KINGSWAY CHRISTIAN COLLEGE

Year 12 ATAR Physics 2017

Task 2

Test: Gravity, Satellites, Motion and Torque.

Name _____

Date due: ***Friday, 17 March 2017***

Time allowed 80 minutes

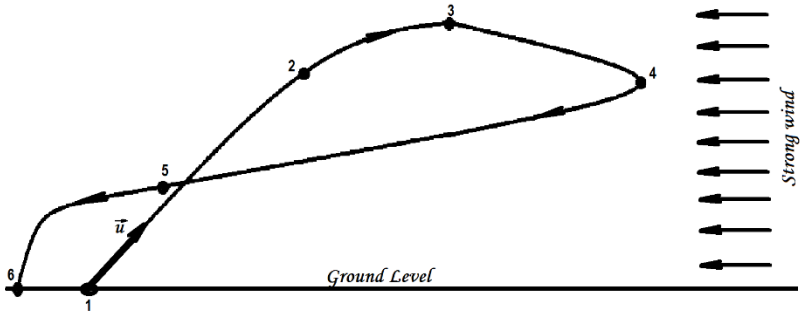
Section A	**Available mark**	**Student mark**
Question 1	7	
Question 2	7	
Question 3	7	
Question 4	8	
Question 5	17	
Question 6	14	
Question 7	8	
Question 8	10	
Question 9	8	
Total marks	***86***	
%	***100***	

Section A: Short answer questions. Write the answers in the spaces provided.

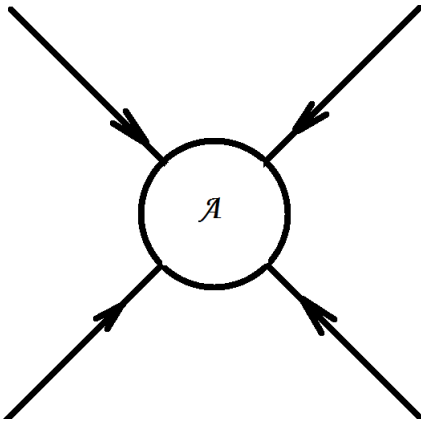
1. A projectile is fired from position 1 on a very windy day and its path is affected by the wind effects (resistance and drag). The initial velocity is shown as $\vec{u}$.

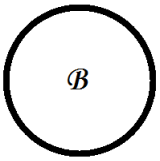
a) Draw and label on the same diagram, the path the projectile would have taken, if there was no wind. [2]

b) Use arrows to indicate the total velocity and total acceleration at the positions labelled 2, 3, 4, 5 and 6. Point 6 is just before landing. [5]



2. a) The gravitational field around an object A with mass m is shown below. Draw the gravitational field for an object B of the same size but with mass 2m. [2]





b) Objects A (mass m), B (mass 2m) and C (mass m) are positioned as shown. C at the centre and A and 2 × B at the vertices of an equilateral triangle.

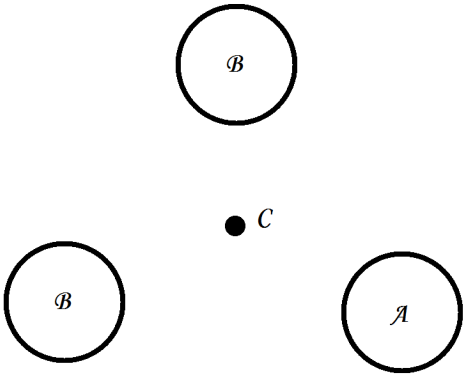
Draw vectors to represent the following:

i) The force on C due to A, [1]

ii) The force on C due to the top B [1]

iii) The force on C due to the bottom B [1]

iv) The resultant force on C due to A and 2 × B. [2]



3. a) Two rowers, who can row at the same speed in still water, set off across a river at the same time. One heads straight across and is pulled downstream somewhat by the current. The other one heads upstream at an angle so as to arrive at a point opposite the starting point. Which rower reaches the opposite side first? [3]

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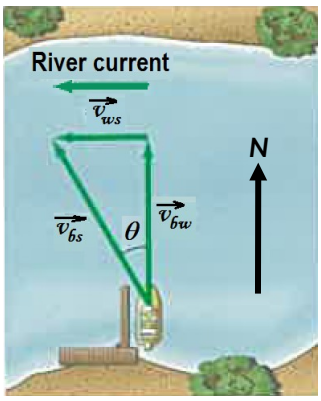
b) A boat that can move in still water with a speed $v_{bw} = 1.85 m.s^{-1}$ heads directly across the river whose current is $v_{ws} = 1.20 m.s^{-1}$.

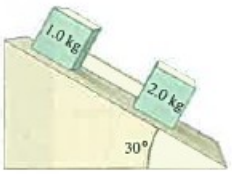
i) What is the velocity (magnitude and direction) of the boat relative to the shore, $\vec{v}_{bs}$? [2]



ii) If the river is 110 m wide, how long will it take to cross and how far downstream will the boat be then? [2]

4. Two boxes, m_1 = 1.0 kg with friction = 0.20 times the normal reaction, and m_2 = 2.0 kg with friction = 0.10 times the normal reaction, are attached with an inextensible cord and placed on a plane inclined at $\theta = 30^\circ$.

a) Draw a free body diagram of the forces acting on m_1. [2]

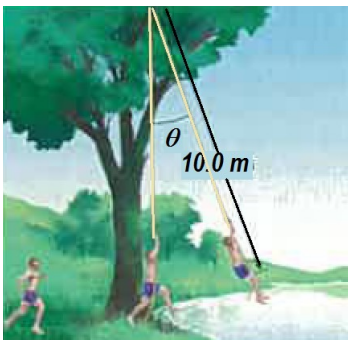


b) Draw a free body diagram of the forces acting on m_2. [2]

c) Write the equations of motion in a direction parallel and perpendicular to the plane and solve for the tension in the cord and the acceleration of the system. [4]

Section B: Problem solving. Answer the questions in the spaces provided. Show all working.

5. a) A 65-kg student runs at 7.0 $m.s^{-1}$ grabs a rope, and swings out over a lake. He releases the rope when his speed is zero.

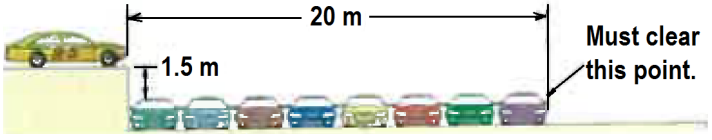


i) What is the angle θ when he releases the rope? [2]

ii) What is the tension in the rope just before he releases it? [2]

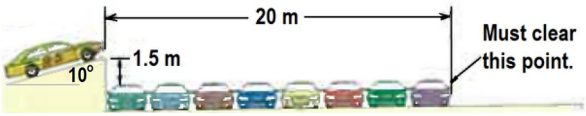
iii) What is the maximum tension in the rope? [2]

b) A stunt driver wants to make his car jump over eight cars parked side by side below a horizontal ramp.



i) With what minimum speed in $km.h^{-1}$ must he drive off the horizontal ramp? The vertical height of the ramp is 1.5 m above the cars, and the horizontal distance he must clear is 20 m. [3]

ii) If the ramp is now tilted upward, so that "take-off angle" is 10^{o} above the horizontal, what is the new minimum speed in km. h^{-1} ? [3]



iii) What is velocity of the stunt car as it crosses “Must clear this point.” [3]

iv) What is the maximum height of the stunt car above the top of the lined cars? [2]

6. a) What is the difference between a geosynchronous and a geostationary satellite? [2]

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b) Calculate the altitude of a geostationary satellite and give two uses of such a satellite. [3]

c) A 1800 kg satellite is orbiting the earth at an orbital radius of 6.87×10^6 m. Calculate

i) The gravitational force of attraction on the satellite [2]

ii) The gravitational field strength of the earth at the orbit [2]

iii) The acceleration due to gravity of the earth at the orbit [1]

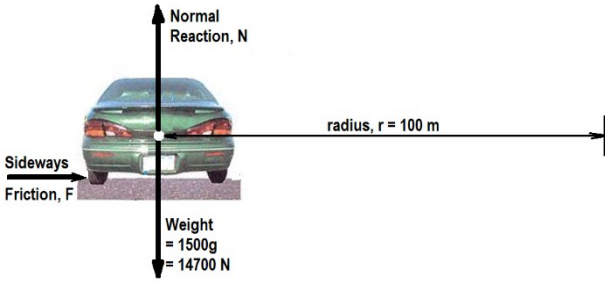
iv) The period of the satellite in this orbit [1]

v) The orbital speed of the satellite [1]

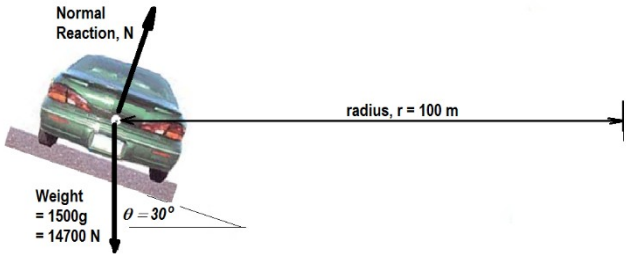
vi) The satellite is to be moved to an orbit with double the period. What will be the new orbital radius of the satellite? [2]

7. A 1500 kg car is negotiating a circular round about with a radius r = 100m. At the instant shown it is heading North at 60 km.h^{-1}.

a) Calculate the sideways friction force, F required to keep the car in circular motion. [2]

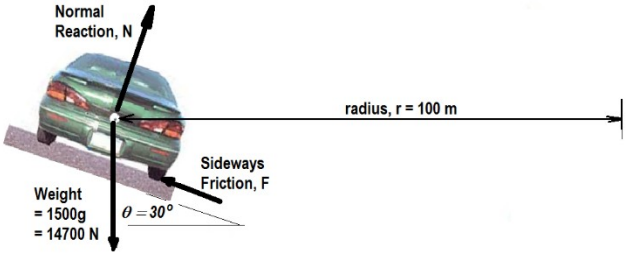


b) The same car is now travelling at optimal speed (no tendency of sideways friction) on a ramp inclined at $\theta = 30^{o}$. The pathway is still circular with radius r = 100 m. Calculate the optimal speed required on this ramp. [2]



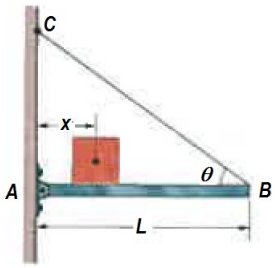
c) The car is still on the 30° ramp and on the circular path with radius = 100 m. However, this time a sideways frictional force of 600 N acts up the slope as shown. Calculate the normal reaction, N and the car speed in $km.h^{-1}$.

[4]



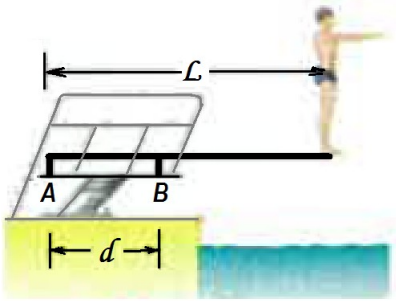
8. a) The length L of the uniform bar is 3.00 m and its weight is 200 N. Also, let the block's weight W = 300 N and the angle $\theta = 30^{o}$. The wire can withstand a maximum tension of 500 N.

i) What is the maximum possible distance x before the wire breaks? [2]



ii) With the block placed at this maximum x, what are the horizontal and vertical components of the force on the bar from the hinge at A? [2]

b) A diver of weight 580 N stands at the end of a diving board of length L = 4.5 m and negligible mass. The board is fixed to two pedestals, A and B, separated by distance d = 1.5 m. Of the forces acting on the board, what are the

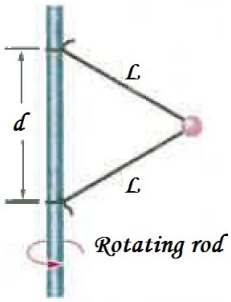


i) magnitude and direction (up or down) of the force from the left pedestal A. [2]

ii) magnitude and direction (up or down) of the force from the right pedestal, B? [2]

iii) Which pedestal (A or B) is being stretched, and which is being compressed? [2]

9. A 15.0 N ball is connected by means of two massless strings, each of length L = 2.00 m, to a vertical, rotating rod. The strings are tied to the rod with separation d = 2.00 m and are taut. The tension in the upper string is 1530 N. What are the



a) tension in the lower string, [2]

b) the net force $\overrightarrow{F_{net}}$ on the ball, and [2]

c) speed of the ball in $m.s^{-1}$ and rpm [4]

END of Task 2.