**5.** (i) Find

$$\int x^2 e^x dx$$

**(4)**

(ii) Use the substitution $u = \sqrt{1-3x}$ to show that

$$\int \frac{27x}{\sqrt{1-3x}} dx = -2(1-3x)^{\frac{1}{2}}(Ax + B) + k$$

where $A$ and $B$ are integers to be found and $k$ is an arbitrary constant.

**(6)**

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**Question 5 continued**

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**Question 5 continued**

**(Total for Question 5 is 10 marks)**

**6.** **In this question you must show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

The temperature, $\theta$ °C, of a car engine, $t$ minutes after the engine is turned off, is modelled by the differential equation

$$\frac{\mathrm{d}\theta}{\mathrm{d}t} = -k(\theta - 15)^2$$

where $k$ is a constant.

Given that the temperature of the car engine
- is 85 °C at the instant the engine is turned off
- is 40 °C exactly 10 minutes after the engine is turned off

(a) solve the differential equation to show that, according to the model

$$\theta = \frac{at + b}{ct + d}$$

where $a$, $b$, $c$ and $d$ are integers to be found.

**(7)**

(b) Hence find, according to the model, the time taken for the temperature of the car engine to reach 20 °C. Give your answer to the nearest minute.

**(2)**

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