Complete solutions to Intro(h)

1. An object with a velocity of $31 \text{ m/s}$ means it travels $31 \text{ m}$ in one second. First we convert $31 \text{ m}$ into $\text{km}$, how?

Divide by 1000:

$$31 \div 1000 = 0.031$$

So $31 \text{ m} = 0.031 \text{ km}$. Therefore the object covers $0.031 \text{ km}$ in one second. What distance does it cover in one hour?

Since $3600 \text{ s} = 1 \text{ hour}$, the object covers $0.031 \times 3600 = 111.6 \text{ km}$ in one hour. Hence

$$31 \text{ m/s} = 111.6 \text{ km/h}$$

2. Since acceleration is $32.174 \text{ feet/sec}^2$ we only need to express $32.174 \text{ feet}$ into metres. Since $1 \text{ foot} = 0.305 \text{ m}$ so

$$32.174 \times 0.305 = 9.813$$

$$32.174 \text{ feet/sec}^2 = 9.81 \text{ m/s}^2 \ (3 \text{ s.f.})$$

3. What does a sound velocity of $342 \text{ m/s}$ mean?

Sound travels a distance of $342 \text{ m}$ in one second. How many miles does it travel in 1 second?

Because $342 \text{ m} = 0.342 \text{ km}$ and $1 \text{ km} = 0.621 \text{ miles}$, so the number of miles in one second is:

$$0.621 \times 0.342 = 0.2124$$

Sound travels a distance of $0.2124 \text{ miles}$ in one second. How far does it travel in 1 hour?

Since there are $3600 \text{ seconds in 1 hour}$ so $0.2124 \times 3600 = 764.64$ Therefore sound velocity is 765 miles per hour.

4. The density $1206 \text{ kg/m}^3$ means $1\text{m}^3$ of air has a mass of $1.206 \text{ kg}$. What is the mass in grams?

There are $1000\text{g}$ in $1\text{kg}$ so we multiply by 1000:

$$1.206 \text{ kg} = 1.206 \times 1000 \text{ g} = 1206 \text{ g}$$

Air has a mass of $1206 \text{ g}$ for $1\text{m}^3$. Next we write $1\text{cm}^3$ in terms of $\text{m}^3$:

$$1 \text{ cm}^3 = 1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm} = 0.01 \text{ m} \times 0.01 \text{ m} \times 0.01 \text{ m}$$

$$= 1 \times 10^{-6} \text{ m}^3$$

$1206 \text{ g/ m}^3$ in $\text{g/cm}^3$ is:

$$1206 \times 1 \times 10^{-6} = 1206 \times 10^{-6}$$

$$= 1.206 \times 10^3 \times 10^{-6}$$

$$= \frac{1.206 \times 10^3}{10^6}$$

$$= \frac{1.206}{10^3}$$

$$= 1.206 \times 10^{-3}$$

Thus

$$1.206 \text{ kg/m}^3 = 1.206 \times 10^{-3} \text{ g/cm}^3 \ (4 \text{ s.f.})$$

5. First we express $1\text{cm}^4$ in terms of $\text{m}^4$:
1cm$^4 = 1cm \times 1cm \times 1cm \times 1cm$

$= 0.01m \times 0.01m \times 0.01m \times 0.01m$

$= 1 \times 10^{-8} m^4$

$0.63cm^4 = 0.63 \times 1 \times 10^{-8} m^4$

$= 6.3 \times 10^{-1} \times 10^{-8} m^4$

$= 6.3 \times 10^{-9} m^4$

$0.63cm^4 = 6.3nm^4 \quad (n = nano = 10^{-9})$

6. We first write 1 foot$^2$ into m$^2$, how?

Since 1 foot = 0.305 m

$1 \text{foot}^2 = 1 \text{foot} \times 1 \text{foot} = 0.305m \times 0.305m$

$= 0.093025 m^2$

$5 \text{feet}^2 = 5 \times 0.093025 m^2$

$= 0.465 m^2 \quad (3 \text{ s.f.})$

7. (a) First we write 30 miles in terms of metres(m), how?

Since 1 mile = 1.609 km we have

$30 \text{ miles} = 30 \times 1.609 \text{ km} = 48.27 \text{ km} = 48270 \text{ m}$

Therefore 30 miles per hour = 48270 metres per hour. Since we want m/s we have to divide by 3600 s (=1 hour):

$\frac{48270}{3600} = 13.4$

30 miles per hour = 13.4 m/s (3 s.f.)

(b) \(80 km/h = \frac{80 \times 1000}{3600} m/s = 22.22 m/s \) (2 d.p.)

(c) 186000 miles per second $= 186000 \times 1.609 \text{ km/s}$

$= 299 274 \text{ km/s}$

$= 299 274 \times 1000 \text{ m/s}$

$= 299 274 000 \text{ m/s}$

$= 2.99 \times 10^8 \text{ m/s} \quad (3 \text{ s.f.})$

8. Elasticity is $0.2 \times 10^{11} N$ over an area of 1m$^2$. How do we convert 1m$^2$ into cm$^2$?

Using 1m = 100cm we have

$1 \text{m}^2 = 1m \times 1m = 100cm \times 100cm$

$= 1 \times 10^4 \text{cm}^2$

Thus

$0.2 \times 10^{11} \text{ N/m}^2 = \left(0.2 \times 10^{11}/1 \times 10^4\right) \text{N/cm}^2$

$= \left(0.2 \times 10^{11}/10^4\right) \text{N/cm}^2$

$= 2 \times 10^6 \text{ N/cm}^2$