ROUND ONE

1. A learner driver passes a point at $10\,\text{m/s}$ and then begins to accelerate at $0{\cdot}8\,\text{m/s}^2$. Six seconds later she is breaking the speed limit in a $50\,\text{km/hr}$ speed limit zone. By how much is she in excess of the limit? (Answer to the nearest m/s).

2. A stone is projected vertically upwards with a velocity of $45\,\text{m/s}$ from a point $50\,\text{m}$ above the ground. Find how long is required for the stone to reach the ground. $\left(g = 10\,\text{m/s}^2\right)$.

3. A local pet shop sold only cats and canaries. In total, there were 72 pets, all in perfect condition. It these had a total of 200 legs, how many were canaries?

ROUND TWO

1. To a woman walking north at $3\,\text{m/s}$ a cyclist appears to have a velocity of $4\,\text{m/s}$ east.

   At what speed is the cyclist travelling?

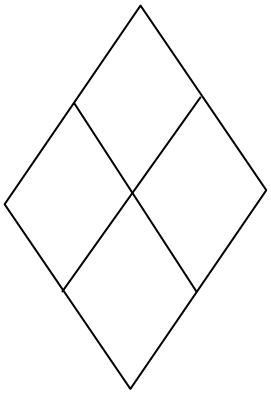
2. A river is $100\ \text{m}$ wide. A current of $\sqrt{11}\,\text{m/s}$ is flowing parallel to the banks.

   An oarsman crosses the river by the shortest route in 20 seconds.

   Calculate his rowing speed across the river.

3. How many quadrilaterals are there in this diagram, which is constructed using 6 straight lines?

   A: 4 B: 5 C: 7 D: 8 E: 9



ROUND THREE

1. A particle is projected with an initial velocity of $\left(24\vec{i}+10\,\vec{j}\right)\text{m/s}$.

   Find the range of the projectile. $\left[g=10\,\text{m/s}^2\right]$

2. A particle is dropped from an aeroplane, travelling horizontally at a constant speed of $70\,\text{m/s}$. The height of the aeroplane at the moment of the drop was $4{\cdot}5\,\text{km}$. Find the horizontal distance in metres travelled by the particle from the point it was dropped to the point it hit the ground.

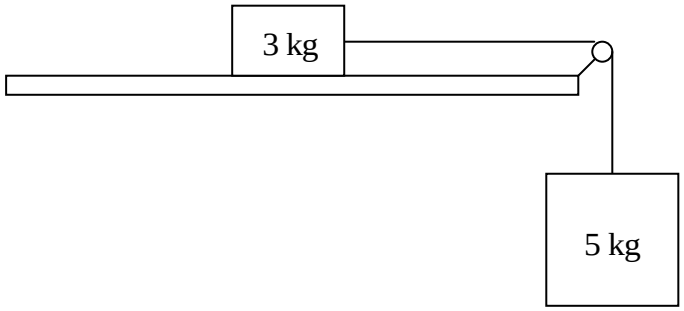
3. A passenger fell asleep on a train halfway to his destination. He slept till he had half as far to go as the distance he travelled while he slept. For what fraction of the whole trip was he asleep?

ROUND FOUR

1. A load of $5\,\text{kg}$ is lowered by a string and the acceleration of the load is 1m/s^2 downwards.

   Find the tension in the string. $\left[g = 10\,\text{m/s}^2 \right]$

2. A particle of mass $3\,\text{kg}$ rests on a smooth table and is connected by a light inextensible string which passes over a smooth light pulley to a $5\,\text{kg}$ mass hanging vertically. If the string is initially at rest and at right angles to the edge of the table, find the tension in the string. $\left[g = 10\,\text{m/s}^2 \right]$



3. A perfect number is one whose proper divisors add up to the number itself. [The number itself is not a proper divisor]. In 2013 a total of forty-eight perfect numbers had been discovered, the largest of which contains more than 3×10^7 digits. All perfect numbers are even. 'Six' $\left[3+2+1\right]$ is the lowest perfect number. What is the second lowest? [Hint: It lies between 17 and 31].

ROUND FIVE

1. Two particles of mass $5\,\text{kg}$ and $3\,\text{kg}$ are joined by a light inextensible string. The heavier mass is projected with a speed of $2\,\text{m/s}$ (away from the lighter mass). The lighter mass is initially at rest. Find the common speed of the two particles after the string becomes taut.

2. Three equal spheres A, B and C lie at rest on a smooth table. The coefficient of restitution between A and B is $0{\cdot}5$ and between B and C is $0{\cdot}4$.

   A is projected at $2\,\text{m/s}$ towards B which in turn collides with C. Find the speed of B after this second collision.

3. I have a bag of coins. In it, one third of the coins are gold, one fifth of them are silver, two sevenths are bronze and the rest are copper. My bag can hold a maximum of 200 coins. How many coins are in my bag?

   A: 101 B: 105 C: 153 D: 195

   E: more information is needed

ROUND SIX

1. Rory's house is $2{\cdot}9\,\text{km}$ from Halpin Crossroads on a straight rural road in Co. Monaghan. At 11.23 hours a motorcyclist passes the crossroads travelling at $30\,\text{m/s}$ and then 40 seconds later she decelerates at $1\,\text{m/s}^2$ coming to a stop at a lay-by in order to rest.

   At 11:24 hours Rory starts to drive his car from outside his house on the road towards Halpin's Cross. He accelerates at $0{\cdot}8\,\text{m/s}^2$ until he reaches a speed of $20\,\text{m/s}$ which he maintains has he passes the lay-by. For how many seconds is the motorcyclist at the lay-by until Rory passes?

2. Two particles, A and B, start initially from points with position vectors $4\vec{i}-7\vec{j}$ and $2\vec{i}+5\vec{j}$ respectively. The velocities of A and B are constant and equal to $-3\vec{i}+x\vec{j}$ and $2\vec{i}+4\vec{j}$.

   If the two particles are on a collision course, find the value of x.

3. Four buses leave the garage at the same time, on the same day. The first one returns to the garage every 16 hours, the second one every 12 hours, the third one every 8 hours and the fourth one every 4 hours.

   How long will it be before they all meet at the garage again?

ROUND SEVEN

1. Two smooth spheres of masses $3\,\text{kg}$ and $1\,\text{kg}$ collide obliquely, [collision along $\vec{i}-\text{axis}$].

   Their velocities before collision are $\left(a\vec{i}-3\vec{j}\right)\text{m/s}$ and $\left(-5\vec{i}+\vec{j}\right)\text{m/s}$ respectively. After the collision the heavier sphere moves in a direction perpendicular to the line of collision.

   The coefficient of restitution between the spheres is $\frac{1}{7}$.

   Find the value of a.

2. A plane is inclined at $45°$ to the horizontal. From a point on the plane a particle is projected down the plane at an angle P to the plane. If the initial speed of the particle is $20\sqrt{2}\,\text{m/s}$, find the value of P if the particle first hits the plane after $1{\cdot}5$ seconds. Answer to nearest degree. $\left[g=10\,\text{m/s}^2\right]$

3. Two entrants in a school's sponsored race adopt different tactics.

   Sean walks for had the time and then runs for the other half.

   Caoimhe walks for half the distance and then runs for the other half.

   Both competitors walk at $3\,\text{km/hr}$ and run at $6\,\text{km/hr}$.

   Sean takes 40 minutes to complete the course.

   How many minutes does Caoimhe take?

   A: 30 B: 35 C: 40 D: 45 E: 50

ROUND EIGHT

1. A wedge of mass $2\,\text{kg}$ rests on a smooth horizontal table with one of its plane faces inclined at $45°$ to the horizontal. The plane face is smooth and on it is placed a particle of mass $1\,\text{kg}$.

   The system is released from rest and the wedge accelerates at $2\,\text{m/s}^2$.

   Find the actual acceleration of the particle. [Answer to nearest m/s^2]. $\left[g = 10\,\text{m/s}^2 \right]$

2. A rocket stands on horizontal ground and is fired vertically from rest with a resultant acceleration of $5\,\text{m/s}^2$. After 70 seconds the engine of the rocket cuts out and the rocket moves freely under gravity. Find the greatest height above the ground reached by the rocket. $\left[g = 10\,\text{m/s}^2 \right]$.

3. A machine cracks open 180,000 eggs per hour. How many eggs is that per second?

   A: 5 B: 50 C: 500 D: 5000 E: 50,000

TIE-BREAKERS

1. A tennis ball of mass $40\,\text{g}$, travelling horizontally, hits a wall at $30\,\text{m/s}$ and rebounds along the same horizontal path at $20\,\text{m/s}$. Calculate the impulse imparted to the ball.

2. Bill walks $4\,\text{km}$ due West from O to A and then $5\,\text{km}$ in a north-east direction from A to B.

   Find the distance from B to O. Give your answer to one place of decimals.

3. A particle travels $17\,\text{m}$ in the third second of its motion and $29\,\text{m}$ in the sixth second of its motion.

   Assuming that the particle is accelerating uniformly, find the acceleration.

ANSWERS

	Question 1	**Question 2**	**Question 3**
Round 1	1 m/s	10 seconds	44
Round 2	5 m/s	6 m/s	E
Round 3	48 m	2100 m	A third of trip
Round 4	45 N	18·75 N	28
Round 5	1·25 m/s	0·45 m/s	B
Round 6	65 seconds	34	48 hours
Round 7	2	11°	D
Round 8	7 m/s^2	18·375 m	B
Tie-Breakers	2 N s	3·6 km	4 m/s^2