1 **D** $x = at^2 + bt + c$

$c = -12$

2 **E**

$$v = \frac{dx}{dt} = 4t - 5$$

When $t = 0, v = -5 \text{ cm/s}$

3 **B** $a = \dfrac{dv}{dt} = 4$

When $t = 0, a = 4 \text{ cm/s}^2$

4 **B**

$$\begin{aligned} v &= 0 \\ 4t - 5 &= 0 \\ t &= \frac{5}{4} = 1.25 \text{ s} \end{aligned}$$

5 **C**

$$\begin{aligned} x &= 0 \\ 2t^2 - 5t - 12 &= 0 \\ (2t+3)(t-4) &= 0 \\ t &= 4 \text{ s} \end{aligned}$$

6 **C** $t = 3$

$$\begin{aligned} x &= 2 \times 3^2 - 5 \times 3 - 12 \\ &= -9 \text{ cm} \end{aligned}$$

7 **A**

$$\begin{aligned} \text{Average velocity} &= \frac{\text{change in position}}{\text{change in time}} \\ &= \frac{-9 - -12}{3} \\ &= 1 \text{ cm/s} \end{aligned}$$

8 **D** The direction of velocity changes at $t = 1.25$.

Position at $t = 1.25$

$$\begin{aligned} &= 2 \times 1.25^2 - 5 \times 1.25 - 12 \\ &= -15.125 \text{ cm} \end{aligned}$$

Distance travelled from $t = 0$ to $t = 1.25$

$$\begin{aligned} &= -12 - -15.125 \\ &= 3.125 \text{ cm} \end{aligned}$$

Distance travelled from $t = 1.25$ to $t = 3$

$$\begin{aligned} &= -9 - -15.125 \\ &= 6.125 \text{ cm} \end{aligned}$$

Distance travelled in the first 3 seconds

$$\begin{aligned} &= 3.125 + 6.125 \\ &= 9.25 \text{ cm} \end{aligned}$$

9 **C** $$\text{Average speed} = \frac{\text{distance travelled}}{\text{change in time}} = \frac{9.25}{3} = 3\frac{1}{12}\ \text{cm/s}$$

10 **B** $$v = u + at = 15 - 10 \times 3 = -15\ \text{cm/s}$$

11 **D** $$v = u + at$$
$$0 = 15 - 10t$$
$$f = \frac{15}{10} = 1.5\ \text{s}$$

12 **D** Maximum height occurs when $v = 0$, i.e. when $t = 1.5$ s

$$s = ut + \frac{1}{2}at^2 = 15 \times 1.5 - \frac{1}{2} \times 10 \times 1.5^2 = 11.25\ \text{m}$$

13 **C** $$s = ut + \frac{1}{2}at^2$$
$$0 = 15t - 5t^2$$
$$5t(t - 3) = 0$$

After 3 s, since $t = 0$ is the initial projection.

14 **E** $$\text{Distance} = \text{area of trapezium} = \frac{1}{2} \times (14 + 6) \times 20 = 200\ \text{m}$$

15 **D** For constant acceleration,

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{change in time}} = \frac{20}{5} = 4\ \text{m/s}^2$$

16 **A** Resolve perpendicular to F_2.

The angle between F_1 and F_2 extended back is $100 + 120 - 180 = 40°$.

$$F_1 \sin 40° - 8 \sin 60° = 0$$
$$F_1 = \frac{8 \sin 60°}{\sin 40°} \approx 10.78\ \text{kg wt}$$

17 **D** Resolve perpendicular to F_1.

The angle between F_2 and F_1 extended back is $100 + 120 - 180 = 40°$.

The angle between the 8 kg wt force and F_1 extended back is $120 - 40 = 80°$.

$$F_2 \sin 40° - 8 \sin 80° = 0$$
$$F_2 = \frac{8 \sin 80°}{\sin 40°}$$

≈ 12.26 kg wt

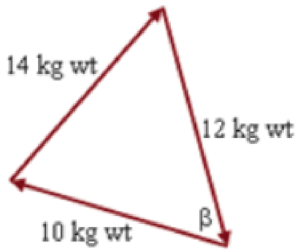
18 **B** Resolve perpendicular to the plane.

$$N - 10\cos 25^\circ = 0$$
$$N = 10\cos 25^\circ$$
$$\approx 9.06 \text{ kg wt}$$

19 **A** Resolve parallel to the plane.

$$F - 10\sin 25^\circ = 0$$
$$F = 10\sin 25^\circ$$
$$\approx 4.23 \text{ kg wt}$$

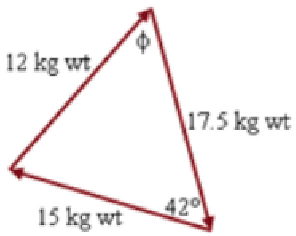
20 **C** Draw the triangle of forces. $\beta = 180^\circ - \alpha$



Use the cosine rule to find β.

$$\cos\beta = \frac{12^2 + 10^2 - 14^2}{2 \times 12 \times 10}$$
$$= 0.2$$
$$\beta \approx 78^\circ$$
$$\alpha \approx 180 - 78 = 102^\circ$$

21 **C** Draw the triangle of forces. $\phi = 180^\circ - \theta$



Use the cosine rule to find ϕ.

$$\cos\phi = \frac{12^2 + 17.5^2 - 15^2}{2 \times 12 \times 17.5}$$
$$= 0.536$$
$$\phi \approx 57^\circ$$
$$\theta \approx 180 - 57 = 122^\circ$$

22 **E** $60\cos 30^\circ \approx 51.96$ kg wt

23 **B** $60\sin 30^\circ = 30$ kg wt