Dynamics - 2018

1. 9702/11/M/J/18/No.8

   The momentum of a car of mass m increases from p_1 to p_2.
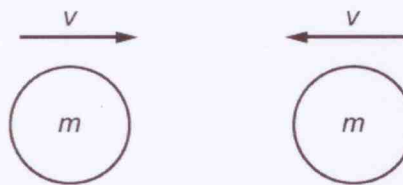
   What is the increase in the kinetic energy of the car?

   (A) $\dfrac{(p_2{}^2 - p_1{}^2)}{2m}$ **B** $\dfrac{(p_2 - p_1)^2}{2m}$ **C** $\dfrac{p_2 - p_1}{2m}$ **D** $\dfrac{p_1 - p_2}{2m}$

   $K \cdot E = \frac{1}{2} mv^2$

   $\Delta E_k = \frac{1}{2} mv^2 - \frac{1}{2} mu^2$

   $= \frac{1}{2} m (v^2 - u^2) \times \frac{m}{m}$

   $= \dfrac{m^2 (v^2 - u^2)}{2m}$

   $= \dfrac{m^2 v^2 - m^2 u^2}{2m}$

   $= \dfrac{p_2{}^2 - p_1{}^2}{2m}$

2. 9702/11/M/J/18/No.9

   Two similar spheres, each of mass m and travelling with speed v, are moving towards each other.

   The spheres have a head-on elastic collision.

   Which statement is correct?

   A The spheres stick together on impact.

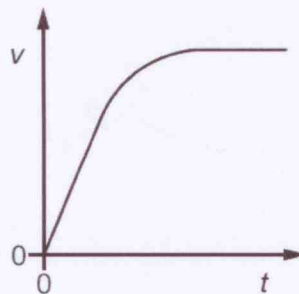   **B** The total kinetic energy after impact is mv^2.

   C The total kinetic energy before impact is zero.
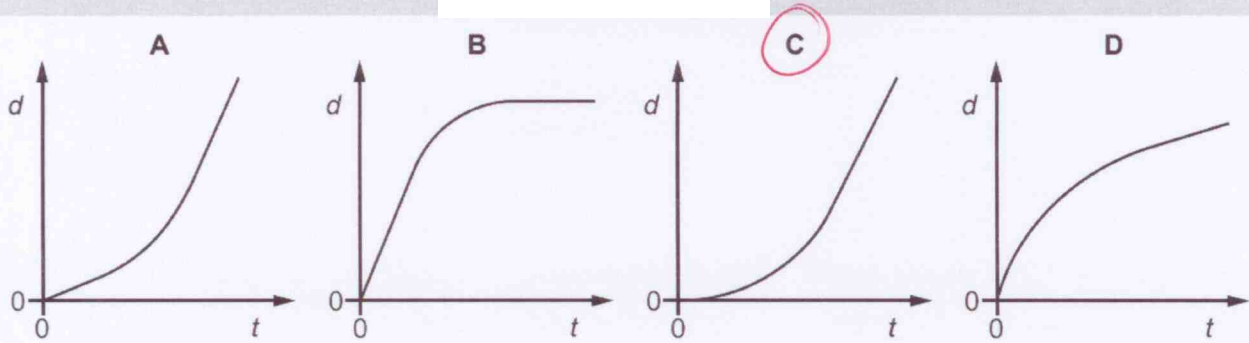
   D The total momentum before impact is $2mv$.

   $E_k = \frac{1}{2} mv^2 + \frac{1}{2} mv^2$

   $= mv^2$

3. 9702/12/M/J/18/No.7

   A sky-diver falls vertically from a helicopter and reaches constant (terminal) velocity. The graph shows the variation with time t of the speed v of the sky-diver.

   Which graph shows the variation with time t of the distance d fallen by the sky-diver?

	A		B		C		D

4. 9702/12/M/J/18/No.8

A tennis ball of mass 55g is travelling horizontally with a speed of $30\,ms^{-1}$. The ball makes contact with a wall before rebounding in the horizontal direction with a speed of $20\,ms^{-1}$. The ball is in contact with the wall for a time of $5.0 \times 10^{-3}\,s$.
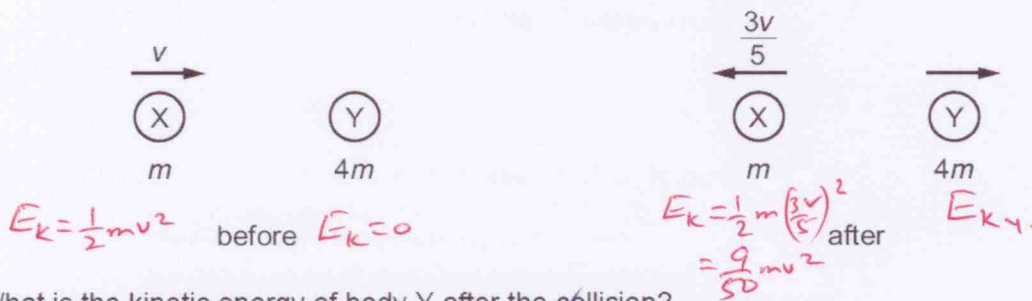
What is the average force exerted on the wall by the ball?

A   110N   B   220N   C   330N   D   550N

$$f = \frac{\Delta P}{\Delta t}$$

$$= \frac{-mv - mu}{\Delta t}$$

$$= \frac{0.05J(-20-30)}{5.0 \times 10^{-3}}$$

$$= 550N$$

5. 9702/12/M/J/18/No.9

An elastic collision occurs between two bodies X and Y. The mass of body X is m and the mass of body Y is $4m$. Body X travels at speed v before the collision and speed $\frac{3v}{5}$ in the opposite direction after the collision. Body Y is stationary before the collision.

$$\xrightarrow{v}$$
(X) m (Y) $4m$ $\xleftarrow{\frac{3v}{5}}$ (X) m (Y) $4m$

$E_k = \frac{1}{2}mv^2$ before $E_k = 0$ $E_k = \frac{1}{2}m\left(\frac{3v}{5}\right)^2$ after E_{ky}.

$$= \frac{9}{50}mv^2$$

What is the kinetic energy of body Y after the collision?

A $\frac{8}{10}mv^2$ B $\frac{34}{50}mv^2$ C $\frac{16}{50}mv^2$ D $\frac{1}{5}mv^2$

$$\frac{1}{2}mv^2 + 0 = \frac{9}{50}mv^2 + E_{ky}$$

$$E_{ky} = \left(\frac{1}{2} - \frac{9}{50}\right)mv^2$$

$$= \frac{16}{50}mv^2$$

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6. 9702/13/M/J/18/No.8

A sky-diver falls from a stationary balloon at time $t = 0$. As the sky-diver falls, her speed and the air resistance increase until the force of the air resistance is equal to her weight.
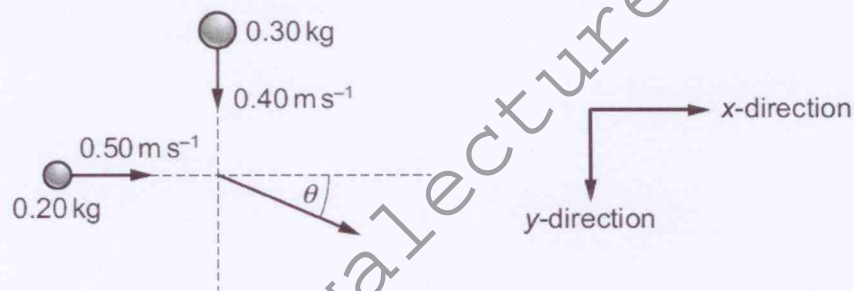
Which graph best shows the variation with time t of the displacement s for the motion of the sky-diver?
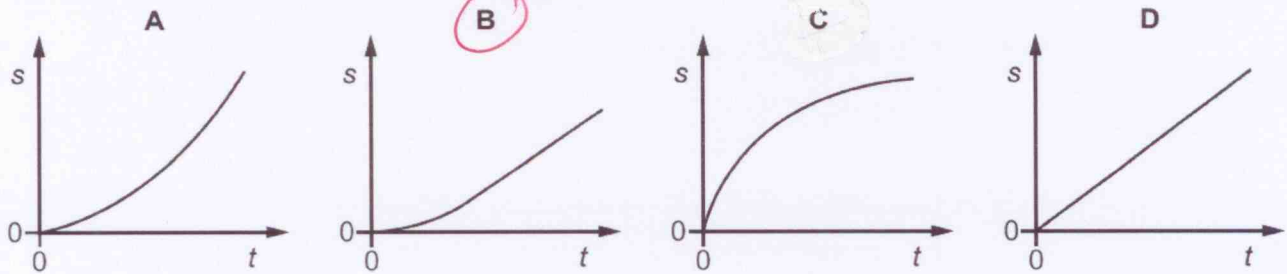
7. 9702/13/M/J/18/No.9

A ball of mass 0.20 kg, travelling in the x-direction at a speed of $0.50\,\text{ms}^{-1}$, collides with a ball of mass 0.30 kg travelling in the y-direction at a speed of $0.40\,\text{ms}^{-1}$.

The two balls stick together after the collision, travelling at an angle θ to the x-direction.

What is the value of θ?

A 39°   B 40°   C 50°   D 51°

Handwritten working:

before collision
p in x direction
$0.2 \times 0.5 = 0.1\,\text{kgms}^{-1}$
p in y direction
$0.3 \times 0.4 = 0.12\,\text{kgms}^{-1}$

after collision
p in x direction
$(0.2+0.3)v\cos\theta = 0.5v\cos\theta$
p in y direction
$(0.2+0.3)v\sin\theta = 0.5v\sin\theta$

$0.1 = 0.5v\cos\theta$
$v = \dfrac{0.2}{\cos\theta}$

$0.12 = 0.5v\sin\theta$
$v = \dfrac{0.24}{\sin\theta}$

$\dfrac{0.2}{\cos\theta} = \dfrac{0.24}{\sin\theta}$

$\dfrac{\sin\theta}{\cos\theta} = \dfrac{0.24}{0.2}$

$\dfrac{\sin\theta}{\cos\theta} = \tan\theta$

$\tan\theta = \dfrac{0.24}{0.2}$

$\tan\theta = 1.2$

$\theta = \tan^{-1}(1.2)$

$= 50.19°$

$\approx 50°$

8. 9702/12/F/M/18/No.10

Steel pellets, each with a mass of 0.60 g, fall vertically onto a horizontal plate at a rate of 100 pellets per minute. They strike the plate with a velocity of 5.0 m s^{-1} and rebound with a velocity of 4.0 m s^{-1}.

↑ change direction

What is the average force exerted on the plate by the pellets?

A 0.0010 N   B 0.0054 N   C 0.0090 N   D 0.54 N

$$F = \frac{mv - mu}{\Delta t}$$

$$= \frac{m(v - u)}{\Delta t}$$

$$= \frac{m(-4 - 5)}{\frac{60}{100} \, s}$$

$$= \frac{0.0006(-4 - 5)}{0.6}$$

$$= \frac{0.009 \, N \times 100}{100}$$

$$= 0.009 \, N$$

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