MARK SCHEME for the May/June 2015 series

0606 ADDITIONAL MATHEMATICS

0606/21 Paper 2 (Paper 2), maximum raw mark 80

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### Abbreviations

- **awrt**: answers which round to
- **cao**: correct answer only
- **dep**: dependent
- **FT**: follow through after error
- **isw**: ignore subsequent working
- **oe**: or equivalent
- **rot**: rounded or truncated
- **SC**: Special Case
- **soi**: seen or implied
- **www**: without wrong working

### 1 (a)

\[
\frac{\log_3 x}{\log_3 27} = \frac{\log_3 x}{3} \quad \text{isw}
\]

- **M1**: Can use other interim bases if all correct but M1 when in base 3 only
- **A1**: NOT \( \log_3 x+3 \)

### 1 (b)

- **M1**: \( \log_a 15 - \log_3 3 = \log_a 5 \) soi
- **M1**: \( \log_a 5^3 \) or \( \log_a a \)
- **A1**: \( \log_a y = \log_a 125a \Rightarrow y = 125a \)

### 2 (a)

\[ f(x) = 2x - 4 \quad \text{and} \quad [f(x)] = -2x + 4 \]

- **B1, B1**: Condone \( y = \ldots \)

### 2 (b)

- **B1**: correct shape; \( y \) intercept marked or seen nearby;
- **B1**: intent to tend to \( y = 3 \) (i.e. not tending to or cutting \( x \)-axis)

### 3 (a)

\[
A = \frac{1}{4} \begin{bmatrix} 51 & -8 & 19 \\ 31 & 2 & 65 \end{bmatrix} - \begin{bmatrix} 20 & 0 & -5 \\ 15 & -10 & 25 \end{bmatrix}
\]

- **M1**: Integer values

### 3 (b)

- **B1**: The (total) value of the stock in **each** of the 3 shops
- **B1**: Must have “each” oe
- **B1**: The **total** value of the stock in all 3 shops
- **B1**: Must have “total” oe
| 4 | **(i)** | \( PT = \frac{1}{8} \tan \left( \frac{3\pi}{8} \right) \) oe | M1 | \( PT = \frac{3\pi}{8} \) \( \sin \frac{3\pi}{8} = \frac{8}{\sin \frac{\pi}{8}} \) |
|   | **(ii)** | \( \frac{1}{2} \times 8^2 \times \frac{3\pi}{4} \) oe \( (75.4) \) | M1 | \( 8 \times \text{their } PT \) \( - \) their sector oe \( (=154.5 \text{ to } 75.4') \) |
|   |   | \( 8 \tan \left( \frac{3\pi}{8} \right) \times 8 \text{ – their sector } \) oe \( (=154.5 \text{ to } 75.4') \) | M1 | awrt 19.3 |
|   | **(iii)** | \( 8 \left( \frac{3\pi}{4} \right) \) oe \( (18.8) \) | M1 | awrt 79.1 |
|   |   | \( 6\pi + 16 \tan \left( \frac{3\pi}{8} \right) \) = 57.5 | M1 | Accept 57.4 to 57.5 |

| 5 | **(a)** | Permutation because the order matters oe | B1 |  |
|   | **(b) (i)** | \( ^6C_4 + ^5C_4 + ^7C_4 \) | M1 | 3 correct terms added |
|   |   | 55 | A1 |  |
|   | **(ii)** | \( ^2C_1 \times ^6C_1 \times ^5C_1 \times ^7C_1 \) | M1 | 4 correct terms multiplied |
|   |   | 420 | A1 |  |
|   | **(iii)** | \( ^6C_1 \times ^2C_1 \) or \( ^2C_2 \times ^5C_1 \times ^6C_1 \) summation | M1 |  |
|   |   | 70 | A1 | for either correct product |
|   |   |  |  | adding two correct products |
|   |   |  |  | If 0 scored, then SC1 for 1,1,1,0 and 0,0,2,1 seen |

| 6 | **(i)** | \( 2t^2 - 14t + 12 = 0 \) \( (t-1)(t-6) \) oe | M1 |  |
|   |   | \( (t=) 1 \) | A1 | If \( t = 1 \) with no working, then M1A1 |
|   | **(ii)** | \( \int (2t^2 - 14t + 12) \, dt \) | M1 |  |
|   |   | \( (s=) \frac{2t^3}{3} - \frac{14t^2}{2} + 12t \) | A2,1,0 | \( -1 \) for each error or for \( +c \) left in or limits introduced |
|   | **(iii)** | \( \frac{dv}{dt} (4t-14) \) \( [4(3)-14 = ] \) -2 cao | M1 |  |
7 (a)  \( \overrightarrow{AB} = 15\mathbf{b} - 5\mathbf{a} = 5(3\mathbf{b} - \mathbf{a}) \) or 
\( \overrightarrow{BC} = 24\mathbf{b} - 3\mathbf{a} - 15\mathbf{b} = 3(3\mathbf{b} - \mathbf{a}) \) or 
\( \overrightarrow{AC} = 24\mathbf{b} - 3\mathbf{a} - 5\mathbf{a} = 8(3\mathbf{b} - \mathbf{a}) \)
Comment: e.g. the vectors are scalar multiples of each other AND they have a common point (A, B or C as appropriate)
B1dep  Dep on both B marks being awarded.

(b) (i)  \( 2\mathbf{i} + 11\mathbf{j} \) soi 
\( \Rightarrow \sqrt{2^2 + 11^2} \)
\( \sqrt{125} \) or \( 5\sqrt{5} \) or 11.2 (3 s.f.) or better
B1fT  ft their \( 2\mathbf{i} + 11\mathbf{j} \) (not \( \overrightarrow{OP} \) or \( \overrightarrow{OQ} \))

(ii) \( \frac{1}{5\sqrt{5}} (2\mathbf{i} + 11\mathbf{j}) \) isw
B1fT  ft their answers from (i)

(iii) \( \frac{\mathbf{i} - 4\mathbf{j} + 3\mathbf{i} + 7\mathbf{j}}{2} \) or \( \frac{2\mathbf{i} + 11\mathbf{j}}{2} \) or 
\( 3\mathbf{i} + 7\mathbf{j} - \frac{2\mathbf{i} + 11\mathbf{j}}{2} \)
\( 2\mathbf{i} + 1.5\mathbf{j} \)
A1

8 (a) (i)  \( ke^{4x+3} (+c) \) oe 
\( k = \frac{1}{4} \) oe
M1  any constant, non-zero \( k \)
A1

(ii) \( \frac{1}{4} (e^{4x+3} - e^{4(2.5)+3}) \) or better
DM1  ft their integral attempt

\( 706650.99... = 707000 \) to 3 sf or better
A1  Accept \( \frac{1}{4}(e^5 - e^3) \)

(b) (i)  \( k \sin\left(\frac{x}{3}\right) (+c) \)
\( k = 3 \)
M1  any constant, non-zero \( k \)
A1

(ii) \( 3\sin\left(\frac{\pi}{6} \times \frac{1}{3}\right) - 3\sin(0) \)
DM1  Dep on their integral attempt in sin; condone omission of lower limit

\( 0.520944... = 0.521 \) to 3 sf or better
A1  Accept \( 3\sin\left(\frac{\pi}{18}\right) \)

(c) \( \int (x^2 + 2 + x^3) \, dx = \frac{x^4}{4} + 2x + \frac{x^4}{3} + c \)
B1  Expands – accept unsimplified
M1  integration of their 3 term expansion
A1  Fully correct
B1  \( + c \)
### Question 9

**(a)**

\[(4x-1)(x+5) \leq 0\]

Critical values \(x = \frac{1}{4}\) and \(-5\) soi

\[-5 \leq x \leq \frac{1}{4}\]

Solves quadratic

A1

Accept: \([-5, \frac{1}{4}]\); \(-5 \leq x \leq 0.25\)

**(b)**

(i) \((x+4)^2 - 25\) or \(a = 4\) and \(b = -25\)

B1, B1

(ii) \((\text{Greatest value}) = 25\)

\(x = -4\)

Must be clear

B1

Correct shape with maximum in second quadrant and crossing positive and negative axes correctly

B1

All 3 intercepts correctly shown on graph

### Question 10

**(i)**

\[\ln y = \ln (Ab^x) \Rightarrow \ln y = \ln A + \ln b^x\]

\[\Rightarrow \ln y = \ln A + x \ln b\]

M1

A1

**(ii)**

\[\ln A = 11.4 \Rightarrow A = e^{11.4}\]

M1

condone misread of scale for M1 (11.2 only)

A1

Allow awrt \(-1\)

**(iii)**

\[x = 2.5 \Rightarrow \ln y = 9\]

\[y = e^9\] or 8000 to 1 sf

M1

A1

Allow awrt 8100

### Question 11

**(i)**

\[7 - x, x, 6 - x\] \(\text{oe}\)

\(\text{their} \) attempt at \(7 - x + x + 6 - x + 16 = 25 \text{ oe}\)

\[x = 4\]

B1

M1

Condone \(x = 4\) for all 3 marks

**(ii)**

\[23 - y, y, 9 - y \text{ oe}\]

\[48 = 30 + 25 + 15 - 7 - 6 - \text{(their} 4 + y\text{)} + \text{their} 4\]

\[\text{oe soi}\]

\[y = 9\]

B1

or \(n(A \cup C) = 48 - 16 = 32\)

M1

or \(32 = 30 + 15 - \text{(their} 4 + y\text{)}\)

or \(48 = (23 - y) + 3 + 16 + y + 4 + 2 + (9 - y)\)

Condone \(y = 9\) for all 3 marks

**(iii)**

\(n(C) = 15\) and \(y + n(B \cap C) = 9 + 6 = 15\)

[and so \(A' \cap B' \cap C = \emptyset\)].

B1

or equivalent deduction