Round 1

1. The buffers at the end of a railway line can stop a train which is travelling at $10\,\text{m/s}$ by being compressed through $10\,\text{cm}$. How many seconds does the uniform deceleration require?

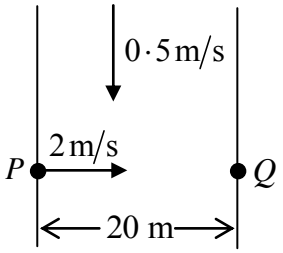
2. A basketball is thrown vertically upwards towards a hoop. The maximum height of the ball is $3{\cdot}3$ metres. If the ball was thrown at a height of $1{\cdot}5$ metres, calculate the velocity at which the ball was thrown. $\left[g = 10\,\text{m/s}^2 \right]$.

3. [Fictional story] The Government launched an investment account, SIS, into which a person may invest a maximum of €5,600 during any calendar year in order to earn a tax-free interest return of ten per cent. I invested €3,850 into that SIS on 3 January 2013. Due to problems with my car I was obliged to withdraw €2,000 on 3 March 2013. A rich uncle has just given me a birthday present of €5,000. How much of that windfall may I invest into the generous savings scheme before 31 December 2013?

Round 2

1. A ship is positioned at the point $\left(10\vec{i}+30\vec{j}\right)$. Twenty-three seconds later it is at the point $\left(56\vec{i}+122\vec{j}\right)$. If the ship is travelling at a constant speed, find that speed. Give your answer correct to one place of decimals.

2. A river is $20\,\text{m}$ wide. A girl can swim at $2\,\text{m/s}$ in still water. The current of the river flows at $0{\cdot}5\,\text{m/s}$ parallel to the banks.



The girl starts from the point P at right angles to the bank. Point Q is directly opposite to P. How far downstream from Q does the girl land?

3. A rectangle with area $125\ \text{cm}^2$ has sides in the ratio 4:5. What is the perimeter of the rectangle? Select one of the following:

A: 18 cm B: 22·5 cm C: 36 cm D: 45 cm E: 54 cm

Round 3

1. In a film a car is driven off a horizontal bridge at $15\,\text{m/s}$. The bridge is 40 m above the water. Calculate the horizontal distance travelled by the car when it hits the water. Give your answer to the nearest metre. $\left[g = 10\,\text{m/s}^2 \right]$.

2. A rocket is projected at an angle β to the horizontal where $\tan\beta = \frac{20}{21}$ at a speed of $58\,\text{m/s}$.
   There are two instances during its flight when the rocket is 75 m above the ground. Find the first of these two times. $\left[g = 10\,\text{m/s}^2 \right]$. Hint: Answer is a whole number.

3. Peri the Winkle starts at the origin and slithers anti-clockwise around a semi-circle with centre $(4,0)$. Peri then slides anti-clockwise around a second semi-circle with centre $(6,0)$ and finally around a third semi-circle with centre $(3,0)$. Where does Peri end this expedition?

   A: $(0,0)$ B: $(1,0)$ C: $(2,0)$ C: $(4,0)$

Round 4

1. An aircraft of mass 100 tonnes accelerates from $5\,\text{m/s}$ to $105\,\text{m/s}$ in 50 seconds. The resistance to motion is $75,000\,\text{N}$ and can be assumed constant. Determine the force produced by the engine. $[1\text{ tonnne} = 1000\text{ kg}]$.

2. A rope with a bucket attached is used to raise water from a well. The mass of the empty bucket is $1{\cdot}2\text{ kg}$ and it can raise 10 kg of water when full. Find the tension in the rope when the bucket is raised with an acceleration of $0{\cdot}3\,\text{m/s}^2$. $\left[g = 10\,\text{m/s}^2\right]$.

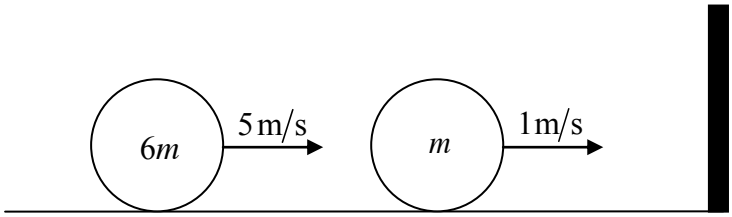
3. Mr. Slowcoach, a maths teacher, jogs to work every day. On Thursday he ran 10% faster than his usual average speed. As a result, his journey time was reduced by two minutes. How many minutes did the journey take on Wednesday?

   A: 22 B: 20 C: 18 D: 10

Round 5

1. A tennis ball of mass 50 grammes is rolled towards a cricket ball of mass 250 grammes. They collide directly and the coefficient of restitution for the event is $0{\cdot}4$. The initial speed of the tennis ball is $2\,\text{m/s}$ and that of the cricket ball is $1\,\text{m/s}$ in the opposite direction. Find the speed of the cricket ball after the collision.

2. A particle of mass m moving with speed $5\,\text{m/s}$ on a smooth horizontal plane collides directly with another particle of mass $6m$ moving with speed $1\,\text{m/s}$ in the same direction. After this collision the heavier particle strikes a vertical wall and rebounds. If the coefficient of restitution between the particles is $\frac{3}{4}$ and between the heavier particle and the wall is $\frac{1}{4}$, find the rebound speed of the heavier particle.



3. The number 3 can be expressed as the sum of one or more positive integers in four different ways:

   $3;\quad 1+2;\quad 2+1;\quad 1+1+1$

   In how many ways can the number 4 be so expressed?

   A: 5 B: 7 C: 8 D: 9

Round 6

1. Two smooth spheres of masses $4\,\text{kg}$ and $5\,\text{kg}$ collide obliquely. The coefficient of restitution for the for the collision is $0{\cdot}8$. Their velocities before the impact are $\left(2\vec{i}+5\vec{j}\right)\text{m/s}$ and $\left(-3\vec{i}-2\vec{j}\right)\text{m/s}$ respectively. The line of impact is along the $\vec{i}$ axis. Calculate the loss in kinetic energy due to the collision.

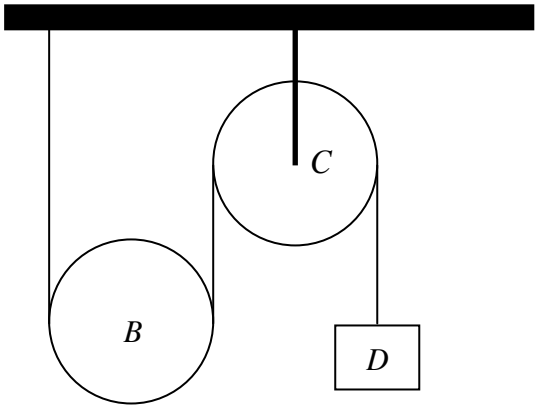
2. A car travelling at $50\,\text{m/s}$ has a constant retardation for 10 seconds followed by a constant acceleration for t seconds; the acceleration and retardation being each $2\,\text{m/s}^2$. Find t if the total distance travelled after $(10+t)$ seconds is the same as it would have been if the original speed had not changed. Give your answer to the nearest second.

3. According to one astronomer, there are one hundred thousand million galaxies in the universe, each containing one hundred thousand million stars. How many stars is this altogether.

   A: 10^{13} B: 10^{22} C: 10^{121} D: 10^{100}

Round 7

1. The diagram shows a light inelastic string with one end attached to the ceiling, passing over a heavy movable pulley B of mass $10\,\text{kg}$ and then over C, a fixed pulley attached to the ceiling. To the other end of the string is attached a particle D of mass $10\,\text{kg}$ hanging freely. Find the downward acceleration of D. $\left[g = 10\,\text{m/s}^2\right]$.



2. Two sailing boats, A and B, are each moving with constant velocity. At a certain instant B is $2\,\text{km}$ due south of A.
The speed and direction of B relative to A is $3\,\text{m/s}$ in the direction North $30°$ East.
Calculate the length of time, to the nearest minute, for which the two boats are less than or equal to $1{\cdot}5\,\text{km}$ apart.

3. Today is 20th March 2013. The Applied Maths exam is due on 21st June 2013. How many days remain for students to achieve their hard earned grade?
[exclude 20th March and 21st June].

Round 8

1. A particle is projected down a plane at $78\,\text{m/s}$. If the angle between the line of projection and the plane is $\tan^{-1}\left(\frac{5}{12}\right)$ and the plane is inclined at an angle of $60°$ to the horizontal, find the landing angle to the nearest degree. $\left[g = 10\,\text{m/s}^2\right]$.

2. A train is 264 metres long. If a girl was jogging at a constant speed in the same parallel direction as the constant velocity of the train then 15 seconds elapsed for the full length of the train to pass her.
If the girl was jogging in the opposite direction to the train then 9 seconds would elapse for the train to pass her. Calculate, to one place of decimals, the constant speed of the girl.

3. The price of my favourite soft drink has gone up by leaps and bounds over the past ten years. In four of those years it has jumped up by 5 cent each year, whilst in the other six years it has bounded up by 2 cent each year. The drink cost 70 cent in 2003. How much does it cost now?

   A: €0·77 B: €0·90 C: €0·92 D: €1·02 E: €1·05

Tie-Breakers

1. A block of mass 12 kg rests on the floor of a lift. If the reaction between the block and the floor is 18 N, find the downward acceleration of the lift. $\left[g = 10\,\text{m/s}^2 \right]$.

2. An insect is flying with a velocity of $\left(-0\cdot6\vec{i} - 0\cdot9\vec{j}\right)\text{m/s}$.
   Find its speed.
   Answer to two places of decimals.

3. A javelin is thrown at an angle of $40°$ above the horizontal with a speed of $30\,\text{m/s}$.
   Find the maximum height reached by the javelin.
   Answer to nearest metre.
   $\left[g = 10\,\text{m/s}^2 \right]$.

Answers

	Q1	Q2	Q3
Round 1	0·02 seconds	6 m/s	€1,750
Round 2	4·5 m/s	5 m	45 cm
Round 3	42 m	3 seconds	*C*
Round 4	275 kN or equivalent	115·36 N	*A*
Round 5	0·3 m/s	0·5 m/s	*C*
Round 6	10 J	24 seconds	*B*
Round 7	4 m/s^2	12 minutes	92
Round 8	10°	5·9 m/s	*D*
Tie-breakers	8·5 m/s^2	1·08 m/s	19 m