Final Exam

Please note the questions below can be edited and changed by your instructor. The printed version is NOT guaranteed to match the online version at a later stage.

Homework Questions

Q1

(1 points)

Which of the following is a scalar quantity?

Select the correct answer

- Velocity
- Acceleration
- Displacement
- None of these
- Speed

Q2

(1 points)

Which of the following is a vector quantity?

Select the correct answer

- Speed
- None of these
- Density
- Mass
- Temperature

Q3

(1 points)

Which of the following statements is true for an object in uniform circular motion:

Select the correct answer

- The instantaneous velocity and instantaneous acceleration vectors are both perpendicular to the circular path.
- none of the above
- The instantaneous velocity and instantaneous acceleration vectors are both tangent to the circular path.
- The instantaneous velocity and instantaneous acceleration vectors are perpendicular to each other.
- The instantaneous velocity and instantaneous acceleration vectors are opposite to each other.

Q4

(1 points)

You are in an elevator. You will experience the largest apparent weight when the elevator...

Select the correct answer

- moves downward at constant speed
- moves downward with increasing speed
- remains stationary
- moves upward with decreasing speed
- moves upward with increasing speed

Q5

(1 points)

Superman is flying at a constant 686 m/s (twice the speed of sound) and experiencing an air drag force of 352,800 N.

According the 1978 superman movie, Lois Lane interviews the man of steel to obtain the following information:

LOIS: And how big are you? How tall are you?
SUPERMAN: About six four.
LOIS: And, uh, how much do you weight?
SUPERMAN: Around two twenty-five.

Taking this information, 225 pounds is around 102 kg, which you can treat as superman's mass.

The magnitude of the net force on superman is...

Image size: s M L Max

Select the correct answer

- 0 N
- none of these
- 999.6 N
- 353800 N
- 352801 N

Q6

(1 points)

In uniform circular motion,

Select the correct answer

- the velocity is always constant in magnitude and direction.
- the velocity is always changing direction but the acceleration is always in the same direction.
- the acceleration is always constant in magnitude and direction.
- the net force is always constant in magnitude and direction.
- both the acceleration and the velocity are continually changing direction.

Q7

(1 points)

An object moves in a circle at constant speed. The work done by the centripetal force is zero because:

Select the correct answer

- the average force for each revolution is zero
- the magnitude of the acceleration is zero
- the centripetal force is perpendicular to the velocity
- the displacement for each revolution is zero
- there is no friction

Q8

(1 points)

When a wheel rolls without slipping,

Select the correct answer

- its motion is purely rotational.

- its motion is purely translational.
- whether its motion is purely rotational or purely translational depends on whether it is rolling up or downhill.
- its motion is a combination of rotational and translational motion.
- every point on its rim has the same linear velocity.

Q9

(1 points)

Pure rolling motion requires friction forces, but we can still rely on the conservation of mechanical energy because...

Select the correct answer

- there is no friction in the real world
- the angular velocity of the center of mass about the point of contact is zero
- the linear velocity of the point of contact (relative to the inclined surface) is zero
- the coefficient of static and kinetic friction are equal
- the coefficient of kinetic friction is zero

Q10

(1 points)

Consider that a coin is dropped into a wishing well. You want to determine the depth of the well from the time T between releasing the coin and hearing it hit the bottom. If the speed of sound is 330 m/s, and $T = 2.57$ seconds, what is the depth h of the well?

Select the correct answer

- 23.1 m
- 26.2 m
- 33.6 m

- 39.8 m
- 30.1 m

Q11

(1 points)

When a 4.10 kg mass is hung veritcally on a light spring that obeys Hooke's law, the spring stretches 2.11 cm. How much work must an external agent do to stretch the spring 4.52 cm from its equilibrium position?

Select the correct answer

- 1.95 J
- 1.31 J
- 1.47 J
- 2.53 J
- 2.22 J

Q12

(1 points)

Calculate the centripetal force required to keep a 4 kg mass moving in a horizontal circle of radius 0.8 m at a speed of 6 m/s.

[$\hat{r}$ is the radial vector pointing outward with respect to the center of the circle]

Select the correct answer

- 180 N $\hat{r}$
- -30.0 N tangent to the circle

- 1440.0 N $\hat{r}$
- 39.2 N tangent to the circle
- -180 N $\hat{r}$

Q13

(1 points)

Here we go again...

After a terrifying experience during her last solo ride with Magic Carpet, in hindsight, Jazmine realizes she quite enjoyed the thrill of that experience. On her next opportunity to ride with Carpet, she requests to fly around in a loop-the-loop circle all over again with uniform speed v, with a careful request this time that Capet doesn't go so fast to risk her falling off!

If Jazmine experiences an apparent weight at the bottom of the loop that is twice her apparent weight at the top of the loop, what is the radius of the circular path?

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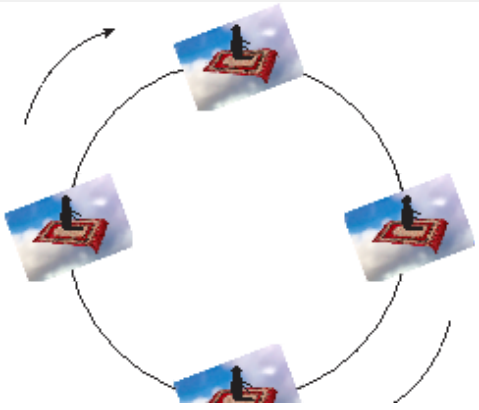

Select the correct answer

- $3v^2/g$
- $5v^2/g$
- $2v^2/g$
- v^2/g
- $4v^2/g$

Q14

(1 points)

A bullet of mass $m = 0.00340$ kg makes a completely inelastic collision with a block of mass $M = 0.0582$ kg which is initially at rest. After the collision, the block then slides forward on a frictionless track into a circular loop of radius $R = 1.83$ m. What is minimum speed of the bullet in order to push the block through the circular loop track?

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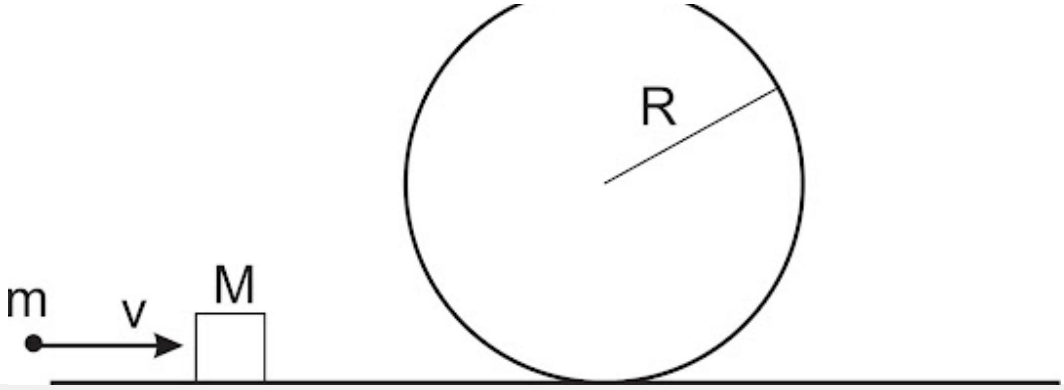


Select the correct answer

- 172 m/s
- 151 m/s
- 120 m/s
- 215 m/s
- 255 m/s

Q15

(1 points)

Let the application of a force be $\vec{F}$ = (8.11, -5.72, 0.909) N be at a position $\vec{r}$ = (-3.47,-9.27,2.16) m in some cartesian coordinate system. Calculate the magnitude of torque about the origin due to this force.

Please enter a numerical answer below. Accepted formats are numbers or "e" based scientific notation e.g. 0.23, -2, 1e6, 5.23e-8

Q16

(1 points)

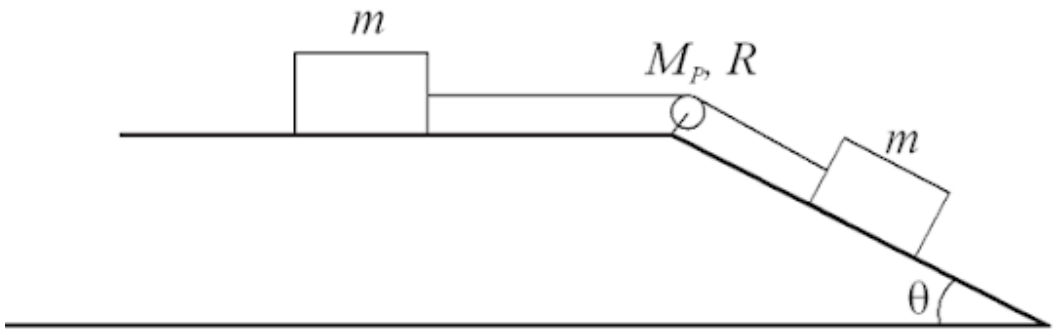
Look familiar? This is the same system that we encountered on Midterm 2, but now we will deal with a massive pulley!

Two identical 5.41 kg boxes are connected by a string and pulley with the first block resting on a horizontal surface and the second block inclined on slope with an angle of 37.0° above horizontal, as shown in the figure below. The pulley has a moment of inertia, $I = \frac{2}{3} M_P R^2$, where M_P = 8.59 kg is the mass of the pulley and R = 4.73 m is the radius of the pulley. The system is released from rest and the blocks begin to slide. The coefficient of kinetic friction between the blocks and the surface are μ_k = 0.15.

Assume the string is massless and does not slip across the pulley.

What is the acceleration of the blocks?

Image size: s M L Max



Please enter a numerical answer below. Accepted formats are numbers or "e" based scientific notation e.g. 0.23, -2, 1e6, 5.23e-8

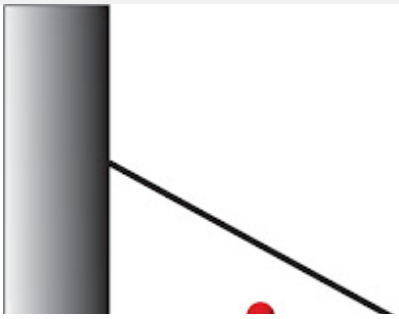
Q17

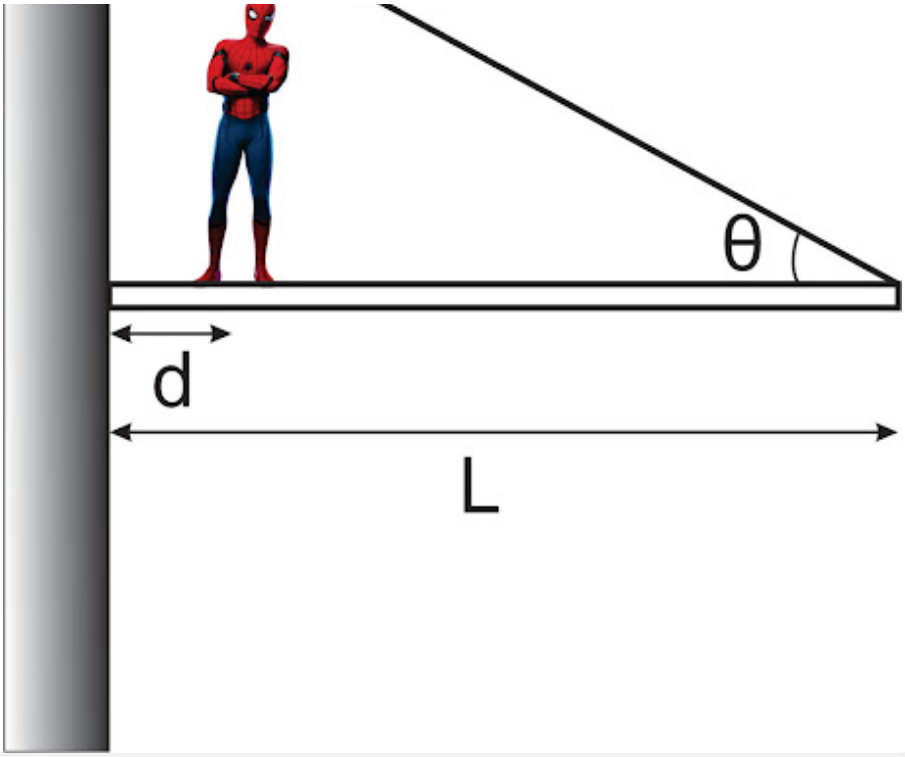
(1 points)

A horizontal beam of length $L = 11.1$ m and weight 207 N is attached to a wall as shown. The far end is supported by a cable which makes an angle of 60 degrees with respect to the beam. Spiderman stands $d = 3.82$m from the wall and weighs 520 N. Determine the tension in the cable.

[Hint: Try picking the point of contact between the beam and the wall as a reference point for the calculation of torques.]

Image size: s M L Max





Please enter a numerical answer below. Accepted formats are numbers or "e" based scientific notation e.g. 0.23, -2, 1e6, 5.23e-8

Q18

This question contains multiple parts. Make sure to read all the instructions and answer each part.

In this question, you will compare the motion of a rolling object to that of point mass.

Hint: While not strictly a requirement, finding a symbolic solution to parts a) and b) before plugging in your numbers will make part c) come out really nice... =)

Part a (1 points)

A point particle of mass 0.200 kg is released from rest a height of $h = 1.60$ m. What is its final velocity after it falls through this height?

Please enter a numerical answer below. Accepted formats are numbers or "e" based scientific notation e.g. 0.23, -2, 1e6, 5.23e-8

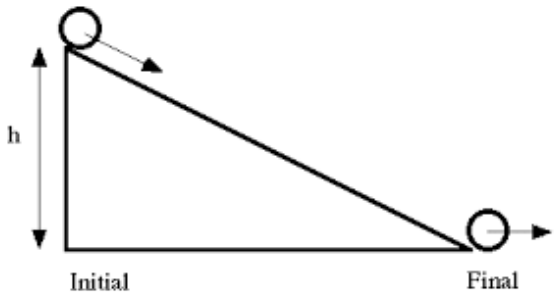
Part b (1 points)

A uniform solid cylinder of mass 0.200 kg and radius $r =$ m rolls without slipping on its side down

an incline from a height $h = 1.60$ m. What is the final linear speed of the cylinder at the bottom of the incline?

[The moment of inertia of the rolling cylinder is $I = \frac{1}{2}mr^2$]

Image size: s M L Max



Please enter a numerical answer below. Accepted formats are numbers or "e" based scientific notation e.g. 0.23, -2, 1e6, 5.23e-8

Part c

(1 points)

Both point mass in part a) and the cylinder in part b) have the same mass. Determine the ratio of the final speed of the cylinder at the bottom of the ramp from part b) to the speed of the point object dropped vertically downward from the same height h in part a).

Select the correct answer

- 1
- 2
- $\sqrt{3}$
- $\sqrt{2/3}$
- $\sqrt{2}$

Q19

(1 points)

A neutron star is the collapsed core of a massive supergiant star. Except for black holes, neutron stars are the smallest and densest currently known class of stellar objects. They are so dense that a normal-sized matchbox containing neutron-star material would have the same weight as a 0.5 cubic km chunk of the Earth (a cube with edges of about 800 metres) from Earth's surface. In the formation of a neutron star, the star's core collapses and experiences an enormous increase in its rotational speed. Let us consider the collapse of a supermassive star into neutron star.

Suppose a large star initially with a mass of 4.38×10^{30} kg and a radius of 7.97×10^{5} m is initially spinning at a rate of one rotation every 35 Earth days. In the collapse to a neutron star, its radius shrinks to 17.2 km. Assume that during the collapse the mass of the star remains constant (not true in reality but good enough for this problem). Use conservation of angular momentum to find the new angular speed of the neutron star's spin in rotations per second.

Treat both the original star and the neutron star after collapse as uniform solid spheres. The moment of inertia of solid sphere of mass M and radius R is $I = \frac{2}{5}MR^2$

Please enter a numerical answer below. Accepted formats are numbers or "e" based scientific notation e.g. 0.23, -2, 1e6, 5.23e-8