Dinosaurs Exercise 2.

How fast could a dinosaur run?

Need: Pen, paper, calculator

Background:
Dinosaurs usually walked on their toes. The scientific term for this is "digitigrade". Other animals that are digitigrade include dogs, cat, and chickens. Humans, bears, and crocodiles walk differently; they are "plantigrade", which means "flat-footed".

Some dinosaurs moved around on four legs (quadrupeds), and some on two legs (bipeds). Others may have run on two legs but walked and grazed on four legs. Some dinosaurs were slow moving and others were fast; all depending on their anatomy. A few of the late, bird-like dinosaurs may have used their short, feathered arms to help speed up their running and perhaps glide from trees to the ground. When running, dinosaurs probably used their tails for balance and some may have used their tails for quickly shifting their balance in quick turns, like a cheetah or kangaroo does today.

How do we know all of this? From footprints!!

Footprints can tell you a lot about the animal that made them. Footprints can give you information about:
- The structure of the animal's foot. For example, how many toes it had, which toes supported the majority of the weight, if there were pads of soft tissue cushioning the feet and if the animal was digitigrade or plantigrade.
- How the animal walked, for example on two legs (bipedal) or four (quadruped).
- How fast the animal moved using the distance between the footprints and the animals leg length….

So…..

How fast did dinosaurs move?

Paleontologists can work out approximate dinosaur speeds by using fossilized footprints and the strudture of the dinosaur's skeleton. In 1976, the British zoologist R. McNeill Alexander used elephants, birds, humans and other animals to derive an equation relating an animal's speed to it's leg length and stride length.

To solve for speed the equation is:

Speed (m/sec)= $0.25 \times$ (stride length)$^{1.67} \times$ (leg length)$^{-1.17} \times$ (gravitational constant)$^{0.5}$

The gravitational constant is 9.8 m/sec^2.
Leg length is estimated using Alexander's equations relating hip height to the length of the part of the foot that hits the ground. This is necessary because it is very difficult to determine which dinosaur made a set of tracks.

Exercise:

The Alexander equation can be rewritten:

$$u = 0.25g^{0.5}l^{1.67}h^{-1.17}$$

which simplifies roughly to:

$$u = 1.4(l/h) - 0.27.$$

Using the simplified formula, calculate running speeds of the 11 dinosaurs listed in metres per second. Which was the fastest and which was the slowest? Would you expect running speed to relate to the size of the dinosaurs – compare calculated speeds with body weights and see if there is any relationship.

	Stride length, l (m)	Hip height, h (m)	Weight (tonnes)
THEROPODA			
Tyrannosaurus	3.0	2.1	6
Allosaurus (1)	3.0	2.0	2
Allosaurus (2)	2.4	1.0	2
Megalosaurus	1.3	1.1	1.2
ornithomimid (1)	1.9	1.2	0.15
ornithomimid (2)	3.2	1.9	0.15
PROSAUROPODA			
Anchisaurus (1)	1.8	1.1	0.5
Anchisaurus (2)	1.5	0.6	0.5
SAUROPODA			
Apatosaurus (1)	2.5	3.0	28
Apatosaurus (2)	1.6	1.5	28
ORNITHOPODA			
hadrosaur	4.2	3.4	11

Reference:
Alexander, R.M., 1976, *Estimates of speeds of dinosaurs*, Nature 261: 129-130