

Physics ATAR - Year 12

Gravity and Motion Test 2 2019

Name:

Mark: / 61

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Teacher: HKR JRM
(Please circle)

Time Allowed: 50 Minutes

Notes to Students:

1. You must include **all** working to be awarded full marks for a question.
2. Marks will be deducted for incorrect or absent units and answers stated to an incorrect number of significant figures.
3. **No** graphics calculators are permitted – scientific calculators only.

Question 1**(6 marks)**

The top of Mount Everest is 8850 m above sea level.

- (a) Calculate the effective magnitude of gravity on the top of Mount Everest. That is, the acceleration due to gravity of objects allowed to fall freely at this altitude.

(4 marks)

- (b) Provide two reasons why this value is considered an estimate.

(2 marks)

Question 2**(5 marks)**

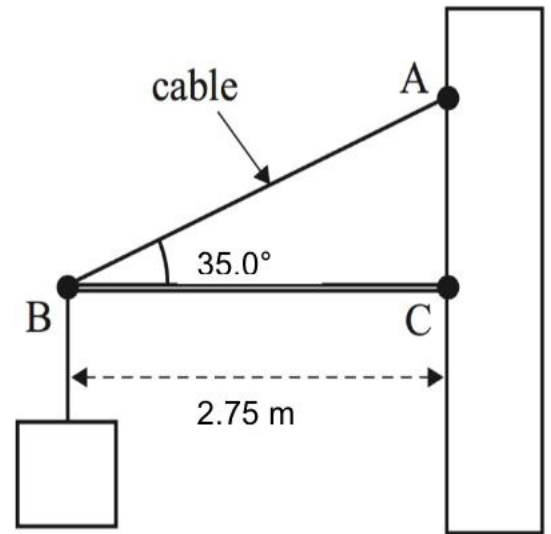
Charon orbits Pluto in 6.3873 Earth days, following a circular path with an average radius of 19,640 km. Calculate the mass of Pluto using the information given to 3 significant figures.

Question 3**(9 marks)**

A 2.75 m horizontal beam of uniform mass is attached to a wall, as shown below. The mass of the beam is 25.0 kg and there is a hanging mass at point B. Point C is a hinge and the cable is attached at an angle of 35.0° to the beam. The maximum tension the cable can provide before snapping is 1.75 kN.

- (a) Calculate the maximum mass that can be suspended at point B if a safety factor of 3 is applied, that is, the maximum mass would cause a tension in the cable that is 3 times less than its snapping limit.

(4 marks)



- (b) Calculate the reaction force the hinge exerts on the beam at Point C.
(If you could not do (a), use $m = 35.0$ kg)

(5 marks)

Question 4**(11 marks)**

The International Space Station (ISS) orbits the Earth at an average altitude of 408 km. Due to factors such as tidal effects and aerodynamic drag from residual atmosphere, the ISS experiences an 'orbital decay' of approximately 2.05 km/month. The ISS has thrusters that periodically fire to return the ISS to its average altitude.

- (a) Calculate the change in speed of the ISS from its average altitude in a time of 3.00 months. (5 marks)

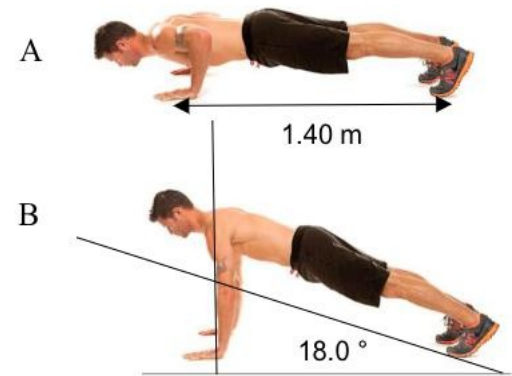
- (b) Explain the effect that this decay in orbit would have on the period of orbit. (3 marks)

- (c) State the direction that the thrusters must apply the force to return the ISS to its average altitude and explain why. (3 marks)

Question 5**(9 marks)**

A student wants to know the effective force he applies from his hands when performing a push-up. He knows that his center of mass is located near his belly-button, a height of 1.10 m, and his mass is 71.0 kg.

- (a) If the student is in a 'low plank' as shown in diagram A, calculate the combined force that his hands must exert on the ground to remain stationary.

(3 marks)

- (b) Calculate the combined force of the ground exerted on the student's feet in this position.

(3 marks)

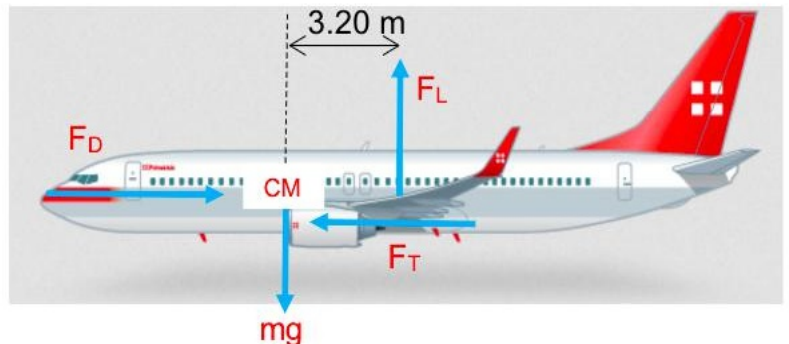
The student then performs a push-up and remains stationary in a 'high plank' as shown in diagram B. In doing so, his arms remain vertical and his body-line is now inclined to an angle of 18.0° above the horizontal.

- (c) With the use of an appropriate equation, state and explain the change in combined force that his hands must exert on the ground, if any, that this position has compared to diagram A. (3 marks)

Question 6

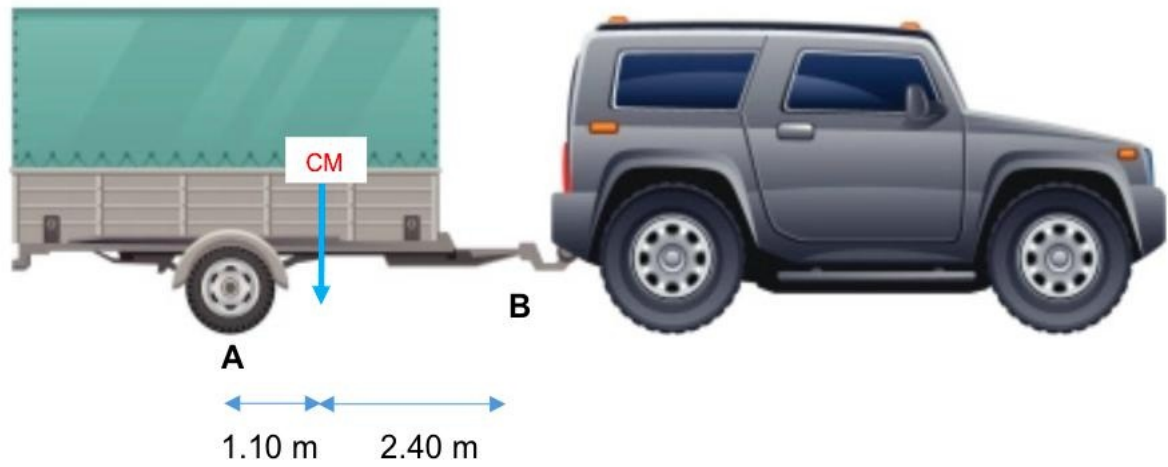
(6 marks)

The forces acting on a 67,000 kg aircraft flying at a constant velocity are shown in the diagram. The engine thrust $F_T = 5.00 \times 10^5$ N acts on a line 1.60 m below the centre of mass CM. Calculate the drag force F_D and the distance above the centre of mass that it acts. Assume F_D and F_T are horizontal.



Question 7**(6 marks)**

A 2250 kg trailer is attached to a stationary truck at point B. Calculate the normal force exerted by the road on the rear tyres at point A and the vertical force exerted on the trailer by the support B.



Question 8**(5 marks)**

Calculate the altitude a satellite must be placed such that the magnitude of the gravitational field strength is half of that on the surface of the Earth.

Question 9**(4 marks)**

Consider a point, 'X' between two masses 'M' and 'm' where the net gravitational force produced by the two masses is zero. The diagram shows the relative distances in R from each of the masses.



Calculate the ratio of the masses m/M given the information above.

END OF TEST