magnitude of the frictional force is $\mu_{\text{static}}\, m\, g = 0.4 \times 30\ \text{kg} \times 9.8\ \text{m s}^{-2} = 118\ \text{N}$. So, in order for the sledge to move we must have

$$2\, F \cos 30^\circ > 118\ \text{N}$$

The minimum force needed is 118 N / (2 cos 30°) = 68 N.

Q16 <u>G is correct</u>

Let the ship have mass m and choose the x-axis to point down the slipway. The component of the gravitational force down the slipway is then

$$F_x^{\text{grav}} = m\, g \sin 8^\circ.$$

Friction points up the slipway. If the ship is stationary, the frictional force has a maximum magnitude

$$F^{\text{max}} = \mu_{\text{static}}\, R$$

where $R = m\, g \cos 8^\circ$ is the magnitude of the reaction force preventing the ship from sinking into the slipway. If the ship is to slide down the slipway we must have

$$F_x^{\text{grav}} > \mu_{\text{static}}\, R$$

However, we have

$$\frac{F_x^{\text{grav}}}{\mu_{\text{static}}\, R} = \frac{mg \sin 8^\circ}{0.2 \times mg \cos 8^\circ}$$

$$= 0.7$$

Hence $F_x^{\text{grav}} = 0.7\, \mu_{\text{static}}\, R$. Since F_x^{grav} is not greater than $\mu_{\text{static}}\, R$, the ship will not slide.

Q17 <u>E is correct</u>

Treat the person as a projectile.

The trapeze artist is launched with the minimum speed required to reach the second trapeze. This is equivalent to saying that the horizontal range covered is the maximum possible for that launch speed. The appropriate formula is therefore the one for maximum range (Unit 2, p27), since the two trapezes are at the same height above the ground:

$$\begin{aligned}
\text{i.e. } R_{\text{max}} &= u^2/g \\
\text{or } u_{\text{min}} &= \sqrt{R\, g} \\
&= \sqrt{7.4\ \text{m} \times 9.8\ \text{m s}^{-2}} \\
&\simeq 8.5\ \text{m s}^{-1}
\end{aligned}$$