1. $\pi \int_0^4 \left(\frac{3}{\sqrt{6x+1}}\right)^2 dx$ OR $\pi \int_0^4 \frac{9}{6x+1} dx$ B1

$\frac{9}{6}\ln|6x+1|$ OR $\frac{9}{6}\ln(6x+1)$ OR $\frac{3}{2}\ln(6x+1)$ M1

$\ln 25 - \ln 1$ M1

$\frac{3\pi}{2}\ln 25$ A1

$\frac{3\pi}{2} \times 2\ln 5$ OR $\frac{3\pi}{2} \times \ln 5^2$ BEFORE SHOWING $3\pi\ln 5$ A1

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2. a) DIFFERENTIATES AFTER EXPANSION

$4xy + 2x^2\frac{dy}{dx} - y^2 - 2xy\frac{dy}{dx} = 0$ M4

COLLECT "$\frac{dy}{dx}$" TOGETHER & CORRECTLY AND CONVINCINGLY ARRIVES AT

$$\frac{dy}{dx} = \frac{y^2 - 4xy}{2x^2 - 2xy}$$ MA1

b) SIGHT OF $4x^2 - 4x + 1$ M1

$(2x-1)^2$ M1

$x = \frac{1}{2}$ OR $k = \frac{1}{2}$ A1

c) SUBSTITUTES "$x = \frac{1}{2}$", $y = 2$ INTO $\frac{dy}{dx}$ M1

OBTAINS ZERO & CONCLUDES A1

d) $y = 2$ A1 c.a.o

3. a) CORRECT ATTEMPT, ELIMINATION OR COMPARING COEFFICIENTS M1

$$\frac{1}{1-x} + \frac{16}{2-3x}$$ A2

IMPLIED OR FULLY SEEN

b) $\frac{1}{1-x} = 1 + x + x^2 + x^3$ MA3

$1 + \frac{3}{2}x + \frac{9}{4}x^2 + \frac{27}{8}x^3$ MA3

OR

$8 + 12x + 18x^2 + 27x^3$

ADDS & CONVINCINGLY ARRIVES AT ANSWER $9 + 13x + 19x^2 + 28x^3$ A1

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4. a) ATTEMPTS QUOTIENT/PRODUCT RULE TO FIND $\frac{dx}{dt}$ OR $\frac{dy}{dt}$ B1

$\frac{1-t^2}{(1+t^2)^2}$ MA1

$\frac{4t}{(1+t^2)^2}$ MA1

SIGHT OF $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$ OR $\frac{dy}{dt} \times \frac{dt}{dx}$ OR $\frac{\frac{4t}{(1+t^2)^2}}{\frac{1-t^2}{(1+t^2)^2}}$ M1

$\frac{4t}{1-t^2}$ A1 c.a.o

b) $\frac{2t^2}{1+t^2} = 6\left(\frac{t}{1+t^2}\right) - 2$ M1

MULTIPLIES BY $1+t^2$ (SENSIBLE ATTEMPT) M1

$2t^2 - 3t + 1 = 0$ A1

$(t-1)(2t-\frac{1}{2})$ M1

$t = 1, \frac{1}{2}$ (BOTH) A1

$(\frac{1}{2}, 1)$ $(\frac{2}{5}, \frac{2}{5})$ MA1 MA1

5. $\frac{du}{dx} = 2x$ B1

$\int \frac{1}{2}x^2 e^u \, du$ OR $\int \frac{1}{2} u e^u \, du$ M1

$\frac{1}{2}ue^u \boxed{- \int \frac{1}{2}e^u \, du}$ M1 M1

$\frac{1}{2}ue^u - \frac{1}{2}e^u$ A1

$\frac{1}{2}x^2 e^{x^2} - \frac{1}{2}e^{x^2} (+c)$ A1

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6. a) $\vec{AB} = (-1,1,9) - (3,-1,2)$ OR $(-4,2,7)$ M A1

$(3,-1,2) \cdot (-4,2,7)$ SEEN M1

OBTAINS ZERO & CONCLUDES A1

b) $r =$ (FIXED POINT) $+ \lambda$(DIRECTION VECTOR) M1

CORRECT STRUCTURE INCLUDING $r = \ldots$

ANY CORRECT FORM, $r = (3,-1,2) + \lambda(-4,2,7)$ ETC A1

c) $(-5,3,16)$ B1 2 correct

B1 All 3 correct

7. a) $\left(\frac{dv}{dx}=\right)$ $\boxed{\frac{1}{2}(3x^2+2x^3)^{-\frac{1}{2}}} \times \boxed{(6x+6x^2)}$ M1 M1

PENALIZE LACK OF BRACKETS BUT ALLOW RECOVERY

SUBSTITUTES $x=11$ INTO THEIR $\frac{dv}{dx}$ M1 ft dep on at least one previous M1

$\frac{36}{5}$ OR 7.2 O.E A1

b) SIGHT OF $\frac{dx}{dv} \times \frac{dv}{dt}$ OR "$\frac{1}{7.2}$" $\times$ 14.4 M1

2 C.A.O A1

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8. a) SEPARATES VARIABLES E.g $\frac{1}{200-\theta}\,d\theta = k\,dt$ O.E M1

"INTEGRATES" BOTH SIDES M1

$-\ln|200-\theta|$ OR $-\frac{1}{k}\ln|200-\theta|$ OR $-\ln(200-\theta)$ MA1

$kt + C$ OR ($t + C$ IF k APPEARS IN LHS) MA1

$200-\theta = e^{-kt+C}$ MA1

CORRECTLY & CONVINCINGLY ARRIVES AT THE GIVEN ANSWER $\theta = 200 + Ae^{-kt}$ A1

b) SUBS $t=0, \theta=20$ OR SHOWS $A=-180$ MA1

$120 = 200$ "-180" e^{-10k} M1 ft

$e^{-10k} = \frac{4}{9}$ OR $e^{10k} = \frac{9}{4}$ M1

USES logs CORRECTLY $k = \frac{1}{10}\ln(2.25)$ OR $-\frac{1}{10}\ln\frac{4}{9}$ OR $0.081093\ldots$ MA1

BEFORE SHOWING 0.0811

c) $e^{-0.0811t} = \frac{2}{9}$ O.E. MA1

USES LOGARITHMS CORRECTLY M1

$t = 18.547\ldots$ A1

9. $\frac{du}{dx} = \sec^2 x$ OE B1

LIMITS $0, \sqrt{3}$ OR CHANGES AT THE END BACK INTO x VARIABLE B1

$\int \sec^4 x \frac{du}{\sec^2 x}$ O.E M1

$\int 1 + u^2 \, du$ M1

$u + \frac{1}{3}u^3$ MA1

CORRECT USE OF LIMITS AND CONSISTENCY & CORRECTLY ARRIVES AT $2\sqrt{3}$ A1