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.

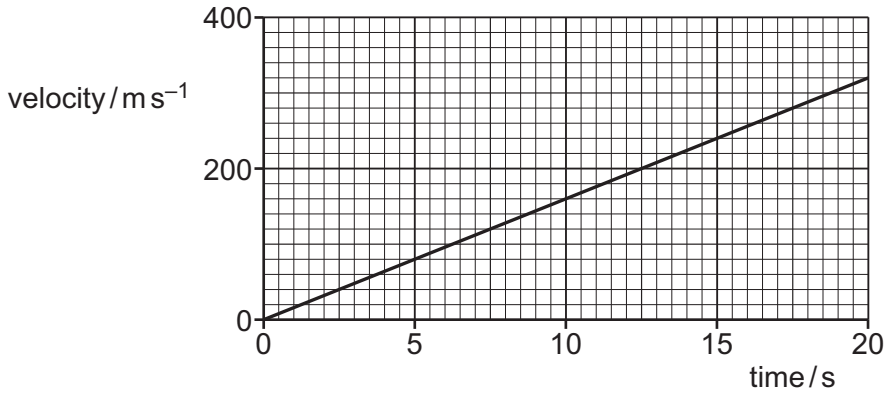

Fig. 1.1

(i) Determine the acceleration of the rocket.

acceleration = ... $m\,s^{-2}$ [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 2.9×10^6 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 ΔE_P

ΔE_P = ... J [2]

(ii) calculate the gain in kinetic energy ΔE_K

ΔE_K = ... J [2]

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

power = ... W [2]

[Total: 10]