CM

A Level Maths Question Countdown

8 days until the 1st exam

Information

- Each of the ten sheets will contain five pure questions and two applied questions.

Pure questions

- Two of the pure questions will be 'standard'.
- Two of the pure questions will be 'problems'.
- The last pure question will involve modelling.

Applied questions

- One of the questions will focus on statistics.
- One of the questions will focus on mechanics.
- On alternate days, the statistics question will look at the large data set. Note that these questions may be brief as opposed to full length exam questions.

Notes to self

Pure questions – standard

1 The second term in an arithmetic sequence is 10.
The seventh term in the same arithmetic sequence is 28.

Find the sum of the first 100 terms of this sequence.

2

$$I = \int_0^{\frac{\pi^2}{16}} 4\sin(\sqrt{x})\ \mathrm{d}x$$

(a) Using the substitution $u = \sqrt{x}$, show that

$$I = k\int_a^b u\sin(u)\ \mathrm{d}u$$

where a, b and k are constants to be found.

(b) Hence, showing your working clearly, find the exact value of I.

Pure questions – problems

3

$$\mathrm{f}(x) = \sqrt{(16 - 2x)}$$

(a) Find, in ascending powers of x, the first three terms in the binomial expansion of f(x), up to and including the term in x^2. Give each term in its simplest form.

(b) Substitute $x = 4$ into your expansion of f(x) **and** hence find an estimate for $\sqrt{2}$.

(c) Explain why it is valid to substitute $x = 4$ into the binomial expansion of f(x).

4 (a) Prove that

$$\frac{\cos 2\theta}{\sin\theta + \cos\theta} \equiv \cos\theta - \sin\theta, \quad \theta \neq \frac{\pi}{4}(4n-1),\ n \in \mathbb{Z}$$

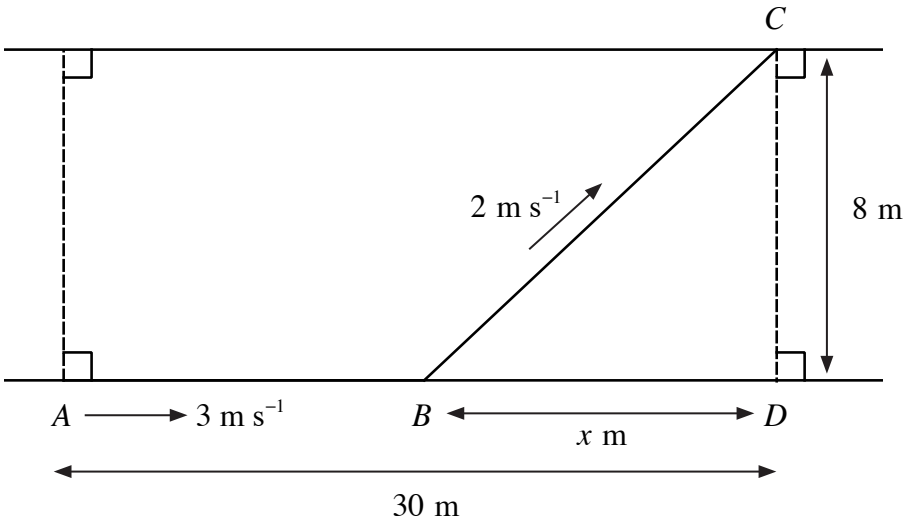
(b) Hence, for $0 < \theta < 2\pi$, solve the equation

$$\frac{5\cos 2\theta}{\sin\theta + \cos\theta} = 1$$

Show your working clearly and give your answers to one decimal places.

Pure questions – modelling

5



Tamira starts jogging from a fixed point A on a straight road AD. At a variable point B on AD, she changes direction to head towards a point C that is fixed on the other side of the road. Her path from B to C is straight, as shown in the diagram above.

Tamira is modelled to jog from A to B at 3 m s^{-1} and from B to C at 2 m s^{-1}. The distance between A and D is fixed at 30 m, the variable distance between B and D is x m and the distance between C and D is fixed at 8 m.

(a) Show that the total time, T seconds, for Tamira to jog from A to C can be given by

$$T = 10 - \frac{1}{3}x + \frac{1}{2}\sqrt{x^2 + 64}$$

(b) Using calculus,

(i) determine the value of x that minimises T,

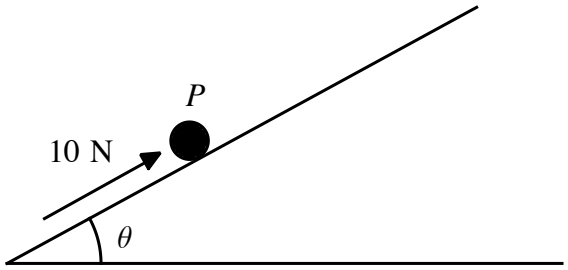
(ii) and hence find the minimum value of T.

(c) Show, using further calculus, that T is minimum for the value of x found in (b).

(d) State one limitation of the model.

Applied questions – mechanics

6



A particle P of mass 2 kg lies on a rough horizontal plane that is inclined at an angle θ to the horizontal where $\tan\theta = \frac{5}{12}$. The particle is held at rest on the plane due to action of a force of magnitude 10 N which acts up the plane in a direction parallel to a line of greatest slope of the plane, as shown in the diagram. The particle is on the point of slipping up the plane.

(a) Find the coefficient of friction between P and the plane.

The force of magnitude 10 N is removed and P moves down the slope from rest.

Given that P is at a **height** of 4 m above the ground,

(b) calculate the time taken for P to reach the bottom of the inclined plane.

Applied questions – statistics

7 Lucas is investigating the relationship between daily mean windspeed, w knots, and daily mean pressure, p hPa.

Using the large data set, he calculates the mean and standard deviation of w and p for three locations, which are labelled A, B and C.

The table below shows his results.

Variable	**Location A**		**Location B**		**Location C**	
	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.
p	1010	7.2	1017	8.0	1022	5.4
w	4.2	1.3	7.7	2.8	8.2	2.4

Lucas' three locations were Hurn, Beijing and Perth.

(a) Using your knowledge of the large data set, suggest, giving reasons for your answer, which location each letter corresponds to.

To measure the linear association between p and w, Lucas instead calculates the product moment correlation coefficient r between p and w for each of his three locations.

Location A: $r = -0.3957$
Location B: $r = -0.2182$
Location C: $r = -0.1745$

The size of Lucas' data set for each location is 100.

(b) Test, at the 10% level of significance, whether there is evidence to suggest a correlation between p and w for each location. State your hypotheses clearly.

(c) Hence, comment on whether there is evidence of a correlation between w and p from Lucas' data at the 10% level of significance.