

14. A large spherical balloon is deflating.

At time  $t$  seconds the balloon has radius  $r$  cm and volume  $V$  cm<sup>3</sup>

The volume of the balloon is modelled as decreasing at a constant rate.

(a) Using this model, show that

$$\frac{dr}{dt} = -\frac{k}{r^2}$$

where  $k$  is a positive constant.

(3)

Given that

- the initial radius of the balloon is 40 cm
- after 5 seconds the radius of the balloon is 20 cm
- the volume of the balloon continues to decrease at a constant rate until the balloon is empty

(b) solve the differential equation to find a complete equation linking  $r$  and  $t$ .

(5)

(c) Find the limitation on the values of  $t$  for which the equation in part (b) is valid.

(2)