Chapter 4 Exercise 4A

Q. 1. (i) $\overrightarrow{v_{BA}} = 30\vec{i} - 25\vec{i}$

$= 5\vec{i}$ m/s

(ii) $\frac{1{,}000}{5} = 200$ s

Q. 2. (i) $\overrightarrow{v_A} = 4\vec{i}$

$\overrightarrow{v_B} = 7\vec{i}$

$\overrightarrow{v_{BA}} = \overrightarrow{v_B} - \overrightarrow{v_A} = 7\vec{i} - 4\vec{i} = 3\vec{i}$ m/s

(ii) Relative distance = relative speed × time $= 3 \times 60$

$= 180$ m

(iii) Time $= \frac{\text{relative distance}}{\text{relative speed}}$

$= \frac{600}{3}$

$= 200$ s

Q. 3. (i) $\overrightarrow{v_c} = 10\vec{i}$ m/s

(ii) $\overrightarrow{v_L} = -15\vec{i}$ m/s

$\therefore \overrightarrow{v_{CL}} = 10\vec{i} - (-15\vec{i}) = 25\vec{i}$ m/s

(iii) $\frac{500}{25} = 20$ s

Q. 4. (i) $\overrightarrow{v_g} = 1.2\vec{i}$ m/s

(ii) $\overrightarrow{v_b} = -1.3\vec{i}$ m/s

$\overrightarrow{v_{gb}} = \overrightarrow{v_g} - \overrightarrow{v_b}$

$= 1.2\vec{i} - (-1.3\vec{i})$

$= 1.2\vec{i} + 1.3\vec{i} = 2.5\vec{i}$ m/s

(iii) Time $= \frac{\text{relative distance}}{\text{relative speed}}$

$= \frac{250}{2.5}$

$= 100$ s

Q. 5. (i) $\overrightarrow{v_{pq}} = \overrightarrow{v_p} - \overrightarrow{v_q}$

$= (5\vec{i} + 2\vec{j}) - (2\vec{i} - 2\vec{j})$

$= 3\vec{i} + 4\vec{j}$ km/h

(ii) $|\overrightarrow{v_{pq}}| = \sqrt{3^2 + 4^2}$

$= 5$ km/h

(iii) $\frac{20}{5} = 4$ hours

Q. 6. (i) $\overrightarrow{v_{AB}} = (4\vec{i} - 3\vec{j}) - (6\vec{i} - \vec{j})$

$= -2\vec{i} - 2\vec{j}$ m/s

$|\overrightarrow{v_{AB}}| = \sqrt{4 + 4} = \sqrt{8}$ m/s

Direction = SW

(ii) $\overrightarrow{v_{CB}} = 8\vec{i} - (6\vec{i} - \vec{j})$

$= 2\vec{i} + \vec{j}$ m/s

$|\overrightarrow{v_{CB}}| = \sqrt{4 + 1} = \sqrt{5}$ m/s

$\tan\theta = \frac{1}{2} \Rightarrow \theta = 26° 34'$

Direction: E 26° 34′N

Q. 7. $\overrightarrow{r_{BA}} = (-3\vec{i} + 6\vec{j}) - (4\vec{i} + 2\vec{j}) = -7\vec{i} + 4\vec{j}$

$\overrightarrow{r_{CA}} = (-4\vec{i} + 2\vec{j}) - (4\vec{i} + 2\vec{j}) = -8\vec{i}$

$|\overrightarrow{r_{BA}}| = \sqrt{49 + 16} = \sqrt{65}$

$|\overrightarrow{r_{CA}}| = \sqrt{64} = 8$

Since $|\overrightarrow{r_{BA}}| > |\overrightarrow{r_{CA}}|$, B is farther

Q. 8. (i) $\overrightarrow{r_{QP}} = (-4\vec{i} + \vec{j}) - (\vec{i} - 2\vec{j})$

$= -5\vec{i} + 3\vec{j}$

(ii) Let $\overrightarrow{r_T} = a\vec{i} + b\vec{j}$

$\overrightarrow{r_{TS}} = \overrightarrow{r_{QP}}$

$(a + 3)\vec{i} + (b - 5)\vec{j} = -5\vec{i} + 3\vec{j}$

$a + 3 = -5$ and $b - 5 = 3$

$a = -8$ and $b = 8$

$\therefore \overrightarrow{r_T} = -8\vec{i} + 8\vec{j}$

Q. 9. $\overrightarrow{v_{CT}} = \overrightarrow{v_C} - \overrightarrow{v_T} = 10\vec{i} + 6\vec{j} - 30\vec{j}$

$= 10\vec{i} - 24\vec{j}$

$|\overrightarrow{v_{CT}}| = \sqrt{100 + 576} = 26$ m/s

$\tan\theta = \frac{24}{10} = 2.4 \Rightarrow \theta = 67° 23'$

Direction: E 67° 23′S

Q. 10. $\overrightarrow{v_{QP}} = (-4\vec{i} + 2\vec{j}) - (6\vec{i} + 2\vec{j}) = 10\vec{i}$ m/s

Time $= \frac{100}{10} = 10$ s

Q. 11. (i) $\overrightarrow{v_A} = 4\vec{i} + 3\vec{j}$

$\overrightarrow{v_B} = -\vec{i} + 3\vec{j}$

$\overrightarrow{v_{BA}} = \overrightarrow{v_B} - \overrightarrow{v_A} = -\vec{i} + 3\vec{j} - (4\vec{i} + 3\vec{j})$

$= -5\vec{i}$ km/h

(ii) The position of B relative to A is $\overrightarrow{r_{BA}} = 40\vec{i}$ km

$\Rightarrow \overrightarrow{v_{BA}} = -\frac{1}{8}(\overrightarrow{r_{BA}})$

Since $\overrightarrow{v_{BA}} = -k(\overrightarrow{r_{BA}})$ where k is a positive constant, they must be on a collision course.