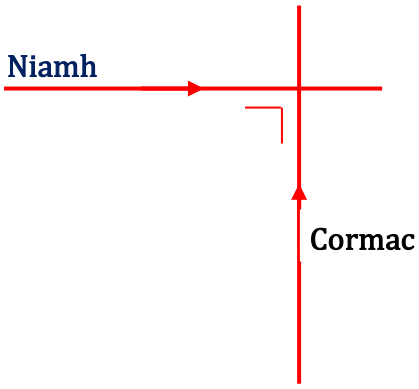
2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

ROUND 1 – 6 Minutes

Marks may be lost for omission of correct units

Q1 A car has entered the **M1** on the Dublin to Belfast road at a speed of $\frac{10}{3}$ **m s^{-1}**, and begins to accelerate at **5 m s^{-2}**. How **many seconds** will elapse before the driver exceeds the speed limit of **120 kilometres per hour**?

Q2 Two straight roads cross at right angles. **Niamh** is walking **eastwards** towards the intersection at **3 m s^{-1}**. **Cormac** is walking **northwards** towards the intersection at $\boldsymbol{u}$ **m s^{-1}**. The velocity of **Niamh relative** to that of **Cormac** is in the direction **East** $\tan^{-1}\left(\frac{4}{3}\right)$ **South**. Find the value of $\boldsymbol{u}$.



Q3 Only **One** of the following numbers is a **prime number**. Which number is it?

A: 2013 **B: 2015** **C: 2017** **D: 2019**

2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

ROUND 2 – 6 Minutes

Marks may be lost for omission of correct units

Q1 A ball was thrown vertically upwards at a speed of $\mathbf{20\ m\ s^{-1}}$. What **distance** did the ball travel in the first **3 seconds**? [**Use** $\boldsymbol{g = 10\ m\ s^{-2}}$]

Q2 A particle $\boldsymbol{A}$ has an initial position vector of $\vec{r}_A = (300\vec{\imath} - 200\vec{\jmath})$ **m** and moves with a constant velocity of $\vec{v}_A = (8\vec{\imath} - 5\vec{\jmath})\ \mathbf{m\ s^{-1}}$. A **second** particle $\boldsymbol{B}$ has an initial position vector $\vec{r}_B = (124\vec{\imath} - 508\vec{\jmath})$ **m** and moves with a constant velocity $\vec{v}_B = (x\vec{\imath} + y\vec{\jmath})\ \mathbf{m\ s^{-1}}$. The two particles **collide** after **11 seconds**. Find the values of $\boldsymbol{x}$ and $\boldsymbol{y}$.

Q3 One light-year is nearly $\mathbf{6 \times 10^{12}}$ **miles**. In **2016**, the Hubble Space Telescope set a new cosmic record, observing a galaxy $\mathbf{13 \cdot 4}$ billion years in the past, just 400 million years after the Big Bang. Calculate the distance in kilometres. [$\mathbf{1\ kilometre = 0 \cdot 62\ miles}$]

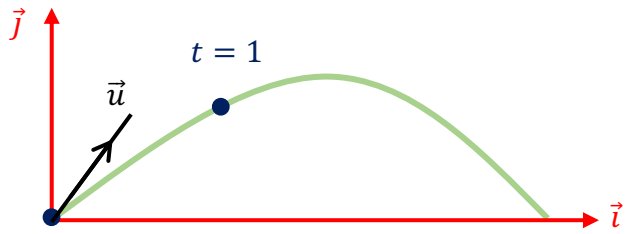
A: $\mathbf{1 \cdot 3 \times 10^{23}}$ **B:** $\mathbf{5 \times 10^{22}}$ **C** $\mathbf{8 \cdot 04 \times 10^{22}}$ **D** $\mathbf{5 \times 10^{23}}$ **E** $\mathbf{4 \cdot 9 \times 10^{23}}$

2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

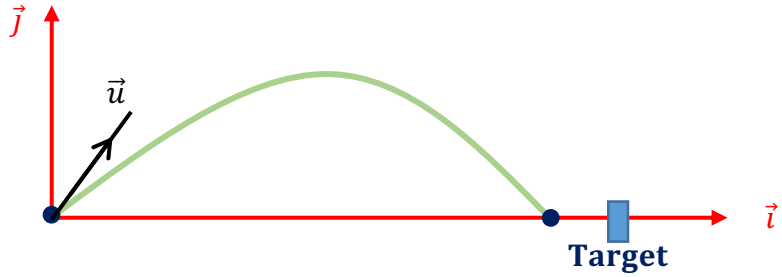
ROUND 3 – 6 Minutes

Marks may be lost for omission of correct units

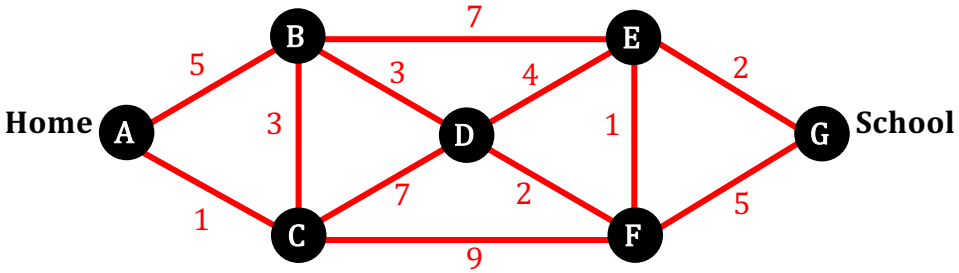
Q1 A ball is projected with an **initial velocity** of $\vec{u} = (12\vec{\imath} + 16\vec{\jmath})$ **m s^{-1}** from a point on the horizontal floor of a gymnasium. At **what angle** to the horizontal is the ball travelling after **one** second? Give your answer to the **nearest degree**. [**Use** $g = 10$ **m s^{-2}**].



Q2 A particle is projected from a point ***P*** on horizontal ground. Its initial velocity is $(x\vec{\imath} + 30\vec{\jmath})$ **m s^{-1}**. It falls **5 metres short** of its target which is **125 metres** from ***P*** along the horizontal. Calculate the value of x. [**Use** $g = 10$ **m s^{-2}**]



Q3 In **1959, Edsger Dijkstra**, a Dutch pioneer of computer programming drew up a set of rules to solve the **shortest path problem**. For example, if an airline wants to connect cities in the most efficient way. **You do not need to know the rules to try this:**
A boy cycles to school at ***G*** from his home at ***A***. The **numbers** represent **metres in hundreds** (not to scale). If he chooses the shortest path, what is the shortest distance he can cycle to reach the school? Give your answer in **kilometres**.

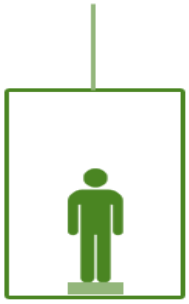


2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

ROUND 4 – 6 Minutes

Marks may be lost for omission of correct units

Q1 A sumo wrestler and has a mass of **140 kilogrammes**. When he stands in a lift which is **accelerating upwards** his **apparent weight increases** by **210 Newton's**.
Calculate the **acceleration** of the lift. [**Use** $g = 10\ \text{m s}^{-2}$]



Q2 A ball of mass $0 \cdot 1$ **kg** strikes a wall horizontally and rebounds along the same path.
It has a strike velocity of $20\ \text{m s}^{-1}$ and rebounds at $10\ \text{m s}^{-1}$. The magnitude of its **impulse** to **loss in kinetic energy** is in the ratio $1 : x$. Find the value of x.

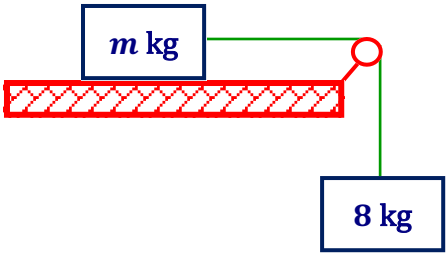
Q3 A shop sells goods at a **profit** of **20%** on the selling price.
What is the **percentage profit** on the **cost price**?

2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

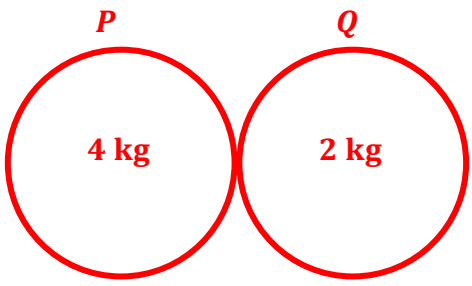
ROUND 5 – 6 Minutes

Marks may be lost for omission of correct units

Q1 A particle of mass $\boldsymbol{m}$ **kg** rests on a smooth horizontal table. It is connected by a light inextensible string which passes over a smooth, light fixed pulley at the edge of the table to a particle of mass **8 kg** which hangs freely under gravity.
The system starts from rest and the **8 kg** moves vertically downwards.
If the **force** exerted by **the string on the pulley** is $\mathbf{48\sqrt{2}}$ **N**, calculate the value of $\boldsymbol{m}$.
[**Use** $\boldsymbol{g}$ $\mathbf{=10\ m\ s^{-2}}$].



Q2 A smooth sphere $\boldsymbol{P}$, of mass **4 kg**, moving with speed $\boldsymbol{u}$ $\mathbf{m\ s^{-1}}$, collides directly with a smooth sphere $\boldsymbol{Q}$, of mass **2 kg**, which is moving in the same direction with speed $\mathbf{2\ m\ s^{-1}}$.
The coefficient of restitution for the collision is $\frac{\mathbf{1}}{\mathbf{3}}$.
After the collision the movement of both spheres continues in the same direction as before, and $\boldsymbol{Q}$ has a speed of $\mathbf{3\ m\ s^{-1}}$. Find the value of $\boldsymbol{u}$.



Q3 The five integers **2, 5, 6, 9, 14** are arranged into a different order. In the new arrangement, the sum of the first three integers is equal to the sum of the last three integers.
What is the middle number in the new arrangement?

A: 2 **B: 5** **C: 6** **D: 9** **E: 14**

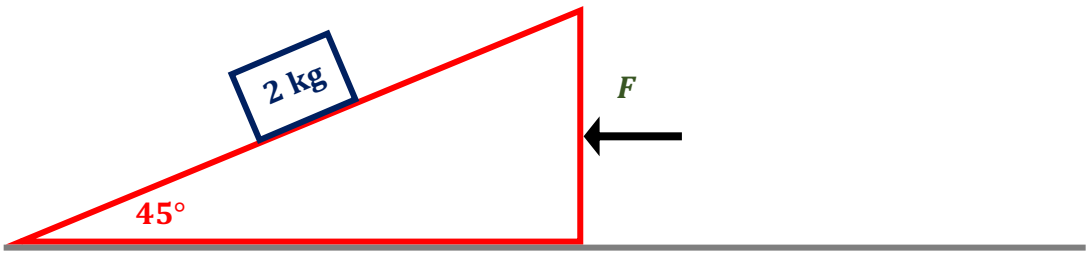
2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

ROUND 6 – 8 Minutes

Marks may be lost for omission of correct units

Q1 At a particular instant a car of mass **700 kg** is pulling a trailer of mass **100 kg**, on a level road at a speed of **10 m s^{-1}** when the engine exerts a constant power of **30 kW**. Friction and air resistance amount to **500 N** on the car and **100 N** on the trailer. Calculate the **tension** in the tow-bar which can be modelled as a uniform non-extensible string.

Q2 A **wedge** rests on a **smooth horizontal** table with one of its smooth plane faces inclined at **45°** to the horizontal. A particle of mass **2 kg** is allowed slide down that smooth face. Calculate the **horizontal force *F*** that must be applied to the wedge in order to prevent its movement. [**Use** $g = 10$ **m s^{-2}**].



Q3 The following is a report from **The Farmers News.**
On **12 October 2017**, on a **one acre** field in Co. Donegal, **1 · 6 inches** of rain fell over twenty four hours. How many **cubic metres** was that volume of rainfall? Give your answer to the nearest whole number.

1 Hectare = 10000 m^2 = 2 · 471 acres

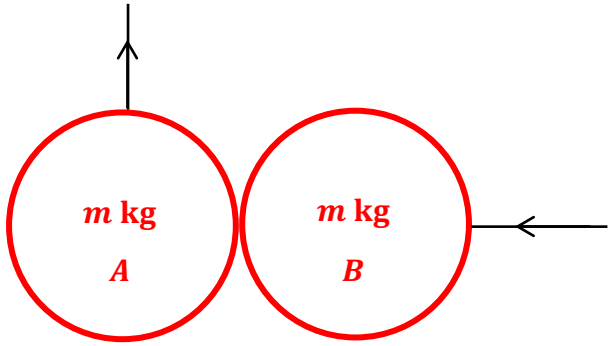
1 metre = 39 · 4 inches

2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

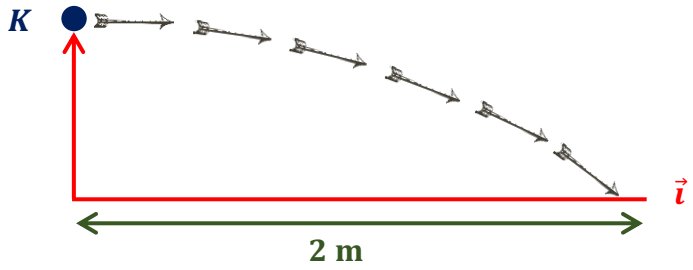
ROUND 7 – 8 Minutes

Marks may be lost for omission of correct units

Q1 Two identical spheres, $\boldsymbol{A}$ and $\boldsymbol{B}$, each of mass $\boldsymbol{m}$ **kg** and both are moving in perpendicular directions with speed $\boldsymbol{u}$ **m s**$^{-1}$ collide obliquely as shown.
The coefficient of restitution for the collision is $\mathbf{0 \cdot 5}$. Find, in terms of $\boldsymbol{u}$, the speed of $\boldsymbol{A}$ after the collision. **Assume the collision** takes place along the $\vec{\boldsymbol{\imath}}$ **axis.**

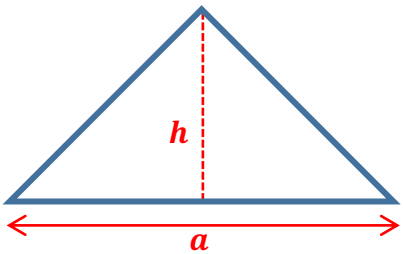


Q2 A ball is projected horizontally from a point $\boldsymbol{K}$ above a horizontal plane with a speed of $\mathbf{2}$ **m s**$^{-1}$. The ball first hits the plane at a point whose horizontal displacement from $\boldsymbol{K}$ is $\mathbf{2}$ **m**. The **coefficient of restitution** between the ball and the plane is $\mathbf{0 \cdot 2}$.
Find the **speed** with which the ball bounces. [**Use** $g = 10$ **m s**$^{-2}$]



Q3 An isosceles triangle has a base of length $\boldsymbol{a}$ and perpendicular height $\boldsymbol{h}$. The length of $\boldsymbol{a}$ is **decreased** by **10%**, and the length of $\boldsymbol{h}$ is **increased** by **10%**.
What is the **percentage change** in the **area** of the triangle?

A. 1% increase
B. 1% decrease
C. No change
D. 10% increase
E. 10% decrease

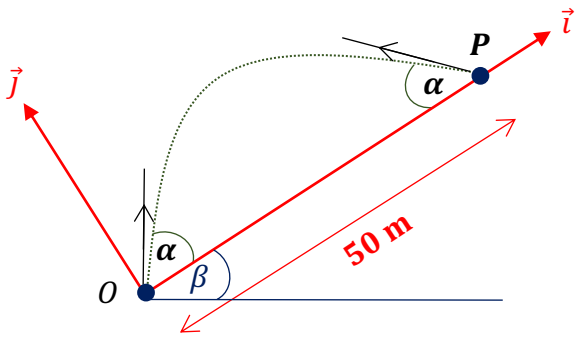


2018 REGIONAL APPLIED MATHS QUIZ – 5th MARCH 2018

ROUND 8 – 8 Minutes

Marks may be lost for omission of correct units

Q1 A particle is projected from a point ***O*** **up** an inclined plane which is inclined at an angle β to the horizontal. At the same time a second particle is projected from a point ***P*** **down** the plane. Both particles are projected at a speed of $\mathbf{12 \cdot 5\ m\ s^{-1}}$ and at an **angle** $\boldsymbol{\alpha}$ to the inclined plane. If the particles meet after **4 seconds** and the distance from ***O*** to ***P*** is **50 m**. Find the value of $\boldsymbol{\alpha}$.



Q2 **Andrew** is jogging eastwards at $\mathbf{4\ m\ s^{-1}}$. **Barry** is jogging at $\mathbf{5\ m\ s^{-1}}$ in a direction **East** $\boldsymbol{\theta}$° **North**. At an instant the faster jogger is $\boldsymbol{d}$ metres **north** of his fellow jogger and this in fact is the shortest distance between them in their subsequent movement. Find the **speed** of **Barry** relative to **Andrew**.

Q3 What is the next letter in the sequence? (**Hint:** can you count?)

O T T F F S S

TIE BREAKER – 6 Minutes per Question

Q1 A metal block of mass **100 kg** sits on a horizontal metal floor. The coefficient of limiting friction between the concrete and the metal is **0 · 5**. What **frictional force** is being applied do the block?

Q2 A space shuttle uses a **30 second** thrust of its manoeuvring thrusters to reduce its forward velocity from $\mathbf{15\ m\ s^{-1}}$ to $\mathbf{12\ m\ s^{-1}}$. Given that the **mass** of the vessel is **45000 kg**, what is the magnitude of the **constant force** produced by the firing of the thrusters?

Q3 A vehicle travels at a constant speed of $\mathbf{30\ m\ s^{-1}}$. The resistances to motion at this speed amounts to **1000 N**. Calculate the **power** developed.

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	$6\ \text{s}$	[No unit required]
Q2	$u = 4\ \text{m s}^{-1}$	[No unit required]
Q3	$\text{C} = 2017$	[No unit required]

Round 2

Q1	$25\ \text{m}$	[Unit required for 2 marks – award 1 mark for $24 \cdot 9\ \text{m}$]
Q2	$\vec{v}_B = 24\vec{\imath} + 23\vec{\jmath}$	[No unit required– award 1 marks for $x = 24$ or $y = 23$]
Q3	A: $1 \cdot 3 \times 10^{23}$	[No unit required]

Round 3

Q1	$27°$	$\left[\text{No unit required – award 1 mark for } \tan^{-1}\left(\frac{1}{2}\right)\right]$
Q2	$x = 20$	[No unit required – award 1 mark for $2g$ or $19 \cdot 6$]
Q3	$1 \cdot 2\ \text{km}$	[No unit required – award 1 mark for 12 or 1200]

Round 4

Q1	$1 \cdot 5\ \text{m s}^{-2}$	[Unit required for 2 marks]
Q2	$x = 5$	[No unit required]
Q3	25%	[No unit required]

Round 5

Q1	$m = 12\ \text{kg}$	[No unit required– award 1 marks for $m = 12 \cdot 6\ \text{kg}$]
Q2	$u = 3 \cdot 125\ \text{m s}^{-1}$	[No unit required]
Q3	E: 14	[No unit required]

Round 6

Q1	$T = 400\ \text{N}$	[Unit required for 2 marks]
Q2	$F = 10\ \text{N}$	[Unit required for 2 marks – award 1 mark for g N or $9 \cdot 8$ N]
Q3	$164\ \text{m}^3$	[No unit required]

Round 7

Q1	$1 \cdot 25u\ \text{m s}^{-1}$	[Unit required for 2 marks]
Q2	$\lvert\vec{v}\rvert = \sqrt{8}\ \text{m s}^{-1}$	[Unit required for 2 marks– award 1 mark for $\vec{v} = 2\vec{\imath} + 2\vec{\jmath}\ \text{m s}^{-1}$]
Q3	B: 1% decrease	[No unit required]

Round 8

Q1	$\alpha = 60°$	[No unit required]
Q2	$\lvert\vec{v}_{BA}\rvert = 1\ \text{m s}^{-1}$	[Unit required for 2 marks – if unit is omitted award 1 mark]
Q3	E	[No unit required]

TIE BREAKER

Q1	$0\ \text{N}$	[No unit required]
Q2	$4500\ \text{N}$	[No unit required]
Q3	$30000\ \text{W}$	[No unit required]