Dawson College

Physics 203-SN1-RE Mechanics

Sample Final Examination

This exam is divided into two parts:

Part I: Problems (*10 marks each*) Solve all six (6) problems. Show all of your work, clearly and in order, to receive full marks. If you use a formula not given on the formula sheet, a derivation must be shown.

Part II: Multiple Choice Questions (*2 marks each*) Answer all twenty (20) questions. Circle the best response from the choices given. If your final selection is unclear you will not be given the marks. No marks will be awarded for diagrams, calculations, or reasoning.

Additional instructions:

1. The best way to use this practice exam is to set aside three hours (the time you will have in the real exam) and do it. Look at the answers and solutions only after you tried writing the whole sample exam.
2. Answer and solutions are found at the end of this document.
3. Use $g = 9.81\,\text{m/s}^2$ for the magnitude of the acceleration due to gravity.

Good luck! ☺

Part I: Problems (*10 marks each*)

Solve all six problems. Show all of your work, clearly and in order, to receive full marks. If you use a formula not given on the formula sheet, a derivation must be shown.

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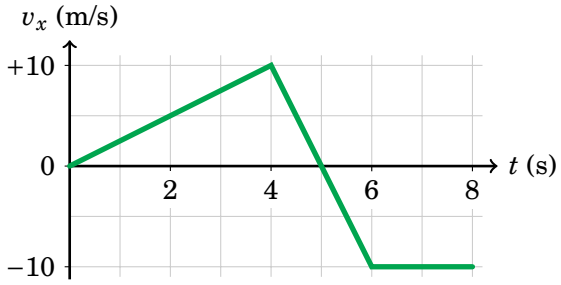
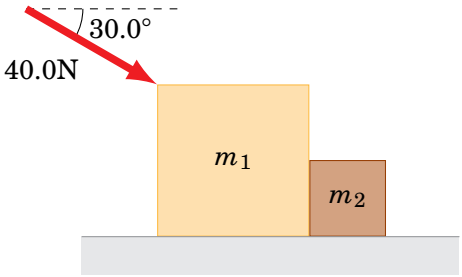
1. The initial position of a particle at $t = 0\,\text{s}$ is $x = -10\,\text{m}$. Below is the velocity-time graph for the particle.

(a) Draw the corresponding position-time graph (with numerical values). [4pts]
(b) Draw the corresponding acceleration-time graph (with numerical values). [4pts]
(c) During which time interval(s) is the particle's speed increasing? [2pts]



2. A 40.0 N force pushes two masses, $m_1 = 8.00\,\text{kg}$ and $m_2 = 4.00\,\text{kg}$, across a horizontal surface. The force is directed 30.0° below the horizontal, as shown in the figure. The coefficient of kinetic friction between both masses and the surface is 0.150.

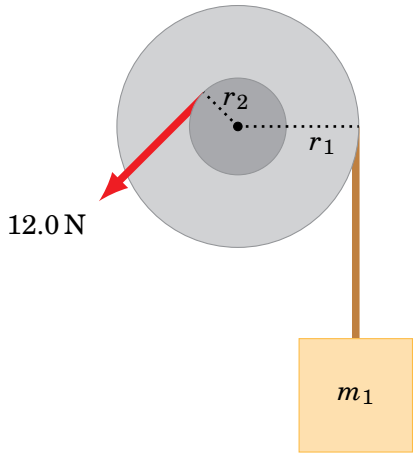
(a) Draw a free body diagram for each mass. [3pts]
(b) What is the acceleration of the masses? [5pts]
(c) What is the force that m_2 exerts on m_1? [2pts]



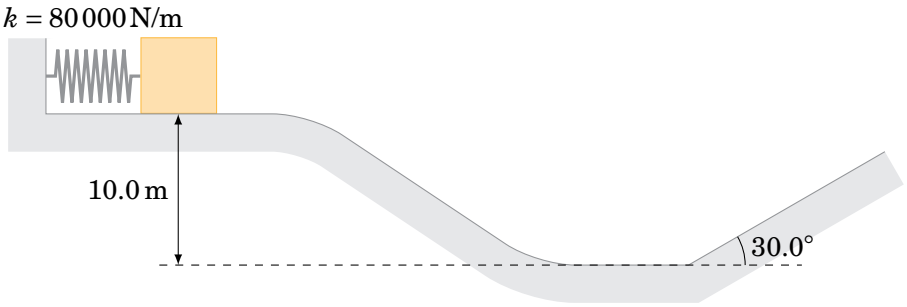
3. A solid wheel (made of two disks of different size) has a moment of inertia $I = 0.400\,\text{kg}\cdot\text{m}^2$. The wheel rotates about a frictionless axle passing through its center. A rope wrapped around the inner radius of the wheel exerts a tangential force of magnitude 12.0 N at a distance $r_2 = 0.100\,\text{m}$ from the axle. A second rope, wrapped around the outer radius of the wheel at a distance $r_1 = 0.250\,\text{m}$ from the axle, is attached to a block of mass $m = 0.875\,\text{kg}$.

(a) What is the angular acceleration of the wheel? [7pts]

(b) If the wheel starts from rest, how many revolutions will it make in 12.0 seconds? [3pts]



4. The spring shown in the figure is compressed 50.0 cm and is used to launch the block, which has a mass of 100 kg. The surface is frictionless *except* for the final 30.0° incline, where the coefficient of kinetic friction is 0.150.



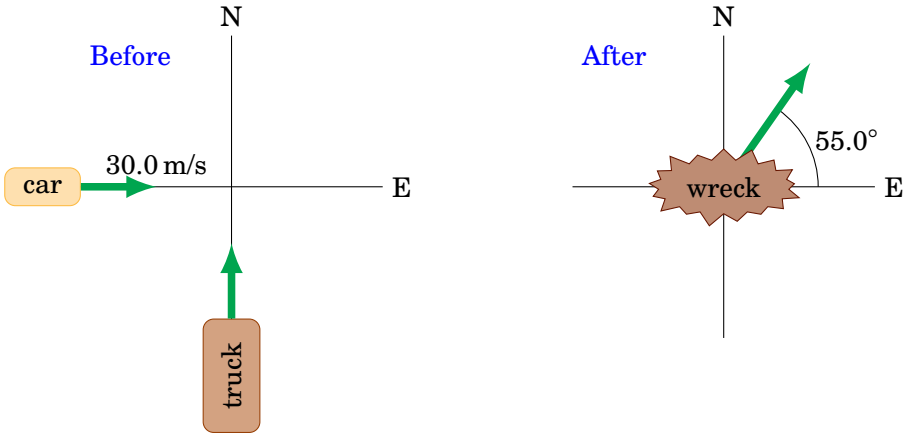
(a) What is the speed of the block when it reaches the valley below its starting point? [4pts]
(b) What distance does the block slide *along* the 30.0° incline before stopping? [6pts]

5. A 1000 kg car, traveling east at 30.0 m/s, collides with a 3000 kg truck, traveling north. After the collision, the vehicles stick together and the combined wreckage moves at 55.0° north of east.

(a) What is the speed of the truck before the collision? [5pts]

(b) What percentage of the initial kinetic energy of the system is lost during the collision? [3pts]

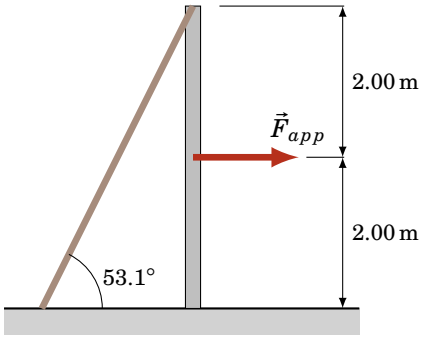
(c) What was the velocity of the center of mass of the car/truck system before the collision? [2pts]



6. A uniform vertical bar of length 4.00 m and mass 25.0 kg rests on rough horizontal ground. The bottom end of the bar touches the ground, and the top end is attached to a cable that runs downward to the left and is anchored to the ground, as shown in the figure. The cable makes an angle of 53.1° with the ground.

A horizontal force of magnitude 600 N is applied to the bar at midheight. The bar is just about to slip for this applied force.

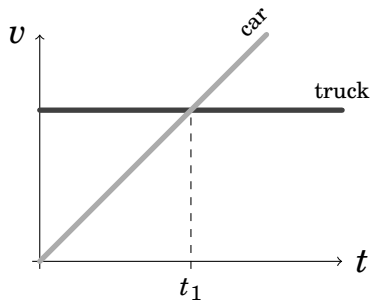
Determine the coefficient of static friction μ_s between the bar and the ground. [10pts]



Part II: Multiple Choice Questions (*2 marks each*)

Answer all twenty questions. Circle the best response from the choices given. If your final selection is unclear you will not be given the marks. No marks will be awarded for diagrams, calculations, or reasoning.

1. The motions of a car and a truck along a straight road are represented by the velocity-time graph below. The two vehicles are side-by-side at time $t = 0$. At time t_1, which of the following statements is correct?



   (a) Both vehicles have traveled the same distance.
   (b) The truck has not moved at all.
   (c) The car has traveled further than the truck.
   (d) The truck has traveled further than the car.
   (e) No information about the distances traveled can be determined from this graph.

2. A package is dropped from a helicopter while the helicopter is moving upwards at 15 m/s. If it takes 25 s before the package strikes the ground, how high above the ground was the package when it was released? (Assume you can neglect air resistance.)

   (a) 2.7 km
   (b) 3.4 km
   (c) 2.2 km
   (d) 3.2 km
   (e) None of the above.

3. If the scalar (dot) product of two vectors is negative, which of the following statements is correct?

   (a) There was a calculator error.
   (b) The angle between the vectors is between 0° and 90°.
   (c) The angle between the vectors is exactly 90°.
   (d) The angle between the vectors is between 270° and 360°.
   (e) The angle between the vectors is between 90° and 180°.

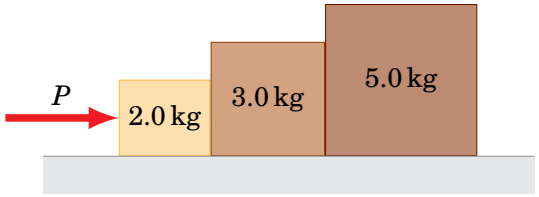
4. A physics student jumps up into the air off of a horizontal floor. How does the force exerted on the student by the floor compare to the student's weight?

   (a) The force of the floor is equal to the weight and in the same direction.
   (b) The force of the floor is equal to the weight and in the opposite direction.
   (c) The force of the floor is less than the weight and in the same direction.
   (d) The force of the floor is less than the weight and in the opposite direction.
   (e) The force of the floor is greater than the weight and in the opposite direction.

5. A cyclist rides up a 30° slope with a constant speed. Which of the following statements is correct?

   (a) The net force acting on the bike points opposite to the direction of motion.
   (b) The net force acting on the bike points in the direction of motion.
   (c) The net force acting on the bike is zero.
   (d) None of the above statements is correct.

6. Three blocks are pushed across a frictionless surface. If the force $P = 6.0\,\text{N}$, what is the magnitude of the force that the 3.0 kg block exerts on the 2.0 kg block?

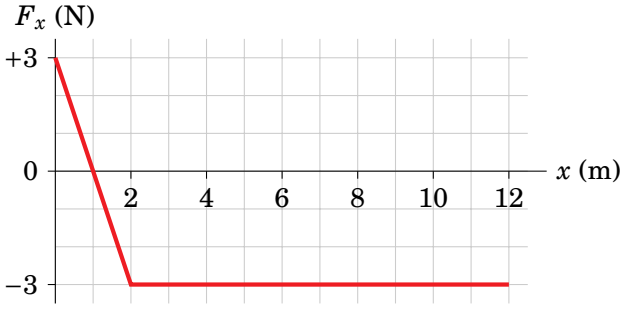


   (a) 8.4 N
   (b) 7.2 N
   (c) 6.4 N
   (d) 5.6 N
   (e) 4.8 N

7. A car drives around a circular curve on a level road. Which of the following statements is correct?

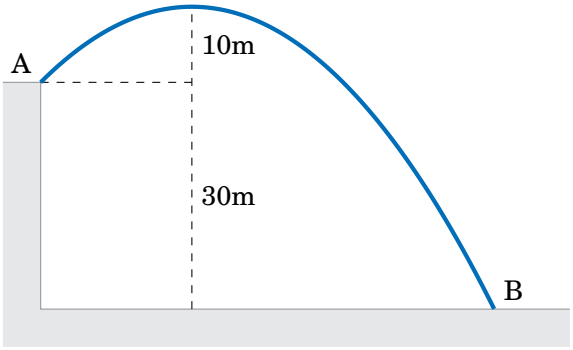
   (a) The friction force of the road on the car is zero, and the car naturally follows the road.
   (b) The friction force of the road on the car increases when the car's speed is lower.
   (c) The friction force of the road on the car increases when the car's speed is higher.
   (d) The friction force of the road on the car increases when the car moves to the outside of the curve.
   (e) There is no net friction force because the road and the car exert equal and opposite forces on each other.

8. The only force acting on a 2.0 kg body as it moves along the x-axis is shown in the figure. At $x = 0\,\text{m}$ the body is already moving at 3.0 m/s in the positive x direction. At what value of x will the body momentarily come to rest?



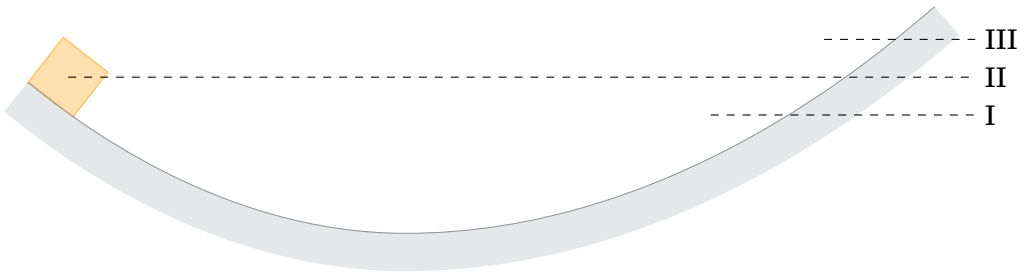
   (a) 3.0 m
   (b) 5.0 m
   (c) 7.0 m
   (d) 9.0 m
   (e) 12 m

9. A 40 g ball is launched at an unknown angle from point A at the top of a 30 m tall cliff. The ball reaches a maximum height of 10 m above the top of the cliff before falling to the ground at point B. Neglecting air resistance, what is the change in kinetic energy from point A to point B?



(a) +12 J
(b) +32 J
(c) +20 J
(d) −12 J
(e) −20 J

10. A box slides along the frictionless surface shown in the figure. At the position shown, the box is already moving down the slope. At which level on the other side will the box stop?



(a) Level III.
(b) Level II.
(c) Level I.
(d) The box will stop at the lowest point in the valley and never make it to the other side.
(e) It depends on the mass of the box.

11. A ball is thrown from a height of 1.50 m with a velocity of 24.0 m/s making an angle of 37 ° above the horizontal. What is the speed of the ball when it reaches its maximum height?

(a) 0 m/s
(b) 14.4 m/s
(c) 19.2 m/s
(d) 21.3 m/s
(e) 24.0 m/s

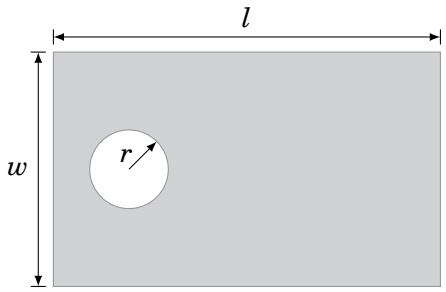
12. A horizontal disk with a moment of inertia $I = 0.150\,\text{kg}\cdot\text{m}^2$ rotates at 3.40 rad/s without friction. A 1.60 kg lump of clay is dropped from rest onto the disk from a very small height. It lands on and sticks to the disk at a point 25.0 cm from the axis of rotation. What is the angular speed of the disk after this collision?

    (a) 2.04 rad/s
    (b) 2.43 rad/s
    (c) 3.40 rad/s
    (d) 4.87 rad/s
    (e) 5.66 rad/s

13. A rigid body is rotating with a uniform angular velocity. Which of the following statements is correct?

    (a) All points on the body have the same angular velocity and the same linear velocity
    (b) All points on the body have the same angular velocity, but different linear velocities
    (c) All points on the body have different angular velocities, but the same linear velocity
    (d) All points on the body have different angular velocities and different linear velocities

14. The figure below shows a plate with a circle cut out of it. The dimensions have been measured to be: $l = (5.12 \pm 0.04)\text{cm}$, $w = (3.10 \pm 0.03)\text{cm}$, $r = (0.52 \pm 0.01)\text{cm}$. Accounting for the uncertainties in the measurements, how should the area of the plate be reported?



    (a) $A = (15.02 \pm 0.05)\text{cm}^2$
    (b) $A = (15.02 \pm 0.09)\text{cm}^2$
    (c) $A = (15.0 \pm 0.2)\text{cm}^2$
    (d) $A = (15.0 \pm 0.3)\text{cm}^2$
    (e) $A = (15.0 \pm 0.8)\text{cm}^2$

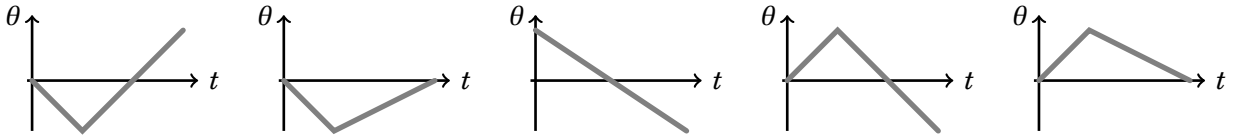
15. A small 125 g rock is being launched by a sling-shot. The position of the rock during launch is

$$x(t) = 30t^4 + 5t$$

    where x is measured in metres, and t is time measured in seconds from the moment the rock is released. What is the magnitude of the force being applied to the rock at $t = 0.12\,\text{s}$?

    (a) 0.0760 N
    (b) 0.459 N
    (c) 0.648 N
    (d) 1.43 N
    (e) 2.62 N

16. A cylinder rotates clock-wise at a constant angular speed for 2 s. It then reverses direction and rotates counter-clock-wise at *half* the angular speed until it returns to its original orientation. Which graph below describes this motion?



(a) (b) (c) (d) (e)

17. A force $\vec{F} = -7.0\,\text{N}\hat{\jmath}$ is applied at $\vec{r} = +0.3\,\text{m}\hat{\imath}$ on an object pivoted at the origin. What torque does this force exert about the origin?

(a) $(+2.1\,\text{N}\cdot\text{m})\hat{k}$
(b) $(-2.1\,\text{N}\cdot\text{m})\hat{k}$
(c) $(2.1\,\text{N}\cdot\text{m})(+\hat{\imath} - \hat{\jmath})$
(d) $(+7.3\,\text{N}\cdot\text{m})\hat{k}$
(e) $(-7.3\,\text{N}\cdot\text{m})\hat{k}$

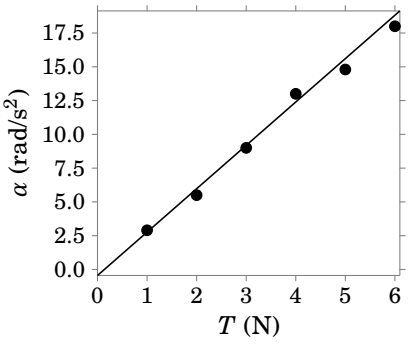
18. A constant non-zero torque is exerted on an object that is free to rotate. Which of the following is constant?

(a) Angular position
(b) Angular velocity
(c) Angular momentum
(d) Angular kinetic energy
(e) None of the above

19. A massless string is wrapped around a massive pulley rotating about a nearly frictionless axle. The angular acceleration of the pulley is measured for various tensions applied with the string. The linear trend line obtained is given by the equation:

$$\alpha = 3.21T - 0.445$$

What are the units of the 3.21 and the -0.445?



(a) $3.21\,\frac{\text{rad}}{\text{s}^2}$ and $-0.445\,\text{N}$
(b) $3.21\,\frac{\text{rad}}{\text{Ns}^2}$ and $-0.445\,\text{N}$
(c) $3.21\,\frac{\text{rad}}{\text{s}^2}$ and $-0.445\,\frac{\text{rad}}{\text{s}^2}$
(d) $3.21\,\frac{\text{rad}}{\text{Ns}^2}$ and $-0.445\,\frac{\text{rad}}{\text{s}^2}$
(e) Neither 3.21 nor -0.445 have units.

20. A round object (radius R) with moment of inertia $\frac{5}{7}MR^2$ is rolling without slipping across a level surface. If its linear speed is v, what fraction of its total kinetic energy is rotational?

(a) 7/5
(b) 25/49
(c) 5/12
(d) 5/7
(e) 1/2

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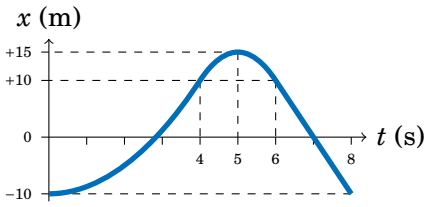
SPOILERS!

ANSWERS begin on the next page...

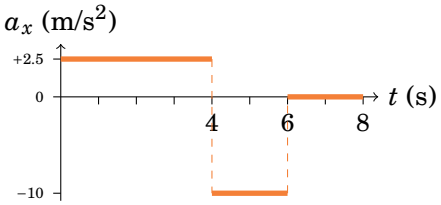
Answers

Problems

1. (a)

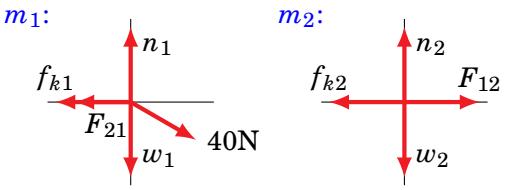


(b)



(c) intervals with increasing speed: 0…4s and 5…6s

2. (a)



(b) $\vec{a} = 1.17\,\text{m/s}^2$ (right)

(c) $\vec{F}_{21} = 10.5\,\text{N}$ (left)

3. (a) $I\alpha_z = +Fr_2 - Tr_1$ and $ma_y = +T - mg$, while $a_y = r_1\alpha_z$ gives

$$\alpha_z = \frac{+Fr_2 - mgr_1}{mr_1^2 + I}$$

$\alpha_z = -2.08\,\text{rad/s}^2$ (this is clock-wise)

(b) $\Delta\theta = \frac{1}{2}\alpha_z t^2 = -149.8\,\text{rad}$, #rev $= \Delta\theta/2\pi = -23.8$.

4. (a) $v = 19.9\,\text{m/s}$

(b) $d = 32.1\,\text{m}$

5. (a) $14.3\,\text{m/s}$

(b) $100\% \times \Delta K/K_\text{i} = -55\%$

(c) Same as after: $\vec{v}_\text{cm} = 13.1\,\text{m/s}$, at 55 ° north of east

6. $\mu_s = 0.465$

Multiple Choice Questions

1. (d)	5. (c)	9. (a)	13. (b)	17. (b)
2. (a)	6. (e)	10. (a)	14. (d)	18. (e)
3. (e)	7. (c)	11. (c)	15. (c)	19. (d)
4. (e)	8. (b)	12. (a)	16. (b)	20. (c)