Physics. You work it out.

Home Gameboard Maths Friction 2i

Friction 2i

A Level

P P P

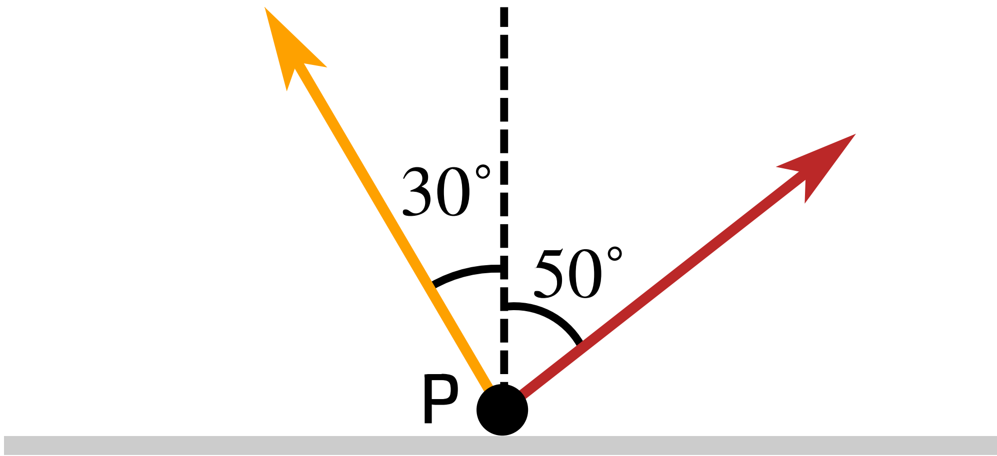

Figure 1: A particle P resting on a horizontal plane and attached to two light strings.

A particle P of weight $30\,\mathrm{N}$ rests on a horizontal plane. P is attached to two light strings making angles of $30\,^\circ$ and $50\,^\circ$ with the upward vertical, as shown in the **Figure 1**. The tension in each string is $15\,\mathrm{N}$, and the particle is in limiting equilibrium.

Part A Frictional force

Find the magnitude of the frictional force on P correct to 3 significant figures.

Does the frictional force on P point to the **left** or to the **right**?.

Part B Coefficient of friction

Find the coefficient of friction between P and the plane correct to 3 significant figures.

Vectors in 3D 2

A Level

P P P

The position vectors of three points A, B and C relative to the origin O are given by the vectors:

$$\vec{OA} = \begin{pmatrix} 4 \\ 3 \\ 3 \end{pmatrix} \qquad \vec{OB} = \begin{pmatrix} 8 \\ 11 \\ -1 \end{pmatrix} \qquad \vec{OC} = \begin{pmatrix} 8 \\ 9 \\ 5 \end{pmatrix}$$

Part A Midpoint of AB

Find the coordinates of point D, the midpoint of AB.

Give your answer in the form $a\underline{\boldsymbol{i}} + b\underline{\boldsymbol{j}} + c\underline{\boldsymbol{k}}$.

$$\overrightarrow{\mathrm{OD}} = \square\, \underline{\boldsymbol{i}} + \square\, \underline{\boldsymbol{j}} + \square\, \underline{\boldsymbol{k}}$$

Part B Find a unit vector

Find an exact expression for a unit vector with the same direction as $\vec{AB}$.

Give your answer in the form $a\underline{\boldsymbol{i}} + b\underline{\boldsymbol{j}} + c\underline{\boldsymbol{k}}$, where $\underline{\boldsymbol{i}}$, $\underline{\boldsymbol{j}}$ and $\underline{\boldsymbol{k}}$ are unit vectors in the x, y and z directions.

The following symbols may be useful: `i, j, k`

Part C The length of $\vec{DC}$

Find an exact expression for the length of $\vec{DC}$.

Part D Angle $A\hat{C}B$

Consider the lengths AB and DC. What can you conclude about the size of angle $A\hat{C}B$?

- $A\hat{C}B < 45°$
- $A\hat{C}B = 45°$
- $A\hat{C}B > 45°$
- $A\hat{C}B < 90°$
- $A\hat{C}B = 90°$
- $A\hat{C}B > 90°$

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STEM SMART Single Maths 48 - Mechanics & Statistics Revision

Physics. You work it out.

Home Gameboard Maths Statistics Probability Probabilities: Households

Probabilities: Households

A Level
P P P

The people living in 3 households are classified as children (C), parents (P) or grandparents (G). The numbers living in each house are shown in the table below.

House number 1	House number 2	House number 3
$4C, 1P, 2G$	$2C, 2P, 3G$	$1C, 1G$

Part A Scenario 1 - a grandparent

All the people in all 3 houses meet for a party. One person at the party is chosen at random. Calculate the probability of choosing a grandparent.

Part B Scenario 2 - a grandparent

A house is chosen at random. Then a person in that house is chosen at random. Using a tree diagram, or otherwise, calculate the probability that the person chosen is a grandparent.

Part C Scenario 2 - a parent

Given that the person chosen by the method in Part B is a grandparent, calculate the probability that there is also a parent living in the house.

Used with permission from UCLES, A level, June 2003, CIE, Paper 6 Probability & Statistics 1 (S1), Question 6

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Projectiles: General 2i

A Level

P P P

A child is trying to throw a small stone to hit a target painted on a vertical wall. The child and the wall are on horizontal ground. The child is standing a horizontal distance of $8\,\mathrm{m}$ from the base of the wall. The child throws the stone from a height of $1\,\mathrm{m}$ with speed $12\,\mathrm{m\,s^{-1}}$ at an angle of $20\,^{\circ}$ above the horizontal.

Part A Finding the angle

Find the direction of motion of the stone when it hits the wall. Give your answer as an angle below the horizontal to 3 significant figures.

Part B Finding V

The child now throws the stone with a speed of $V\,\mathrm{m\,s^{-1}}$ from the same initial position and still at an angle of $20\,^{\circ}$ above the horizontal. This time the stone hits the target which is $2.5\,\mathrm{m}$ above the ground.

Find V to 3 significant figures.

Used with permission from UCLES, A Level, June 2014, OCR M2, Question 8

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Forces on a Supported Beam

A Level

A uniform beam AB of mass $15.0\,\mathrm{kg}$ and length $4.00\,\mathrm{m}$ is freely hinged to a vertical wall at A. The beam is held in equilibrium in a horizontal position by a light rod PQ of length $1.50\,\mathrm{m}$. P is fixed to the wall vertically below A and PQ makes an angle of $30.0°$ with the vertical. The force F exerted on the beam at Q by the rod is in the direction PQ. This force is shown in **Figure 1**.

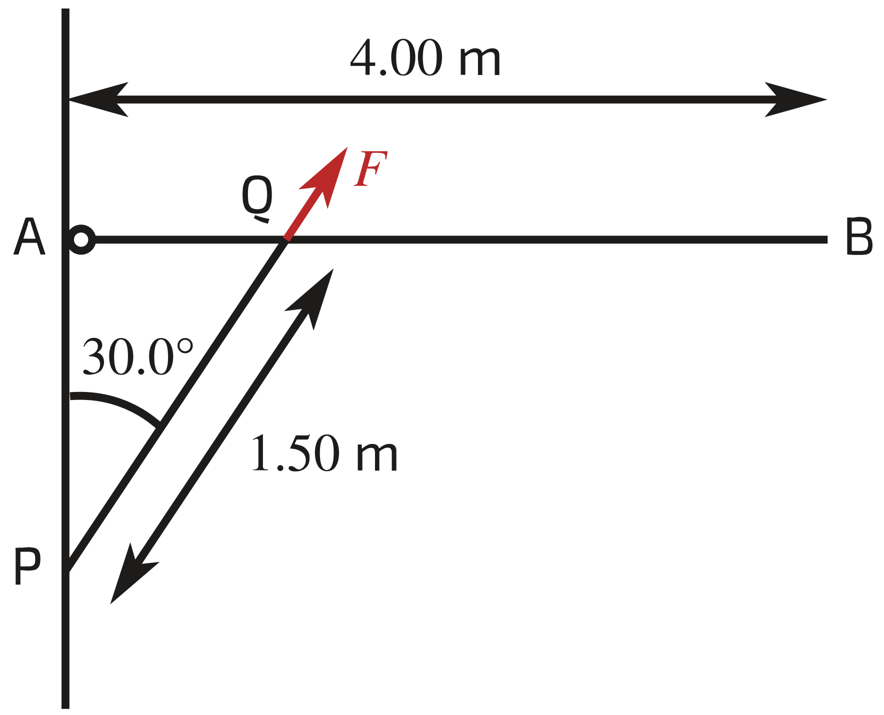

Figure 1: The hinged beam AB supported by the light rod PQ.

Part A The force on the beam at Q

Find the magnitude of F, the force the rod exerts on the beam at Q.

Part B The force on the beam at A

Find the magnitude of the force exerted on the beam at A by the pivot.

Part C The angle of the force at A

At A the force exerted on the beam is to the left. Find the angle the force makes to the horizontal. Use a positive sign if the force is directed above the horizontal and a negative sign if the force is directed below the horizontal.

Adapted from UCLES, A Level, June 2012, OCR M2, Question 3

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Home Gameboard Maths Statistics Probability Normal Distribution 1

Normal Distribution 1

Further A

P P P

The random variable Y is normally distributed with mean μ and variance σ^2, where μ and σ are integers.

It is found that P$(Y > 150.0) = 0.0228$ and P$(Y > 143.0) = 0.9332$. Find the values of μ and σ.

Part A Value of μ

Enter the value of μ.

Part B Value of σ

Enter the value of σ.

Adapted with permission from UCLES, A level, Jun 2015, OCR, S2, Question 1

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Hypothesis Testing: Normal Distribution 3

A Level P P P

Average Speed Cameras (ASC) are a way of encouraging motorists to reduce their speed. Modern systems use automated numberplate recognition to monitor how long it takes a car to travel between two points, from which the average speed of the car can be worked out.

A particular stretch of road is known to be an accident blackspot, and an ASC system is introduced with the aim of improving safety. Before the cameras are installed, the speed of the cars is monitored over a long period of time and it is found to obey a normal distribution with a mean of $75.0\,\mathrm{mph}$ and a standard deviation of $3.00\,\mathrm{mph}$. A few weeks after the cameras are installed the speed of the cars is monitored again. A sample of 400 cars is taken, and their speed is found to be normally distributed with a mean of $72.0\,\mathrm{mph}$.

Part A Null and alternative hypotheses

A hypothesis test is carried out to determine whether the cameras have been effective in reducing driver mean speed. Let μ represent the population mean speed. Drag and drop items into the boxes below to state the null and alternative hypotheses for the test.

H_0: μ $\boxed{}\boxed{}$

H_1: μ $\boxed{}\boxed{}$

Items:

$\boxed{\mu}$ $\boxed{\overline{X}}$ $\boxed{<}$ $\boxed{\neq}$ $\boxed{=}$ $\boxed{>}$ $\boxed{0.00}$ $\boxed{72.0}$ $\boxed{75.0}$

Part B Probability distributions

Drag and drop answers into the boxes below to describe the probability distributions involved in the hypothesis test. You may assume that the standard deviation of the speeds of the cars after the cameras are installed is the same as before the cameras were installed, $3.00\,\mathrm{mph}$.

Let X be the speed of a car. If the null hypothesis is true, the speed of cars in the population is given by a normal distribution with a mean of [ ] and a variance of [ ]. Hence,

$$X \sim \mathrm{N}(\boxed{}, \boxed{})$$

As X is normally distributed, the mean values of samples of X with size n will also be normally distributed. Let $\overline{X}$ be the mean speed of a sample of 400 cars. Then the distribution of $\overline{X}$ is

$$\overline{X} \sim \mathrm{N}(\boxed{}, \boxed{})$$

Items:

0.00 0.00750 0.0225 0.150 0.450 1.73 3.00 9.00 72.0 75.0

Part C Carrying out the test

Fill in the blanks to complete the description of the hypothesis test.

Drag and drop items into the boxes below to carry out the hypothesis test at the 1% significance level.

The hypothesis test is a [ ]-tail test. At the 1% significance level, the critical region is $\overline{X}$ [ ] [ ].

The mean speed of the sample of 400 cars was found to be $72.0\,\mathrm{mph}$. This value is in the [ ].

Therefore, [ ] the null hypothesis. There [ ] significant evidence that the mean speed of drivers is lower after the cameras were installed.

Items:

one **two** **three** $<$ $\neq$ $=$ $>$ 74.65 74.95 75.05 75.35 **acceptance region** **critical region** **reject** **do not reject** **is** **is not**

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