

SECTION A

1. (a) $\vec{AE} = \frac{1}{2} \vec{AD}$ *A1*

attempt to find \vec{AD} *M1*

e.g. $\vec{AB} + \vec{BD}$, $\vec{u} + \vec{v}$

$$\vec{AE} = \frac{1}{2}(\vec{u} + \vec{v}) \left(= \frac{1}{2}\vec{u} + \frac{1}{2}\vec{v} \right)$$

A1 *N2*

[3 marks]

(b) $\vec{ED} = \vec{AE} = \frac{1}{2}(\vec{u} + \vec{v})$ *A1*

$$\vec{DC} = 3\vec{v}$$
 A1

attempt to find \vec{EC} *M1*

e.g. $\vec{ED} + \vec{DC}$, $\frac{1}{2}(\vec{u} + \vec{v}) + 3\vec{v}$

$$\vec{EC} = \frac{1}{2}\vec{u} + \frac{7}{2}\vec{v} \left(= \frac{1}{2}(\vec{u} + 7\vec{v}) \right)$$

A1 *N2*

[4 marks]

Total [7 marks]

2. (a) min value of r is -1 , max value of r is 1 *A1A1* *N2*
[2 marks]

(b) C *A1* *N1*
[1 mark]

(c) linear, strong negative *A1A1* *N2*
[2 marks]

Total [5 marks]

| | | | | |
|----|--|--|-----------------|----|
| 3. | (a) | $4 \text{ (ms}^{-1}\text{)}$ | A1 | N1 |
| | | | [1 mark] | |
| | (b) | recognising that acceleration is the gradient | M1 | |
| | | e.g. $a(1.5) = \frac{4-0}{2-0}$ | | |
| | | $a = 2 \text{ (ms}^{-2}\text{)}$ | A1 | N1 |
| | | | [2 marks] | |
| | (c) | recognizing area under curve e.g. trapezium, triangles, integration | M1 | |
| | | correct substitution | A1 | |
| | | e.g. $\frac{1}{2}(3+6)4, \int_0^6 v(t) dt$ | | |
| | | distance = 18 (m) | A1 | N2 |
| | | | [3 marks] | |
| | | | Total [6 marks] | |
| 4. | (a) | (i) new mean is $20+10=30$ | A1 | N1 |
| | (ii) new sd is 6 | A1 | N1 | |
| | | [2 marks] | | |
| | (b) | (i) new mean is $20 \times 10 = 200$ | A1 | N1 |
| | (ii) METHOD 1 variance is 36 new variance is $36 \times 100 = 3600$ | A1 | N2 | |
| | | | | |
| | | METHOD 2 | | |
| | | new sd is 60 | A1 | |
| | | new variance is $60^2 = 3600$ | A1 | N2 |
| | | | [3 marks] | |
| | | | Total [5 marks] | |

5. (a) attempt to use substitution or inspection

M1

e.g. $u = 1 + e^x$ so $\frac{du}{dx} = e^x$

correct working

A1

e.g. $\int \frac{du}{u} = \ln u$

$\ln(1 + e^x) + C$

*A1**N3**[3 marks]*

(b) **METHOD 1**

attempt to use substitution or inspection

M1

e.g. let $u = \sin 3x$

$\frac{du}{dx} = 3 \cos 3x$

A1

$\frac{1}{3} \int u du = \frac{1}{3} \times \frac{u^2}{2} + C$

A1

$\int \sin 3x \cos 3x dx = \frac{\sin^2 3x}{6} + C$

*A1**N2**[4 marks]*

METHOD 2

attempt to use substitution or inspection

M1

e.g. let $u = \cos 3x$

$\frac{du}{dx} = -3 \sin 3x$

A1

$-\frac{1}{3} \int u du = -\frac{1}{3} \times \frac{u^2}{2} + C$

A1

$\int \sin 3x \cos 3x dx = \frac{\cos^2 3x}{6} + C$

*A1**N2**[4 marks]*

METHOD 3

recognizing double angle

M1

correct working

A1

e.g. $\frac{1}{2} \sin 6x$

$\int \sin 6x dx = \frac{-\cos 6x}{6} + C$

A1

$\int \frac{1}{2} \sin 6x dx = -\frac{\cos 6x}{12} + C$

*A1**N2**[4 marks]**Total [7 marks]*

6. (a) recognizing double angle
e.g. $3 \times 2 \sin x \cos x, 3 \sin 2x$

M1

$$a = 3, b = 2$$

A1A1**N3****[3 marks]**

- (b) substitution $3 \sin 2x = \frac{3}{2}$

M1

$$\sin 2x = \frac{1}{2}$$

A1

finding the angle

A1

$$\text{e.g. } \frac{\pi}{6}, 2x = \frac{5\pi}{6}$$

$$x = \frac{5\pi}{12}$$

A1**N2**

Note: Award **A0** if other values are included.

[4 marks]**Total [7 marks]**

7. (a) $f'(x) = -x^{-2}$ (or $-\frac{1}{x^2}$)

A1 **N1**

$$f''(x) = 2x^{-3}$$
 (or $\frac{2}{x^3}$)

A1 **N1**

$$f'''(x) = -6x^{-4}$$
 (or $-\frac{6}{x^4}$)

A1 **N1**

$$f^{(4)}(x) = 24x^{-5}$$
 (or $\frac{24}{x^5}$)

A1 **N1****[4 marks]**

(b) $f^{(n)}(x) = \frac{(-1)^n n!}{x^{n+1}}$ or $(-1)^n n! (x^{-(n+1)})$

A1A1A1 **N3****[3 marks]****Total [7 marks]**

SECTION B

8. (a)
$$\begin{aligned} f(x) &= 3(x^2 + 2x + 1) - 12 \\ &= 3x^2 + 6x + 3 - 12 \\ &= 3x^2 + 6x - 9 \end{aligned}$$

A1
A1
AG *N0*
[2 marks]

(b) (i) vertex is $(-1, -12)$ *A1A1* *N2*

(ii) $y = -9$, or $(0, -9)$ *A1* *N1*

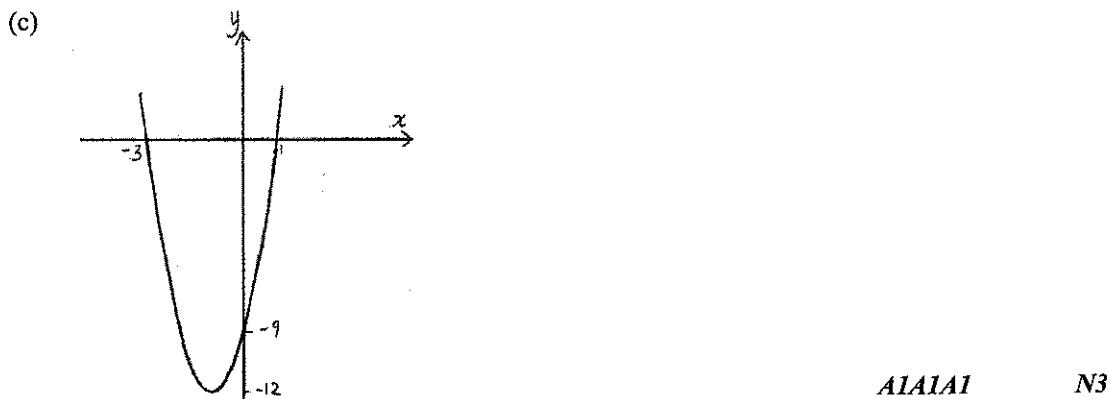
(iii) evidence of solving $f(x) = 0$ *M1*
e.g. factorizing, formula

correct working *A1*

e.g. $3(x+3)(x-1) = 0, x = \frac{-6 \pm \sqrt{36+108}}{6}$

$x = -3, x = 1$, or $(-3, 0), (1, 0)$ *A1A1* *N2*

[7 marks]



Note: Award *A1* for a parabola opening upward,
A1 for vertex in approximately correct position,
A1 for intercepts in approximately correct positions.
Scale and labelling not required.

[3 marks]

(d) $\begin{pmatrix} p \\ q \end{pmatrix} = \begin{pmatrix} -1 \\ -12 \end{pmatrix}, t = 3$

A1A1A1 *N3*

[3 marks]

Total [15 marks]

9. (a) (i) number of ways of getting $X = 6$ is 5

$$P(X = 6) = \frac{5}{36}$$

*A1**A1 N2*

(ii) number of ways of getting $X > 6$ is 21

$$P(X > 6) = \frac{21}{36} \left(= \frac{7}{12} \right)$$

*A1**A1 N2*

$$(iii) P(X = 7 | X > 6) = \frac{6}{21} \left(= \frac{2}{7} \right)$$

*A2 N2**[6 marks]*

(b) attempt to find $P(X < 6)$

$$e.g. 1 - \frac{5}{36} - \frac{21}{36}$$

M1

$$P(X < 6) = \frac{10}{36}$$

A1

fair game if $E(W) = 0$ (may be seen anywhere)

R1

attempt to substitute into $E(X)$ formula

M1

$$e.g. 3\left(\frac{5}{36}\right) + 1\left(\frac{21}{36}\right) - k\left(\frac{10}{36}\right)$$

correct substitution into $E(W) = 0$

A1

$$e.g. 3\left(\frac{5}{36}\right) + 1\left(\frac{21}{36}\right) - k\left(\frac{10}{36}\right) = 0$$

work towards solving

M1

$$e.g. 15 + 21 - 10k = 0$$

$$36 = 10k$$

A1

$$k = \frac{36}{10} (= 3.6)$$

*A1 N4**[8 marks]**Total [14 marks]*

10. (a) $f'(x) = -\sin x + \sqrt{3} \cos x$ *A1A1 N2
[2 marks]*
- (b) (i) at A, $f'(x) = 0$ *R1*
 correct working *A1*
e.g. $\sin x = \sqrt{3} \cos x$
 $\tan x = \sqrt{3}$ *A1*
 $x = \frac{\pi}{3}, \frac{4\pi}{3}$ *A1*
 attempt to substitute their x into $f(x)$ *M1*
e.g. $\cos\left(\frac{4\pi}{3}\right) + \sqrt{3} \sin\left(\frac{4\pi}{3}\right)$
 correct substitution *A1*
e.g. $-\frac{1}{2} + \sqrt{3}\left(-\frac{\sqrt{3}}{2}\right)$
 correct working that clearly leads to -2 *A1*
e.g. $-\frac{1}{2} - \frac{3}{2}$
 $q = -2$ *AG N0*
- (ii) correct calculations to find $f'(x)$ either side of $x = \frac{4\pi}{3}$ *A1A1*
e.g. $f'(\pi) = 0 - \sqrt{3}$, $f'(2\pi) = 0 + \sqrt{3}$
 $f'(x)$ changes sign from negative to positive *R1*
 so A is a minimum *AG N0
[10 marks]*
- (c) max when $x = \frac{\pi}{3}$ *R1*
 correctly substituting $x = \frac{\pi}{3}$ into $f(x)$ *A1*
e.g. $\frac{1}{2} + \sqrt{3}\left(\frac{\sqrt{3}}{2}\right)$
 max value is 2 *A1 NI
[3 marks]*
- (d) $r = 2$, $a = \frac{\pi}{3}$ *A1A1 N2
[2 marks]*

Total [17 marks]