Neap:

PHYSICS VCE UNITS 3&4
DIAGNOSTIC TOPIC TESTS 2017

TEST 4: HOW FAST CAN THINGS GO? (I)

TOTAL 45 MARKS (45 MINUTES)

Student's Name: _____ Teacher's Name: _____

Directions to students

Write your name and your teacher's name in the spaces provided above.
Answer all questions in the spaces provided.

Use $g = 10 \text{ N kg}^{-1}$.

Question 1 (9 marks)

Figure 1 shows a stunt motorcyclist who is attempting to ride over a river of width 60 m using a ramp which is inclined at 30° to the horizontal. The motorcyclist will land on the bank on the other side of the river which is at the same horizontal plane as the take-off point.

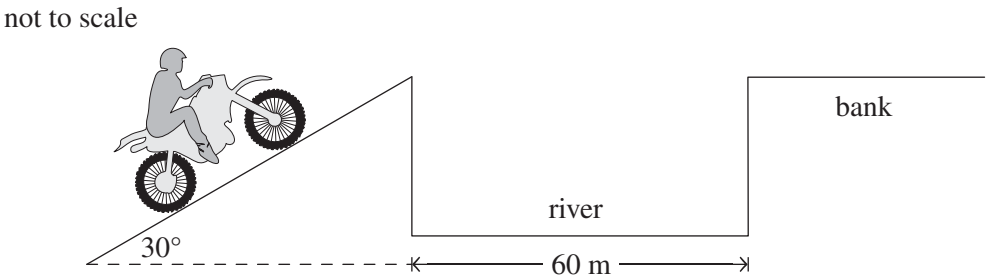

Figure 1

The motorcyclist travels at a speed such that he just clears the river width of 60 m.

a. Calculate how long the stunt motorcyclist is in the air during this stunt. 3 marks

s

b. Calculate the minimum speed the stunt motorcyclist would need to jump over the river. 2 marks

m s^{-1}

c. Calculate the maximum height above the launch point that the stunt motorcyclist reaches while jumping. 2 marks

m

d. In reality, the stunt motorcyclist needs to take-off at a speed greater than that identified in the answer to part **b**.

Explain why this is so. 2 marks

Question 2 (7 marks)

A car of mass 1000 kg is travelling down a slope of 30° to the horizontal and decelerating at 1.0 m s^{-2}. Road–tyre friction decelerates the car once the breaks are applied. The engine is off as the car travels down the slope. This is shown in Figure 2.

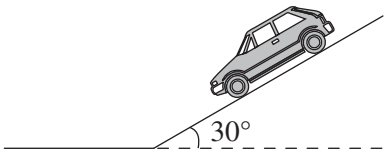

Figure 2

a. Calculate the magnitude of the net force acting on the car. 2 marks

N

b. Calculate the magnitude of the force being applied by the car's brakes. 3 marks

N

c. Calculate the magnitude of the normal reaction acting on the car. 2 marks

N

Question 3 (5 marks)

A tug boat is pulling a ship as shown in Figure 3. The engine force applied by the tug boat is 10 kN. The drag force on the tug boat due to the water is 1.0 kN and the drag force on the ship is 2.0 kN. The ship and the tug boat are accelerating at 1.0 m s^{-2}. The mass of the tug boat is 1000 kg.

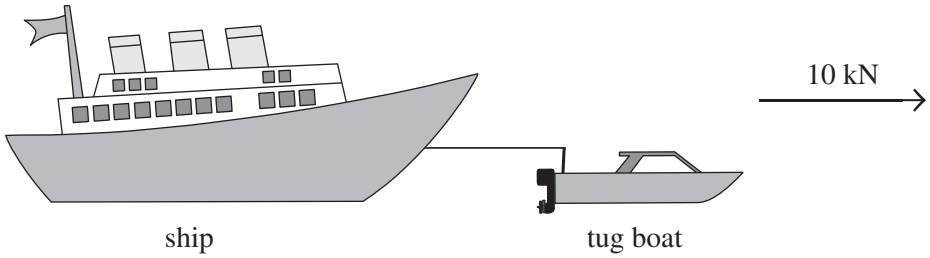

Figure 3

a. Calculate the magnitude of the tension in the rope between the tug boat and the ship. 2 marks

N

b. Calculate the mass of the ship. 3 marks

kg

Question 4 (8 marks)

Figure 4 shows the top view of a car travelling at a constant speed of 20 m s^{-1} anticlockwise around a large circular roundabout of radius 100 m. The direction of north is indicated by N. The centre of the car is at point P.

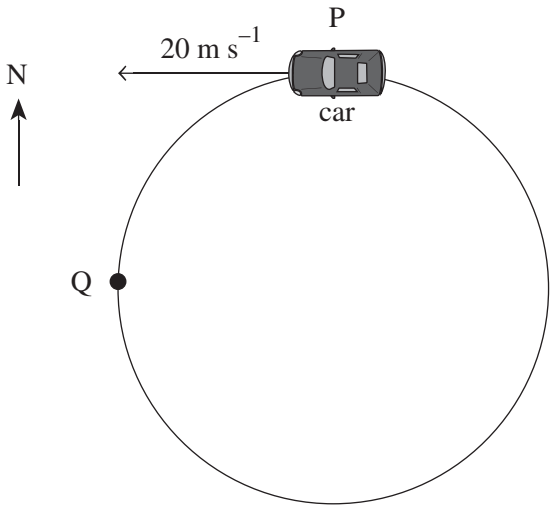

Figure 4

a. Which of the following options (**A**–**G**) below correctly describes the direction of the velocity, acceleration and centripetal force of the car at point P? 1 mark

	Velocity	Acceleration	Centripetal force
A.	west	west	west
B.	west	none	none
C.	west	west	south
D.	west	south	south
E.	east	south	north
F.	east	south	south
G.	east	north	north

The mass of the car is 1000 kg.

b. Calculate the magnitude of the centripetal force acting on the car. 2 marks

N

c. Explain the force, and determine its magnitude, that is keeping the car moving in a circle. 2 marks

_____

_____

N

The car now travels onto a circular banked track. The speed of the car is 20 m s^{-1} and the radius of the circular track is 100 m. The angle of the track (θ) is organised so that at this speed the only forces acting on the car are as shown in Figure 5.

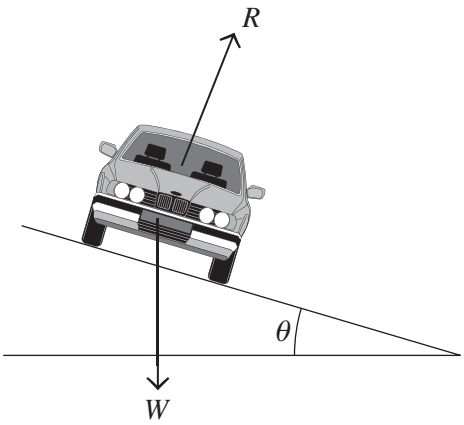

Figure 5

d. Calculate the angle of banking of the track. 3 marks

°

Question 5 (16 marks)

A ball is swung in a horizontal circle at a constant speed from the end of a string that is $L = 1.0$ m long. The string makes an angle of $\theta = 30°$ with the vertical. The mass of the ball is 0.100 kg. This is shown in Figure 6.

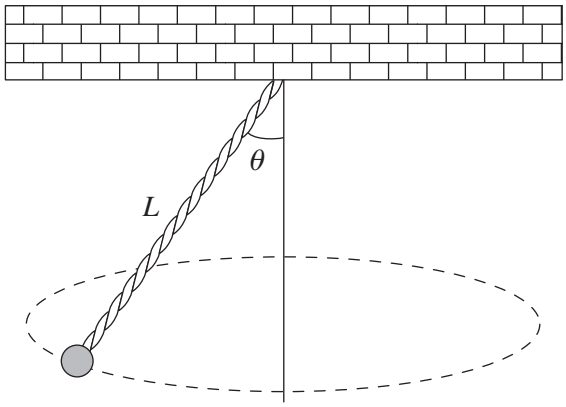

Figure 6

a. Determine the tension in the string. 2 marks

N

b. Determine the net force acting on the ball. 2 marks

N

c. What is the speed of the ball? 2 marks

m s^{-1}

d. What is the period of rotation of the ball? 2 marks

s

The string is now whirled in a vertical circle as shown in Figure 7.

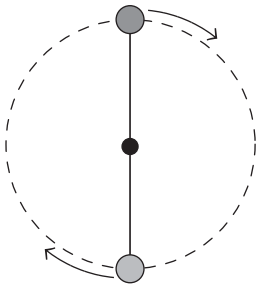

Figure 7

e. Determine the speed of the ball at the top of the path when the string tension is equal to the weight of the ball. 3 marks

m s^{-1}

f. Determine the minimum speed of the ball at the top of the path that allows the ball to maintain its circular path. 2 marks

$m\ s^{-1}$

g. Calculate the speed of the ball at the bottom of the path so that the string tension is equal to twice the weight of the ball at this point. 3 marks

$m\ s^{-1}$