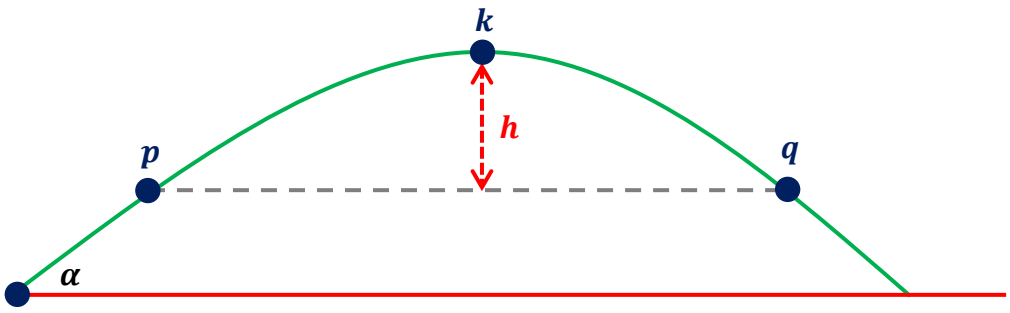
2017 NATIONAL APPLIED MATHS QUIZ – 11th MARCH 2017

ROUND 1 – 8 Minutes

Marks may be lost for omission of correct units

Q1 Sean is cycling **eastwards at** $\mathbf{8\ m\ s^{-1}}$ when he observes another cyclist, Orla, whose course relative to Sean is $\sqrt{\mathbf{80}}\ \mathbf{m\ s^{-1}}$ in a **northern** direction. In reality, Orla is moving **east** $\boldsymbol{\theta}°$ **north**. Calculate the value of $\boldsymbol{\theta}$, give your answer correct to **one decimal place**.

Q2 A particle of **unit mass** is projected with initial speed $\boldsymbol{u}$ at an angle $\boldsymbol{\alpha}$ to the horizontal and $\boldsymbol{k}$ is the point of its maximum height. The time for it to travel from $\boldsymbol{p}$ to $\boldsymbol{q}$ is **6 seconds**, where $\boldsymbol{pq}$ is a horizontal line. Calculate the loss in its potential energy as it drops through the vertical displacement $\boldsymbol{h}$. [**Use** $\boldsymbol{g} = \mathbf{10\ m\ s^{-2}}$]



Q3 Around the year **100 AD**, Nicomachus, a Greek philosopher, initiated the idea of what is now called, in number theory, abundant numbers. The integer **12** is the lowest abundant number, because the sum of its proper divisors **[1, 2, 3, 4, 6]** totalling **16** is **greater** than the number itself.
How **many abundant numbers** are there between **20** and **30** inclusive?

A: 0 **B: 1** **C: 2** **D: 3** **E: 4**

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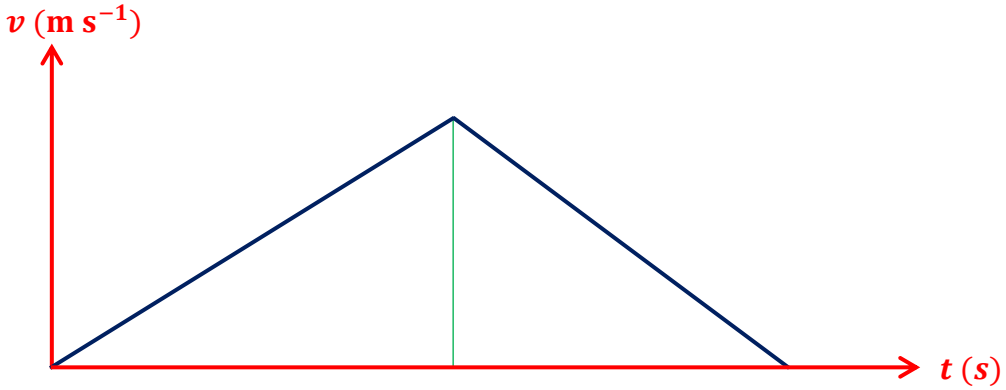
ROUND 2 – 8 Minutes

Marks may be lost for omission of correct units

Q1 A car of mass **600 kg** attains a maximum speed of **20 m s^{-1}** when travelling **down** an incline of $\sin^{-1}\left(\frac{1}{20}\right)$ with the **engine switched off**.
It can attain a maximum speed of **10 m s^{-1} up** the same incline when the **engine is working.**
The resistance to motion in each case is kv^2, where v is the speed at which the car is travelling.
Find the **Power, in kilowatts**, at which the engine is working. [**Use** $g = 10$ **m s^{-2}**]

Q2 Flaminio metro station in Rome (well known to some Irish rugby fans) is **4 · 5 kilometres** from metro La Spagna (famous Spanish Steps). A train starting at rest in Flaminio station accelerated at **0 · 5 m s^{-2}** and then immediately decelerates to rest at **0 · 625 m s^{-2}**, reaching La Spagna.
What is the maximum speed achieved by the train if the time for the journey is **3 minutes**?



Q3 Every day, Siobhan goes up an escalator on her way to work. If she stands still, it takes her **60 seconds** to travel from bottom to top. One day the escalator was out of order and so she had to walk up it and reached the top in a time of **90 seconds**.
How many seconds would it take her to travel up the escalator if she walked up at the same speed as before while the escalator was working as normal?

A: 30 **B: 32** **C: 36** **D: 75**

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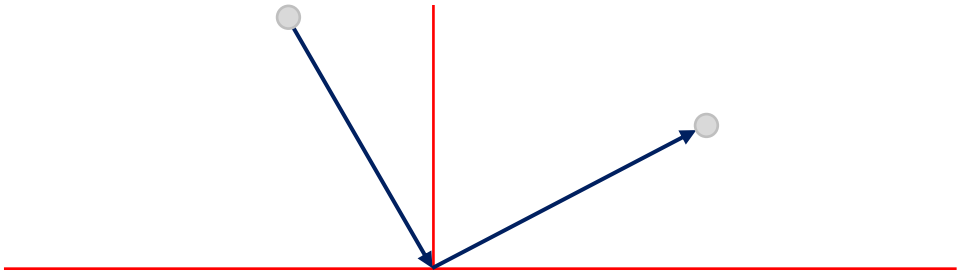
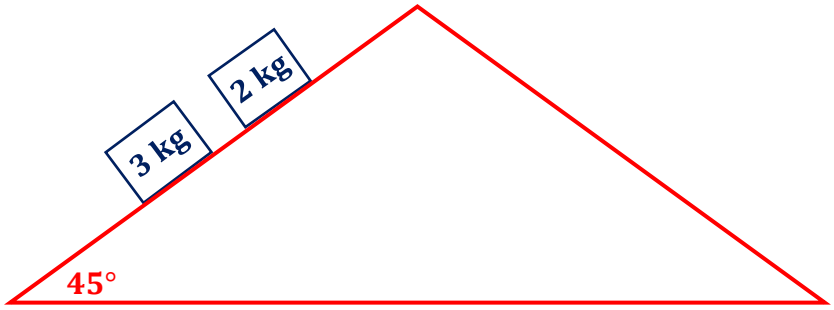
ROUND 3 – 8 Minutes

Marks may be lost for omission of correct units

Q1 Hailstones strike a frozen lake at an angle of **30°** to the **vertical** and they rebound at an angle of **60°** to the **vertical**.
Calculate the **coefficient of restitution** for the impact of the hailstones on the ice.



Q2 A wedge rests on a **smooth** horizontal table with one of its plane faces inclined at **45°** to the horizontal. This plane face is **smooth** and on it are placed particles of mass **3 kg** and **2 kg**.
When the system is released from rest, the wedge accelerates at **2 m s^{-2}**.
Find the **actual acceleration** of the **3 kg mass**, give your answer correct to **one decimal place.**



Q3 There friends make the following statements:
Brian says, "**Exactly one** of **David** and **Caoimhe** is **telling the truth**".
David says, "**Exactly one** of **Brian** and **Caoimhe** is **telling the truth**".
Caoimhe says, "**Neither Brian nor David is telling the truth**".
Which of the three friends is lying?

A: Just Brian **B: Just David** **C: Just Caoimhe** **D: All three of them**

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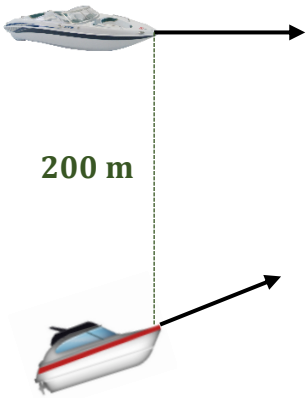
ROUND 4 – 8 Minutes

Marks may be lost for omission of correct units

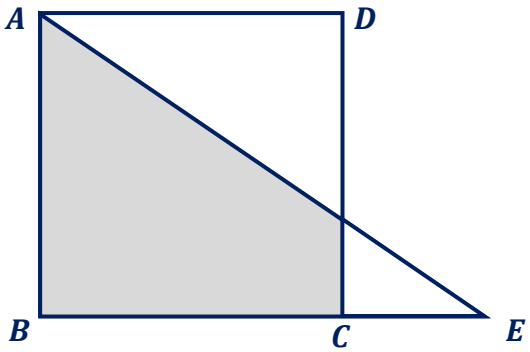
Q1 A balloon ascends vertically at a uniform speed. **Five seconds** after it leaves the ground, a particle is let fall from the balloon. The particle takes **eight seconds** to reach the ground. Calculate, **to one decimal place**, the **speed** at which the balloon is rising.
[**Use** $g = 10\ \text{m s}^{-2}$]

Q2 A speedboat, travelling **east** at $20\ \text{m s}^{-1}$ is **200 metres** due **north** of a motorboat which sets off trying to get as close as possible to the speedboat at a speed of $12\ \text{m s}^{-1}$. The motorboat cannot catch the speedboat, what is the closest distance the motorboat can achieve?



Q3 The diagram shows a square $ABCD$ and a right-angled triangle ABE. The length of BC is 3. The length of BE is 4. What is the area of the shaded region?

A: $\frac{21}{4}$ **B:** $\frac{43}{8}$ **C:** $\frac{11}{2}$ **D:** $\frac{45}{8}$



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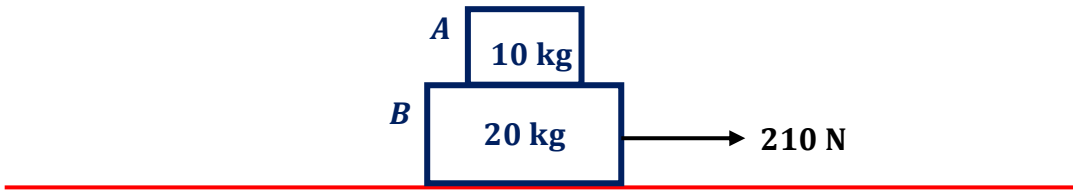
ROUND 5 – 8 Minutes

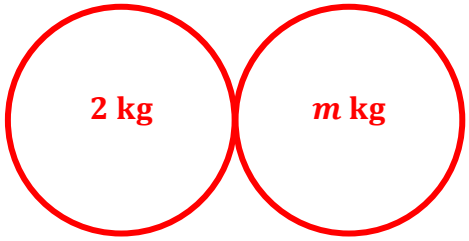
Marks may be lost for omission of correct units

Q1 Two blocks, $\boldsymbol{A}$ and $\boldsymbol{B}$, shown in the diagram are at rest on a **rough** horizontal surface. A force of $\mathbf{210\ N}$ is applied to Block $\boldsymbol{B}$, thus preventing $\boldsymbol{A}$ from slipping on $\boldsymbol{B}$. Blocks $\boldsymbol{A}$ and $\boldsymbol{B}$ have masses of $\mathbf{10\ kg}$ and $\mathbf{20\ kg}$ respectively. The coefficient of friction between the two blocks is $\mathbf{0 \cdot 5}$. Calculate the coefficient of friction between $\boldsymbol{B}$ and the horizontal surface. [**Use** $\boldsymbol{g = 10\ m\ s^{-2}}$]

Note: The force causing $\boldsymbol{A}$ to move is the **frictional force** between $\boldsymbol{A}$ and $\boldsymbol{B}$.



Q2 A smooth sphere of mass $\mathbf{2\ kg}$ collides obliquely with a stationary sphere of mass $\boldsymbol{m}\ \mathbf{kg}$. The **coefficient of restitution** between the spheres is $\frac{\mathbf{1}}{\mathbf{3}}$. **After the collision** the two spheres move at **right angles** to one another. Calculate the value of $\boldsymbol{m}$.



Q3 The number '$\boldsymbol{ba}$' is the two-digit number with units digit $\boldsymbol{a}$ and tens digit $\boldsymbol{b}$. The digits $\boldsymbol{a}$ and $\boldsymbol{b}$ are distinct(different) and non-zero. What is the largest possible value of $(\boldsymbol{ab - ba})$?

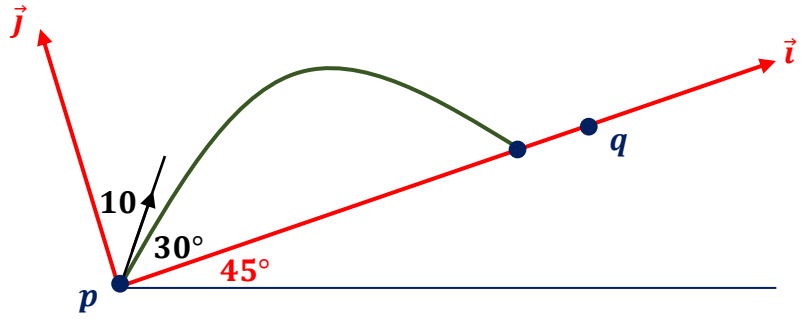
A: 81 **B: 72** **C: 63** **D: 54** **E: 68**

2017 NATIONAL APPLIED MATHS QUIZ – 11th MARCH 2017

ROUND 6 – 8 Minutes

Marks may be lost for omission of correct units

Q1 A plane is inclined at $\mathbf{45°}$ to the horizontal. A particle is projected up the plane with a speed of $\mathbf{10\ m\ s^{-1}}$ and at an angle of $\mathbf{30°}$ to the inclined plane from the point $\boldsymbol{p}$. The point $\boldsymbol{q}$ is **six metres** along the plane from $\boldsymbol{p}$. How far short of $\boldsymbol{q}$ does the particle land.
Give your answer correct to the nearest metre.[**Use** $\boldsymbol{g = 10\ m\ s^{-2}}$]



Q2 Car $\boldsymbol{A}$ passes a point $\boldsymbol{p}$ with a velocity of $\mathbf{6\ m\ s^{-1}}$ and a uniform acceleration of $\mathbf{2\ m\ s^{-2}}$. **One second** later car $\boldsymbol{B}$ passes the same point with a velocity of $\mathbf{16\ m\ s^{-1}}$ and a uniform acceleration of $\mathbf{1\ m\ s^{-2}}$.
What is the speed of $\boldsymbol{B}$ when, after going in front, it is at its greatest distance from car $\boldsymbol{A}$?

Q3 The combined age of **Aisling** and **Brian** is **39.** The combined age of **Brian** and **Cathal** is **40.** The combined age of **Cathal** and **Dara** is **38**. The combined age of **Dara** and **Eiméar** is **44.** The total of all five ages is **105**. Which of the five is the youngest?

A: Aisling **B: Brian** **C: Cathal** **D: Dara** **E: Eiméar**

TIE BREAKER – 6 Minutes per Question

Q1 A water tank is $\mathbf{5/6}$ **full**. When **30 litres** of water are removed from the tank, the tank is $\mathbf{4/5}$ full. How much water does the tank hold when full?

Q2 A ball of mass $\mathbf{0 \cdot 1\ kg}$ strikes a wall horizontally with a speed of $\boldsymbol{u}\ \mathbf{m\ s^{-1}}$ and rebouds at $\mathbf{2\ m\ s^{-1}}$. The coefficient of restitution for the impact is $\mathbf{0 \cdot 4}$.
Calculate the loss in kinetic energy due to the impact.

Q3 At an instant, a car of mass $\mathbf{500\ kg}$ is travelling along a horizontal road at a speed of $\mathbf{15\ m\ s^{-1}}$. Its engine is working at a power of **30 kW**. If the resistance to motion is **500 N**, calculate the acceleration at that instant.

MARKING SCHEME

AWARD 2 MARKS FOR A CORRECT SOLUTION

[Deduct a maximum of 1 mark for rounding errors and/or incorrect Units]

Round 1

Q1	$48 \cdot 2°$	$\left[\text{No unit required } - \text{ award 1 mark for } \tan^{-1}\left(\frac{\sqrt{80}}{8}\right)\right]$
Q2	450 J	[Unit required for 2 marks – if unit is omitted award 1 mark]
Q3	D: 3	[No unit required, Note: the abundant numbers are 20, 24, 30]

Round 2

Q1	$3 \cdot 75$ kW	[No unit required]
Q2	50 m s^{-1}	[Unit required for 2 marks – if unit is omitted award 1 mark]
Q3	$C = 36$	[No unit required]

Round 3

Q1	$e = \frac{1}{3}$	[No unit required]
Q2	$7 \cdot 2 \text{ m s}^{-2}$	[Unit required for 2 marks – if unit is omitted award 1 mark]
Q3	C: Just Caoimhe	[No unit required]

Round 4

Q1	$24 \cdot 6 \text{ m s}^{-1}$	$\left[\text{Unit required for 2 marks – award 1 mark for } \pm\frac{320}{13} \text{ m s}^{-1}\right]$
Q2	160 m	[Unit required for 2 marks – if unit is omitted award 1 mark]
Q3	$D = \frac{45}{8}$	[No unit required]

Round 5

Q1	$\mu = \frac{1}{5} = 0 \cdot 2$	[No unit required]
Q2	$m = 6$ kg	[No unit required]
Q3	$B = 72$	[No unit required, $91 - 19 = 72$]

Round 6

Q1	1 m	$\left[\text{No unit required– award 1 mark for } s_x = 5\left(\sqrt{6} - \sqrt{2}\right) = 5 \cdot 176 \text{ m}\right]$
Q2	24 m s^{-1}	[Unit required for 2 marks – if unit is omitted award 1 mark]
Q3	D: Dara	[No unit required, $A = 21, B = 18, C = 22, D = 16, E = 28$]

TIE BREAKER

Q1	900 litres	[No unit required]
Q2	$1 \cdot 05$ J	[No unit required]
Q3	3 m s^{-2}	[No unit required]