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 $\frac{(p_2^2 - p_1^2)}{2m}$ B $\frac{(p_2 - p_1)^2}{2m}$ C $\frac{p_2 - p_1}{2m}$ D $\frac{p_1 - p_2}{2m}$

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

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

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

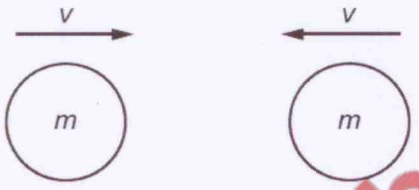
$= \frac{m^2(v^2 - u^2)}{2m}$

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

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

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.

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

$= mv^2$

Which statement is correct?

A The spheres stick together on impact.

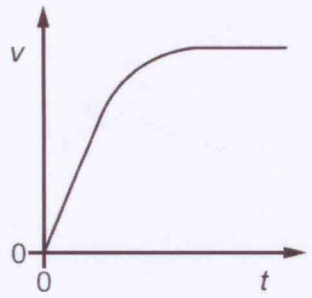
B The total kinetic energy after impact is mv^2.

C The total kinetic energy before impact is zero.

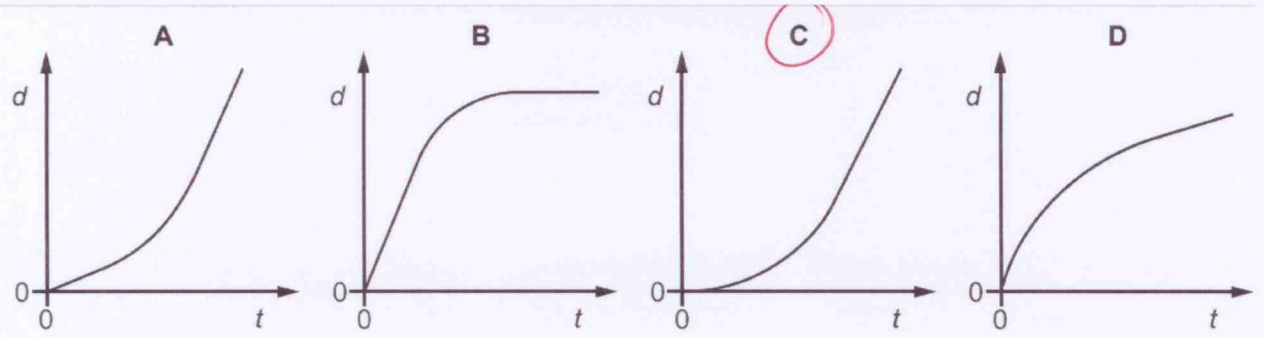
D The total momentum before impact is $2mv$.

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?



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

A tennis ball of mass 55 g is travelling horizontally with a speed of 30 m s^{-1}. The ball makes contact with a wall before rebounding in the horizontal direction with a speed of 20 m s^{-1}. The ball is in contact with the wall for a time of 5.0×10^{-3} s.

What is the average force exerted on the wall by the ball?

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

$F = \frac{\Delta p}{\Delta t}$

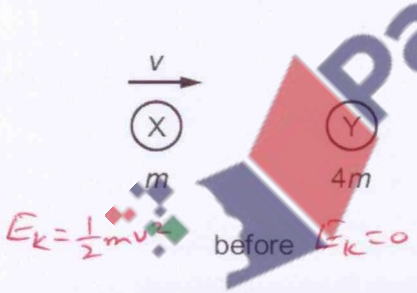
$= \frac{-mv - mu}{\Delta t}$

$= \frac{0.055(-20-30)}{5.0\times10^{-3}}$

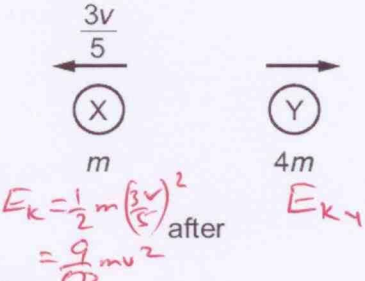
$= 550\,N$

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.



$E_K = \frac{1}{2}mv^2$ $E_K = 0$



$E_K = \frac{1}{2}m\left(\frac{3v}{5}\right)^2 = \frac{9}{50}mv^2$ E_{K4}

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** $\frac{1}{5}mv^2$

$\frac{1}{2}mv^2 + 0 = \frac{9}{50}mv^2 + E_{K4}$

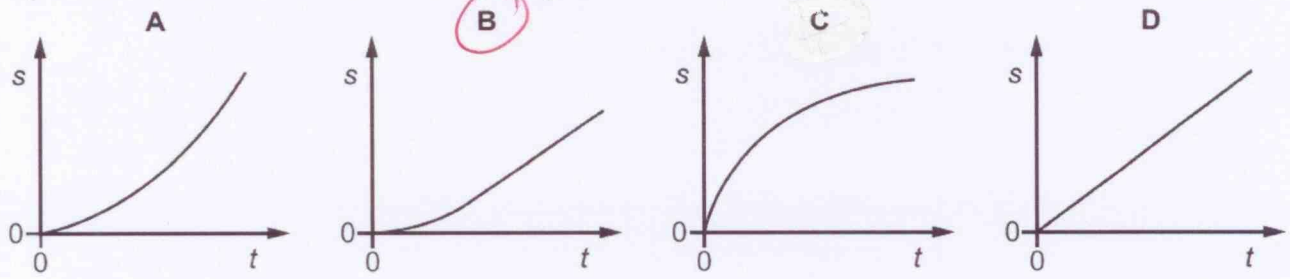
$E_{K4} = \left(\frac{1}{2} - \frac{9}{50}\right)mv^2$

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

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.

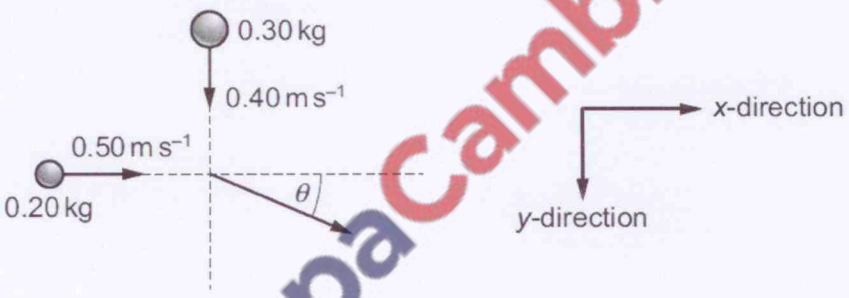
Which graph best shows the variation with time t of the displacement s for the motion of the sky-diver?



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 m s^{-1}, collides with a ball of mass 0.30 kg travelling in the y-direction at a speed of 0.40 m s^{-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°

before collision

p in x direction

$0.2 \times 0.5 = 0.1$ kg m s^{-1}

p in y direction

$0.3 \times 0.4 = 0.12$ kg m s^{-1}

after collision

p in x direction

$(0.2 + 0.3)v \cos\theta = 0.5v\cos\theta$

p in y direction

$(0.2 + 0.3)v \sin\theta = 0.5v\sin\theta$

$0.1 = 0.5v\cos\theta$

$v = \frac{0.2}{\cos\theta}$

$0.12 = 0.5v\sin\theta$

$v = \frac{0.24}{\sin\theta}$

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

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

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

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

$\tan\theta = 1.2$

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

$= 50.19^\circ$

$\simeq 50^\circ$

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

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

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

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

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

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

$= 0.009\ N$