

**State Examination Commission – Physics Higher Level, 2008**

**Question 12a**

State the principle of conservation of energy. (4)

In a pole-vaulting competition an athlete, whose centre of gravity is 1.1 m above the ground, sprints from rest and reaches a maximum velocity of  $9.2 \text{ m s}^{-1}$  after 3.0 seconds. He maintains this velocity for 2.0 seconds before jumping. Draw a velocity-time graph to illustrate the athlete's horizontal motion.

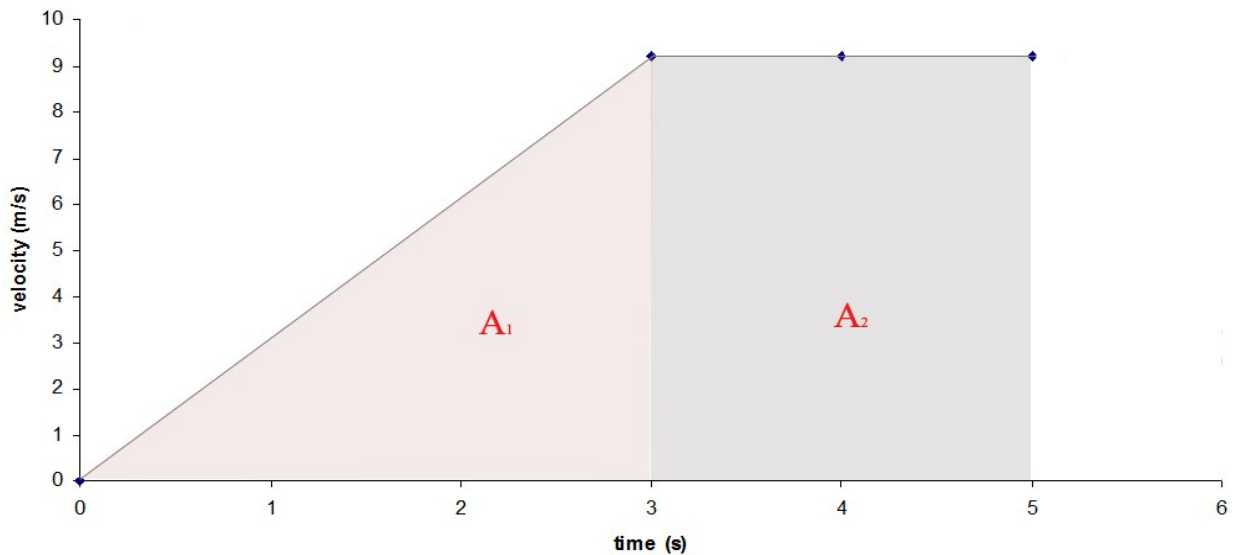


Use your graph to calculate the distance travelled by the athlete before jumping. (12)

What is the maximum height above the ground that the athlete can raise his centre of gravity? (12)  
(acceleration due to gravity =  $9.8 \text{ m s}^{-2}$ )

State the principle of conservation of energy. (4)

basic statement



In a pole-vaulting competition an athlete, whose centre of gravity is 1.1 m above the ground, sprints from rest and reaches a maximum velocity of  $9.2 \text{ m s}^{-1}$  after 3.0 seconds. He maintains this velocity for 2.0 seconds before jumping. Draw a velocity-time graph to illustrate the athlete's horizontal motion. Use your graph to calculate the distance travelled by the athlete before jumping. (12)

$$\begin{aligned}
 \text{Distance travelled} &= \text{area under graph} \\
 &= A_1 + A_2 \\
 &= \frac{1}{2}(3)(9.2) + 2(9.2) \\
 &= 32.2 \text{ m}
 \end{aligned}$$

What is the maximum height above the ground that the athlete can raise his centre of gravity? (12)

Supposing the athlete converts all his kinetic energy into potential energy, then

$$\begin{aligned}
 \frac{1}{2}mv^2 &= mgh \\
 \Rightarrow h &= \frac{v^2}{2g} = \frac{(9.2)^2}{19.6} \\
 &= 4.3 \text{ m}
 \end{aligned}$$

Therefore, max height above ground =  $4.3 + 1.1 = 5.4 \text{ m}$