

2016 NATIONAL APPLIED MATHS QUIZ – 12<sup>th</sup> MARCH 2016

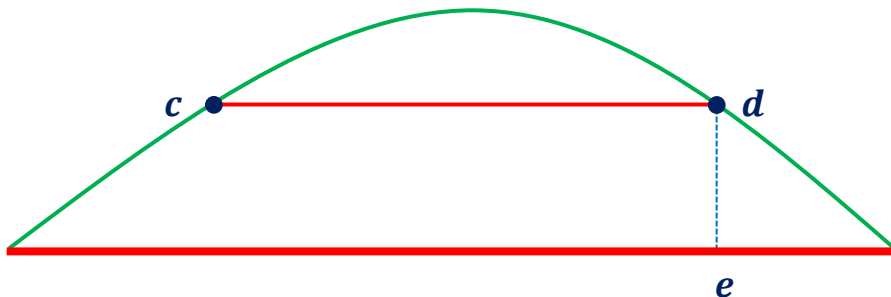
ROUND 1 – 8 Minutes

Marks may be lost for omission of correct units

- Q1 The non-stop Eurostar train from Rome to Geona, passes the control tower at Pisa station travelling at  $30 \text{ m s}^{-1}$  and accelerating uniformly. During the **tenth second** after passing the control tower the train travels  $30 \cdot 5$  metres.  
Calculate its **actual speed** when it has progressed **19 seconds** from the control tower.



- Q2 A projectile fired on a horizontal plane follows the path as shown.  
[*cd*] is a horizontal line and at *c* the projectile has been in flight for 3 seconds.  
At *d* the projectile has been in flight for 7 seconds.  
Calculate the vertical distance [*de*]. [Use  $g = 10 \text{ m s}^{-2}$ ]



- Q3 Tegwen has the same number of brothers as she has sisters. Each one of her brothers has 50% more sisters than brothers.  
How many children are in Tegwen's family?

A 5      B 7      C 9      D 11      E 13

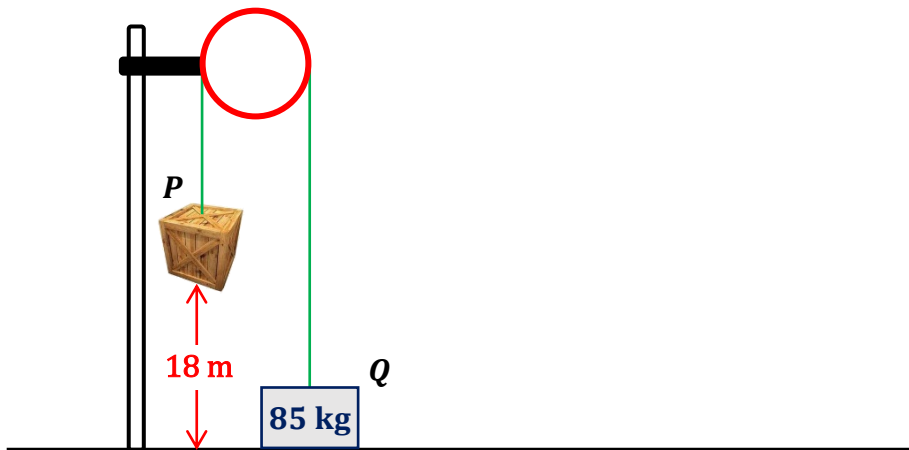
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ROUND 2 – 8 Minutes

Marks may be lost for omission of correct units

- Q1 A crate  $P$  containing blocks of wood has a total mass of  $m$  kg, ( $m > 85$ ). The crate is connected to a counterweight  $Q$ , of mass  $85$  kg, by a rope which passes over a fixed pulley. Initially the counterweight is held in contact with the ground, as shown in the diagram. The counterweight is released. In the ensuing motion both the crate and the counterweight move vertically.

The following modelling assumptions are made: the crate and the counterweight are considered as particles; the rope is light and inextensible; the pulley is smooth; there is no air resistance. Given that the crate reaches the ground in  $7.5$  s and taking  $g = 10 \text{ m s}^{-2}$ . Calculate the value of  $m$ , give your answer correct to the nearest kilogram.



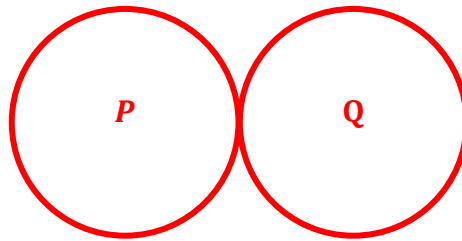
- Q2 A supply ship starts from a position of  $(-133\vec{i} + 121\vec{j})$  km and travels with a uniform velocity of  $(8\vec{i} - 8\vec{j})$  km hr<sup>-1</sup>. Its target ship starts at  $(-70\vec{i} + 100\vec{j})$  km and sails with a constant velocity of  $(-7\vec{i} - 3\vec{j})$  km hr<sup>-1</sup>. Find the **position vector** of the meeting point in terms of  $\vec{i}$  and  $\vec{j}$ .
- Q3 When travelling by train from **Madrid to Carboa**, you pass a sign saying “**Carboa 200 Kilometres**”. The  $3\frac{1}{2}$  kilometres later, you pass another sign saying “**Halfway between Madrid and Carboa**”. How many kilometres is the train journey between the two cities?

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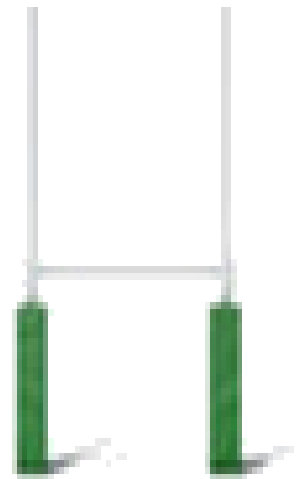
ROUND 3 – 8 Minutes

Marks may be lost for omission of correct units

- Q1 A smooth sphere  $P$  moving with velocity  $(5\vec{i} + 4\vec{j}) \text{ m s}^{-1}$  collides with a smooth equal sphere  $Q$  moving with velocity  $(3\vec{i} + 2\vec{j}) \text{ m s}^{-1}$  on a smooth horizontal table. After the collision the spheres move in parallel directions. Calculate the **speed of  $Q$**  after the collision. Give your answer correct to **two decimal places**.



- Q2 A rugby ball is kicked at an angle of  $45^\circ$  above the horizontal. The ball rebounds off the cross bar which is **3.2 metres** above the ground and a horizontal distance of **20 metres** from where the ball was kicked. Calculate the **speed** with which the ball was kicked. Give your answer to **two decimal place**. [Use  $g = 10 \text{ m s}^{-2}$ ]



- Q3 When Michael had his first car, **50 Litres** of petrol cost €40. [Many years ago!] He filled up on New Year's day 2016 and noticed that **40 Litres** of petrol cost €50. By approximately what percentage has the cost of petrol increased over the time?

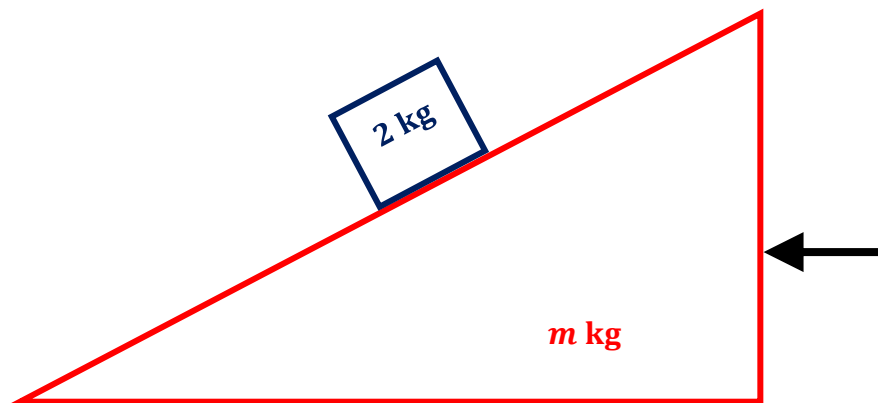
A 50%      B 56%      C 67%      D 17%

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**ROUND 4 – 8 Minutes**

Marks may be lost for omission of correct units

- Q1** A girl standing still tosses a ball vertically upwards. **One second later** she tosses another ball vertically upwards with the same initial speed. The balls collide **0.5 seconds later**. With what initial speed were they tossed? [Use  $g = 10 \text{ m s}^{-2}$ ]
- Q2** A smooth wedge, of mass  $m \text{ kg}$  and slope  $\sin^{-1}\left(\frac{3}{5}\right)$ , rests on a smooth horizontal surface. A particle of mass **2 kg** is allowed to slide down its face. Calculate the horizontal force required to prevent the wedge from moving. [Use  $g = 10 \text{ m s}^{-2}$ ]



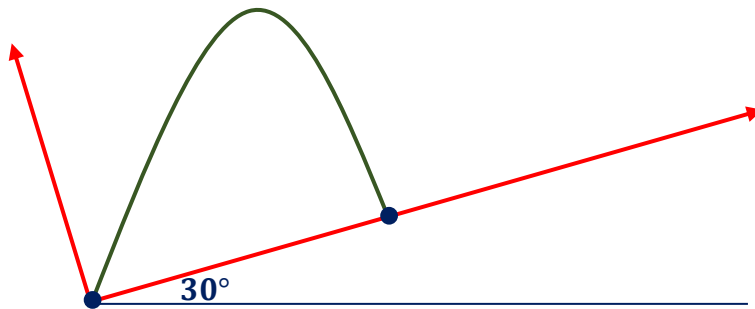
- Q3** The Knave of hearts tells only the truth on Mondays, Tuesdays, Wednesdays and Thursdays. He tells only lies on all the other days. The Knave of Diamonds tells the truth only on Fridays, Saturdays, Sundays and Mondays. He tells only lies on all the other days. On one day last week, they both said, "Yesterday I told lies." On which day of the week was that?
- A: Sunday    B: Monday    C: Tuesday    D: Thursday    E: Friday

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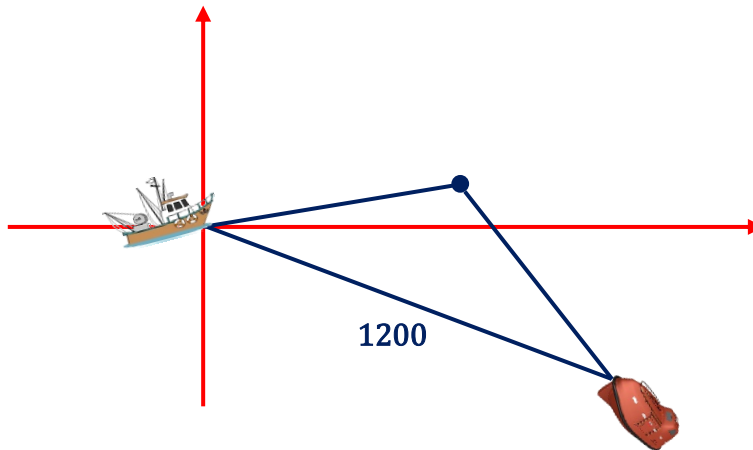
**ROUND 5 – 8 Minutes**

Marks may be lost for omission of correct units

- Q1** A particle is fired up an inclined plane at an angle  $\alpha$  to the horizontal. Its initial speed is  $50 \text{ m s}^{-1}$  and the plane is inclined at an angle of  $30^\circ$  to the horizontal. The particle strikes the plane in a perpendicular direction after **7.6 seconds**. Calculate the value of  $\alpha$  to the nearest degree. [Use  $g = 10 \text{ m s}^{-2}$ ]



- Q2** A lifeboat is located **1200 metres** in a direction **East  $20^\circ$  South** from a fishing boat in distress. The fishing boat is travelling at  $5 \text{ m s}^{-1}$  in a direction **East  $10^\circ$  North**. What is the minimum time in which the lifeboat, travelling at  $10 \text{ m s}^{-1}$ , can reach the fishing boat? Give your answer correct to the nearest second.



- Q3** Four different straight lines are drawn on a flat piece of paper. The number of points where two or more lines intersect is counted. Which of the following could **NOT** be the number of such points?

A: 4

B: 1

C: 3

D: 2

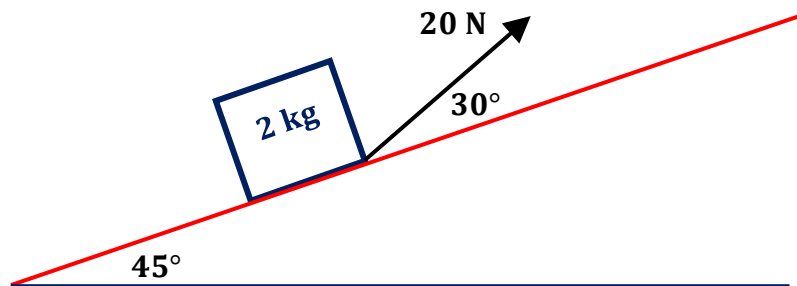
E: 5

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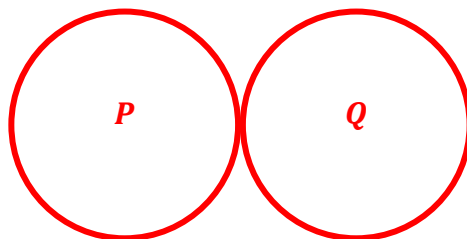
ROUND 6 – 8 Minutes

Marks may be lost for omission of correct units

- Q1 A particle of mass **2 kg** is placed on a rough plane which is inclined at an angle of **45°** to the horizontal. A force of magnitude **20 N** acts upwards on the particle at an angle of **30°** to the inclined plane.  
If the particle is on the point of slipping calculate the value of the **coefficient of limiting friction**. Give your answer correct to **two decimal places**. [Use  $g = 10 \text{ m s}^{-2}$ ]



- Q2 A smooth sphere **P** moving with speed **u** collides with an equal sphere **Q** which is at rest. The direction of motion of **P** before and after impact makes angles  $\tan^{-1}\left(\frac{3}{4}\right)$  and  $\tan^{-1}1$  respectively with the line of centres. After impact the speeds of **P** and **Q** are in the ratio  $3\sqrt{2}:v$ . Find the value of **v**.



- Q3 In a sequence, each term after the first two terms is the mean of all the terms which come before that term. The first term is **8** and the tenth term is **26**. What is the second term?

A: 17      B: 18      C: 44      D: 52      E: 68

## TIE BREAKER – 6 Minutes per Question

- Q1** A boy runs **20 metres** to the **East** in **5 seconds** and then **30 metres** to the south in **7 seconds**. What is his average speed? Give answer to the nearest metre per second.
- Q2** A ball is thrown vertically upwards with an initial speed of  **$40 \text{ m s}^{-1}$** . How far does it travel in the first five seconds of its motion? [Use  **$g = 10 \text{ m s}^{-2}$** ]
- Q3** In a street of **80** houses, **24** have broadband. What proportion of the houses on the street do not have broadband? Give your answer as a decimal.

## 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  $31 \text{ m s}^{-1}$  [Unit required for 2 marks – if unit is omitted award 1 mark]  
Q2  $105 \text{ m}$  [Unit required for 2 marks – award 1 mark for  $\frac{21g}{2} \text{ m s}^{-1}$ ]  
Q3  $D: 11$  [No unit required]

#### Round 2

- Q1  $m = 97 \text{ kg}$  [No unit required]  
Q2  $-99 \cdot 4\vec{i} - 87 \cdot 4\vec{j}$  [No unit required]  
Q3  $393 \text{ km}$  [No unit required]

#### Round 3

- Q1  $3 \cdot 33 \text{ m s}^{-1}$  [Unit required for 2 marks – award 1 mark for  $\frac{8}{3}\vec{i} + 2\vec{j}$  or  $\frac{10}{3} \text{ m s}^{-1}$ ]  
Q2  $15 \cdot 43 \text{ m s}^{-1}$  [Unit required for 2 marks – award 1 mark for  $\sqrt{\frac{500g}{21}} = 15 \cdot 28 \text{ m s}^{-1}$ ]  
Q3  $B = 56\%$  [No unit required]

#### Round 4

- Q1  $10 \text{ m s}^{-1}$  [Unit required for 2 marks – award 1 mark for  $g \text{ m s}^{-1}$  or  $9 \cdot 8 \text{ m s}^{-1}$ ]  
Q1  $9 \cdot 6 \text{ N}$  [Unit required for 2 marks – award 1 mark for  $\frac{24g}{25} \text{ N}$  or  $9 \cdot 408 \text{ N}$ ]  
Q3  $E = \text{Friday}$  [No unit required]

#### Round 5

- Q1  $71^\circ$  [No unit required - award 1 mark for  $41^\circ$ ]  
Q2  $86$  [No unit required]  
Q3  $D: 2$  [No unit required]

#### Round 6

- Q1  $0 \cdot 77$  [No unit required]  
Q2  $v = 1$  [No unit required]  
Q3  $C: 44$  [No unit required]

#### TIE BREAKER

- Q1  $3 \text{ m s}^{-1}$  [Unit required for 2 marks – if unit is omitted award 1 mark]  
Q2  $85 \text{ m}$  [Unit required for 2 marks – if unit is omitted award 1 mark]  
Q3  $0 \cdot 7$  [No unit required]