

A1 Two terms correct

A1A1

$$30v^2 - 615.47v - 69120 = 0$$

$$\text{SC3 for } 30v^2 + 615.47v - 69120 = 0$$

A1

$$v = \frac{615.47 \pm \sqrt{615.47^2 + 4 \times 30 \times 69120}}{2 \times 30}$$

M1

Speed is 59.3 m s^{-1}

A1

7

[13]

7

- (a) $r = 1.2 \sin \theta$

$1.2 \cos \theta$ 0 marks

B1

1



(b) Resolve horiz: $T \sin \theta = m\omega^2 r$ EXAM PAPERS PRACTICE

$$T \cos \theta = m\omega^2 r \text{ etc M1 (+ second M1)}$$

M1A1

$$T \sin \theta = 4 \times 5^2 \times 1.2 \sin \theta$$

$$T = 120$$

A1

Resolve vert: $T \cos \theta = 4g$

$$\text{M1 for } \tan \theta = \frac{30 \sin \theta}{g}$$

M1A1

$$\cos \theta = 0.32666$$

$$\theta = 70.9^\circ \text{ or } 1.24^\circ$$

A1

6

[7]

© 2026 Exam Papers Practice. All Rights Reserved