PART B - BIOPHYSICS

(Assume acceleration due to gravity g = 10Nkg^{-1} where necessary unless otherwise stated)

Answer in a separate booklet.

01. a) A man racing his son has half the kintic energy of the son, who has half the mass of the father. The man speeds up by 1.0ms^{-1} and then has the same kinetic enrgy as the son. What were the original speeds of man and son?

b) A 68kg sky diver fills at a constant terminal speed 59 ms^{-1}.
   i. At what rate is the gravitational potential energy of the Earth-Sky diver system being reduced?
   ii. At what rate is mechanical energy being dissipated?

c) A human being can be electrocuted if a current as small as 50mA passes near the heart. An electrician working with sweaty hands makes good contact with the two conductor he is holding. If his resistance is 200 Ω, what might the total voltage be?

d) Estimate the muscle power of a 60kg spinter who can reach a speed of 10ms^{-1} in 2.5s.

e) Estimate the height gain of a pole vaulter running at a top speed of 10ms^{-1} before launch; how can the pole vaulter gain extra height.

02. a) The human ear is most sensitive at a frequency of 3000 Hz when it can just detect sound waves of intensity 10^{-12} Wm^{-2}. Calculate;
   i. the sound energy incident each second on an eardrum of area 20mm^2 at this intensity.
   ii. the wavelength of sound waves in air at 3kHz. Comment on this value for wavelength in relation to possible resonances in the tube (auditory tube) leading to the eardrum.
   Assume the speed of sound in air = 340ms^{-1}

b) By definition, the intensity level of 0dB is where the intensity is 10^{-12} Wm^{-2}. A decibel meter at a distance of 10m from a small source of sound gives a reading 70dB.
   i. What is the intensity of the sound waves at the meter?
   ii. What would be the dB reading on the meter at 30m from the source of sound?

c) When sound waves fall on the eardrum the drum vibrates in approximate simple harmonic motion transmitting vibrations to the bones of the middle ear. At a sound frequency of 3000 Hz for an amplitude of oscillation of the eardrum of 0.1μm,
Calculate;

i. the maximum speed of the eardrum,

ii. its maximum acceleration. Estimate the maximum pressure difference between the outer and middle ear (ie. Across the eardrum) given, the thickness x the density of the drum tissue is approximate 0.1 kgm^{-2}.

03. a) i. Explain what is meant by depth of field, illustrating your answer with a diagram.

ii. Accommodation is the ability of the eye to change its focal length. How does the eye do this and why does the ability to accommodate change with age.

b) A myopic person has a far point of 1.0 metre. Assume his eye lens retina distance to be 2cm. Use this information to calculate;

i. the minimum power of eye lens

ii. the total power for the (eye lens + correcting lens for myopia) required for the person's far point to be at infinity. And

iii. the power of the correcting lens.

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