Oxford Physics Course Companion

Unofficial suggested solutions

By **Noël M. Nimstad** and **Mzhahid Sibai**

Contents

1 Topic A – Space, time and motion

1.1 Subtopic A.1 – Kinematics

A1:P11 Question 1

a) The total distance is given as the sum of distance traveled during each translation, $2.5 + 3.8 = 6.3\,[\mathrm{km}]$

b) Displacement is a vector quantity, thus taking the magnitude of the sum of the two vector displacements caused by the movement:

$$\left\| \begin{pmatrix} 2.5 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ 3.8 \end{pmatrix} \right\| = \left\| \begin{pmatrix} 2.5 \\ 3.8 \end{pmatrix} \right\|$$
$$= \sqrt{2.5^2 + 3.8^2} \approx \boxed{4.55\,[\mathrm{km}]}$$

c) Since this can be scenario can be set up as a right angle triangle, with the boat as the hypothesis' outer vertex, using trigenometry the angle can is determined as:

$$\tan\theta = \frac{o}{a} \rightsquigarrow \theta = \tan^{-1}\frac{2.5}{3.8} \approx 33.3^\circ$$

A1:P11 Question 2

a) 15 minutes corresponds to a 90 degree ($\frac{\pi}{2}\,[\mathrm{rad}]$) rotation on a clock, or one quarter of its perimeter. Therefore the distance travelled by the tip of the pointer must be:

$$s = \frac{2\pi r}{4} = \frac{15\pi}{2} \approx 23.6\,[\mathrm{cm}]$$

The displacement however is the distance between the points $\langle 0\,,15\rangle$ and $\langle 15\,,0\rangle$, thus using Pythagora's theorem[a]:

$$s = \sqrt{15^2 + 15^2} = \sqrt{450} = 21.2\,[\mathrm{cm}]$$

b) Analagously to question a but for the 180 degrees ($\pi\,[\mathrm{rad}]$) rotation resulting from 30 elapsed minutes:

$$s_{\text{distance}} = \frac{2\pi r}{2} = 15\pi \approx 47.1\,[\mathrm{cm}]$$
$$s_{\text{displacement}} = \sqrt{0^2 + 30^2} = 30\,[\mathrm{cm}]$$

A1:P12 Question 3

Since they are headed in completley oposite directions, $s_{\text{Ada}} + s_{\text{Matt}} = 580\,[\mathrm{m}]$. Ada's speed of 20 $[\mathrm{km\,h^{-1}}]$

is approximately $5.56\,[\mathrm{m\,s^{-1}}]$ Since $s = \int v\,\mathrm{d}t$:

$$v_{\text{Ada}}t + v_{\text{Matt}}t = 580$$

$$5.56 \times 60 + v_{\text{Matt}} \times 60 = 580$$

$$\therefore v_{\text{Matt}} \approx 4.11\,[\mathrm{m\,s^{-1}}] \equiv \boxed{14.8\,[\mathrm{km\,h^{-1}}]}$$

A1:P12 Question 4

$$1\,[\mathrm{ly}]$$

[a] $a^2 + b^2 = c^2$

2 Topic B – The particulate nature of matter

2.1 Subtopic B.1 – Thermal energy transfers