EXAM #3

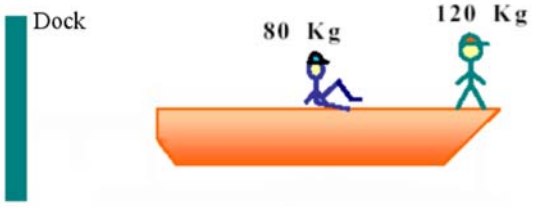
MECHANICS
40% of the final grade

Winter 2016 Name:_____

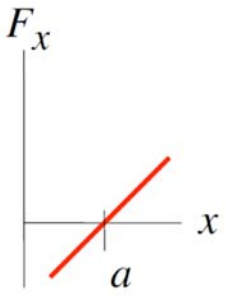
Each multiple-choice question is worth 2 marks.

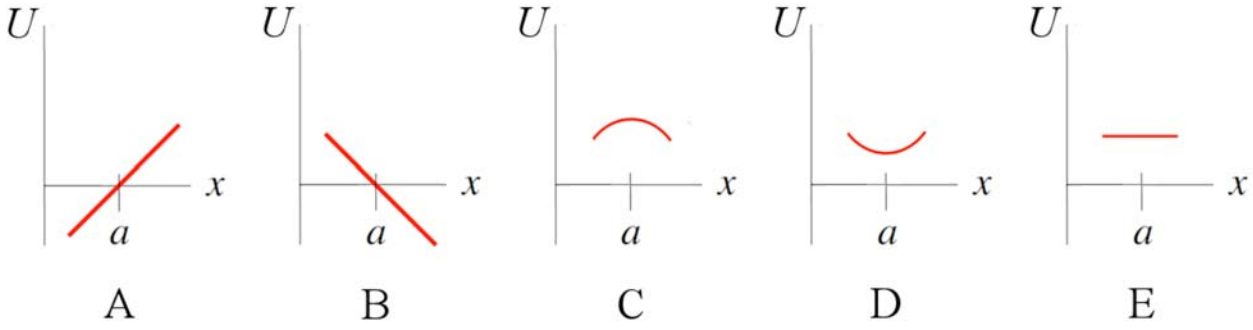
1. A rowboat is located at a certain distance from a dock. In the boat, there is an 80 kg person and a 120 kg person. Neglecting the friction exerted by water, what happens if the 80 kg person changes position with the 120 kg person?

- ❑ The boat moves away from the dock.
- ❑ The boat remains the same distance from the dock.
- ❑ The boat moves away or closer to the dock, depending on its mass.



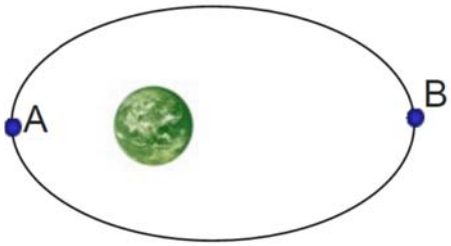
2. Here is the graph of a conservative force acting on an object as a function of its position. Which of the following graphs is the only one that can properly represent U close to a?





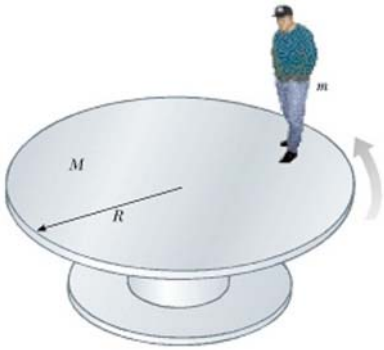
Answer:_____

3. A satellite is on an elliptical orbit around the Earth. When the satellite goes from point A to point B, the net work done on the satellite is...

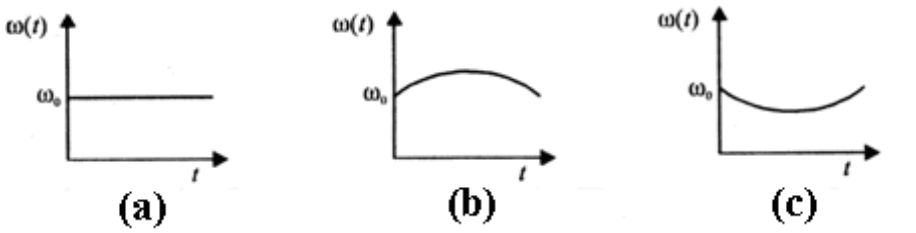


- ❑ positive.
- ❑ negative.
- ❑ zero.
- ❑ positive, negative or zero, depending on the mass of the satellite.

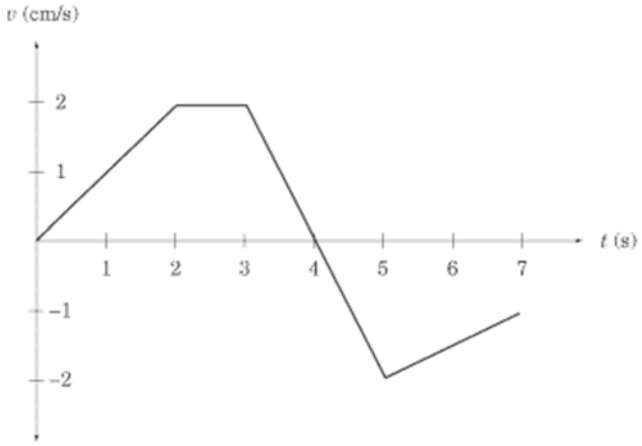
4. A circular platform turns without friction with speed ω_0 about an axis passing through its centre. A person on the edge of the platform is walking towards the other side of the platform at a constant speed passing through the centre. Which graph shows the angular velocity of the platform as a function of time while the person moves from one side of the platform to the other?



- ❑ a
- ❑ b
- ❑ c

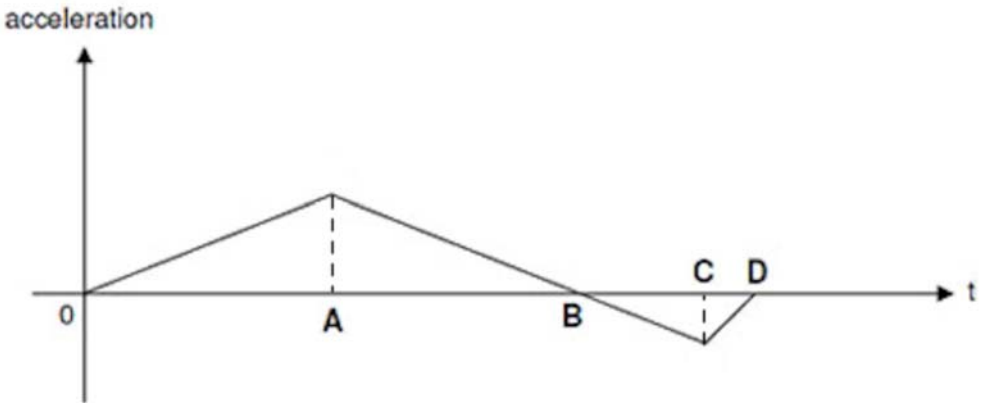


5. Here is the graph of the speed of a 4 kg object as a function of time.



The net work done on the object between t = 2 s and t = 4 s is _____ J.

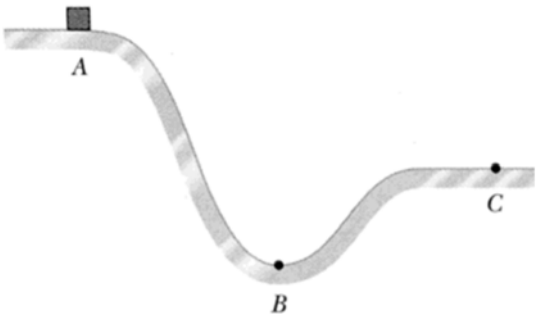
6. This is the graph of the acceleration of an object as a function of time. The initial velocity of the object is zero.



At what instant does the object have the largest speed?

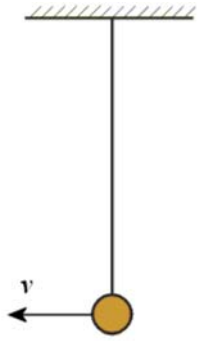
- ❑ At time A
- ❑ At time B
- ❑ At time C
- ❑ At time D

7. A block slides down the slope shown in the figure. When it arrives at point B, the frictional force on the block is...



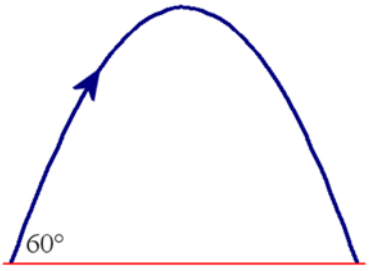
- ❑ equal to $\mu_c mg$.
- ❑ larger than $\mu_c mg$.
- ❑ smaller than $\mu_c mg$.

8. In the situation shown in the figure...



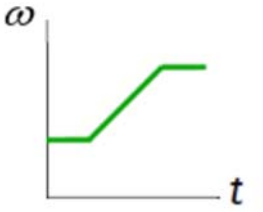
- ❑ the tension of the rope is greater than the weight of the pendulum.
- ❑ the tension of the rope is the same as the weight of the pendulum.
- ❑ the tension of the rope is smaller than the weight of the pendulum.

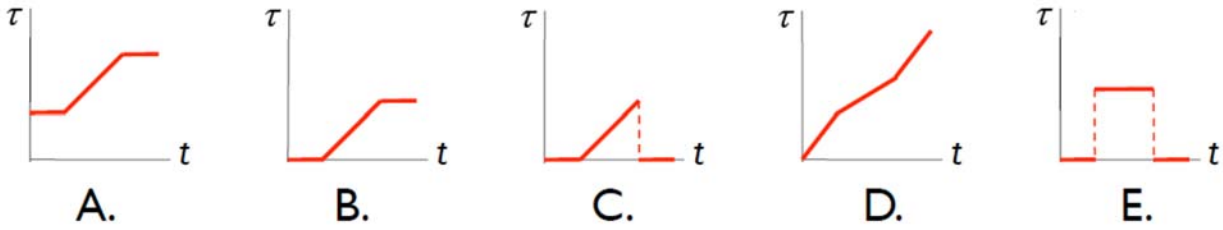
9. A projectile thrown with a 60° launch angle falls to the ground. What happens if the launch angle is increased to 65°? (Ignoring air friction.)



- ❑ The maximum height increases and the range increases.
- ❑ The maximum height increases and the range decreases.
- ❑ The maximum height decreases and the range increases.
- ❑ The maximum height decreases and the range decreases.

10. This is the graph of the angular speed of an object as a function of time. Which of the following graphs is the graph of the net torque acting on the object?





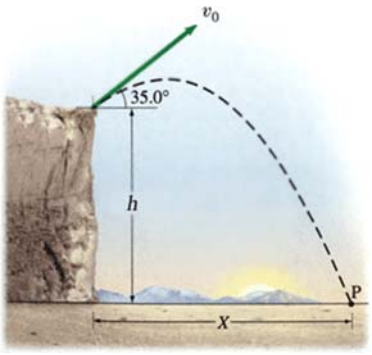
Answer: _____

11. In an elevator, the apparent weight of a person is less than mg. Identify all the situations where this is possible.

1. The elevator moves upwards with a constant speed.
2. The elevator moves downwards with a constant speed.
3. The elevator moves upwards and its speed decreases.
4. The elevator moves downwards and its speed decreases.
5. The elevator moves upwards and its speed increases.
6. The elevator moves downwards and its speed increases.

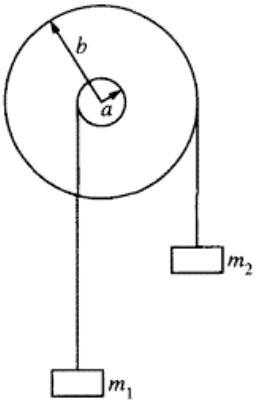
Answer(s): _____

12. How does the velocity of the projectile when it hits the ground change if the launch angle is increased to 45° while keeping the same initial speed? (Ignoring air friction.)



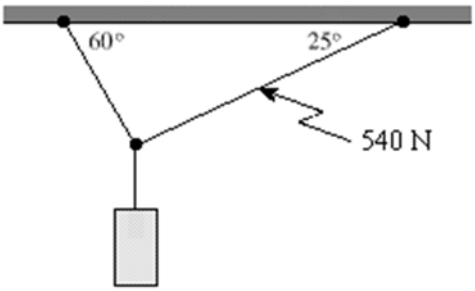
- ❑ It increases.
- ❑ It decreases.
- ❑ It stays the same.
- ❑ It depends on the height of the cliff.

13. In the situation shown in the figure, which mass is the largest if the pulley is in a rotational equilibrium?



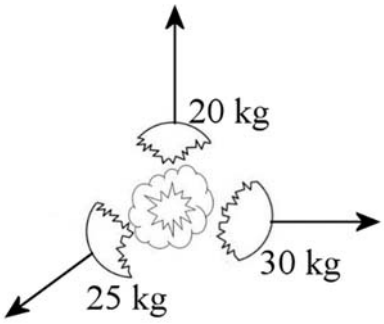
- ❑ Mass 1
- ❑ Mass 2
- ❑ The two masses are the same.

14. In the situation shown in the figure, the tension of the rope to the left is...



- ❑ greater than 540 N.
- ❑ equal to 540 N.
- ❑ smaller than 540 N.

15. A bomb initially at rest explodes into three fragments as shown in the figure. Which of these three pieces has the largest momentum? (I'm talking about the magnitude of the momentum.)



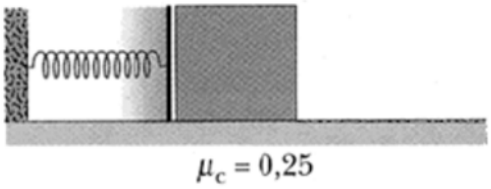
- ❑ The 20 kg piece
- ❑ The 25 kg piece
- ❑ The 30 kg piece
- ❑ They all have the same momentum

Answers:1a 2c 3b 4b 5 -0,008J 6b 7b 8a 9b 10e 11 3 and 6 12c 13a 14a 15b

16. (15 points)

A 100 kg box (when empty) initially at rest is resting against a 1 m compressed spring. The spring constant is 6400 N/m and the coefficient of friction between the box and the ground is 0.25. Ignore air friction.

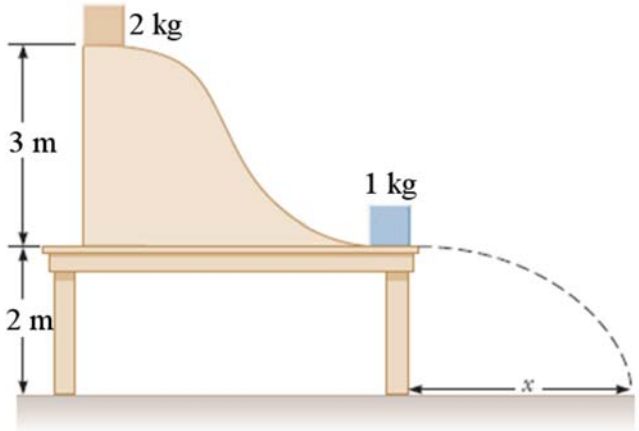
a) What is the speed of the box when the spring is neither compressed nor stretched?
b) What is the total distance travelled by the box before it stops?
c) Now suppose that we redo this experiment but with Claudia, whose mass is 50 kg, locked inside the box. What is the number of g experienced by Claudia when the compression of the spring is 50 cm?



Answers: a) 7.688 m/s b) 13.06 m c) 2.171

17. (10 points)

In the situation shown in the figure, a 2 kg block initially at rest slides down a frictionless incline to finally hit a 1 kg block at rest. After a completely inelastic collision, the two blocks fall to the ground. At what distance from the table did the blocks fall? (x in the figure.) Ignore air friction.

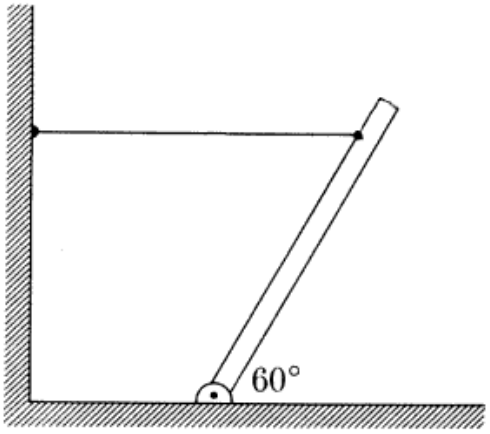


Answer: 3.266 m

18. (15 points)

A 600 kg beam can rotate without any friction around a pivot linking the end of the beam to the ground. A 5 m long rope prevents the beam from falling. The beam has a length of 4 metres and the rope is fixed at 20 cm from the end of the beam. The rope is exactly horizontal. Ignore air friction.

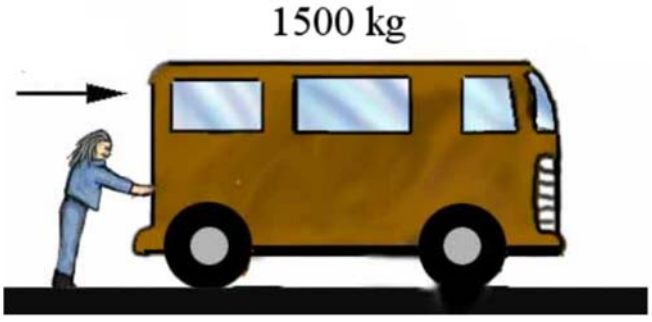
a) What is the tension of the rope?
b) How fast will the tip of the beam hit the ground if the rope breaks?



Answers: a) 1787 N b) 10.09 m/s

19. (10 points)

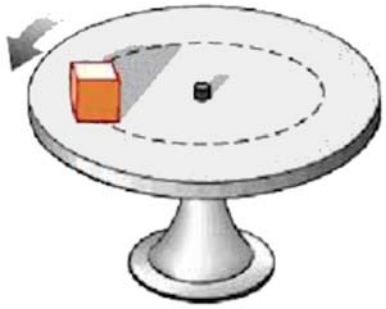
Mohammed pushes his vehicle for 10 s with a constant force. During this time, Mohammed's average power is 2 hp. After being pushed, the vehicle continues to move, but its motion ends because there is a 50 N constant friction force opposed to the motion of the vehicle (acting even when Mohammed is pushing). What is the total distance travelled by the vehicle (between the moment Mohammed starts pushing and the moment the vehicle stops)?



Answer: 298.4 m

20. (10 points)

A 200 g block is on a turntable with a radius of 40 cm. The distance between the block and the centre of the table is 25 cm and the coefficient of static friction between the block and the table is 0.8. What is the maximum possible angular speed so the block does not slide?



Answer: 5.6 rad/s

21. (10 points)

During an expedition on Mars, Arthur slips and falls into the Valles Marineris Canyon, with a depth of 7 km. We will neglect air resistance in this problem (anyway, it is very weak on Mars) and the variation of g with the altitude.

a) What is the duration of Arthur's free fall?
b) How fast will Arthur hit the bottom of the canyon?

Use the following data:
Mars's mass = 6.4185×10^{23} kg
Mars's radius = 3386 km

Answer: a) 61.21 s b) 228.7 m/s