

1 (a) Define acceleration.

.....  
 ..... [1]

(b) A rocket is launched vertically from the surface of the Earth.

Fig. 1.1 shows the variation of the velocity of the rocket with time for the first 20 s after its launch.

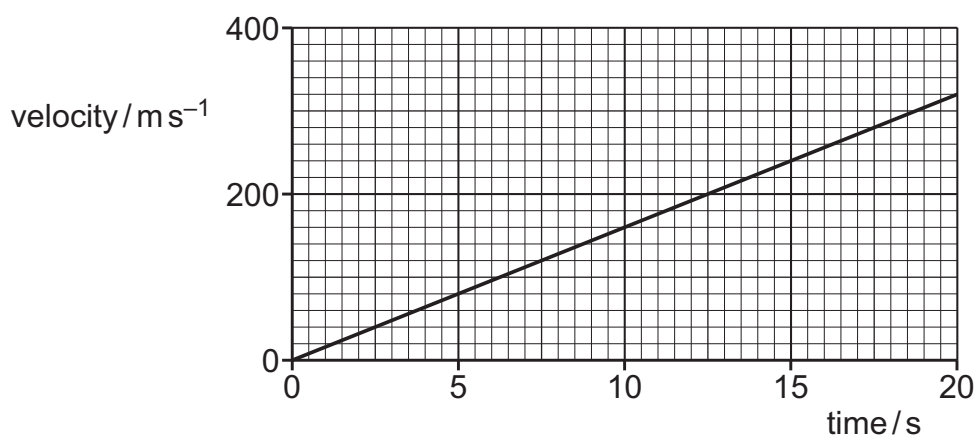


Fig. 1.1

(i) Determine the acceleration of the rocket.

acceleration = .....  $\text{ms}^{-2}$  [1]

(ii) Show that the height of the rocket above the surface of the Earth at a time of 20 s after launch is 3.2 km.

[2]

(c) The mass of the rocket in (b) is  $2.9 \times 10^6 \text{ kg}$ . Assume that this mass remains constant.

For this rocket, from launch to its height at a time of 20 s after launch:

(i) calculate the gain in gravitational potential energy  $\Delta E_p$

$\Delta E_p = \dots\dots\dots \text{ J}$  [2]

(ii) calculate the gain in kinetic energy  $\Delta E_k$

$\Delta E_k = \dots\dots\dots \text{ J}$  [2]

(iii) determine the average power output of the rocket engines. Assume that resistive forces are negligible.

power = .....  $\text{ W}$  [2]

[Total: 10]