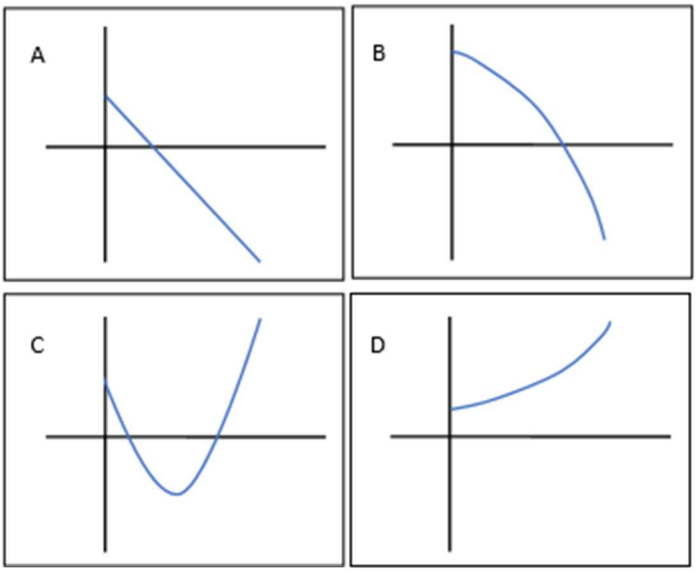
UP 1 Sample Midterm Exam

Problems 1 – 16 are worth 3 points each.

1. $kg \cdot m^2/s^2$ are SI units of
   a) Energy
   b) Force
   c) Power
   d) Pressure
   e) None of the above

2. During a lab, a student measured the mass and length of a cable. The student calculated that the mass per unit length of the cable was 1.78192 kg/m with an uncertainty of 0.36715 kg/m. Which of the following is the correct way to report this measurement according to our lab formatting?
   a) $(2 \pm 0.4)\ kg/m$
   b) $(1.8 \pm 0.4)\ kg/m$
   c) $(1.78 \pm 0.4)\ kg/m$
   d) $(1.78 \pm 0.367)\ kg/m$
   e) $(1.78192\ \pm 0.36715)\ kg/m$

3. Suppose an object starts from rest and undergoes positive acceleration in one dimension. Which of the following plots could show **the object's position** as a function of time?



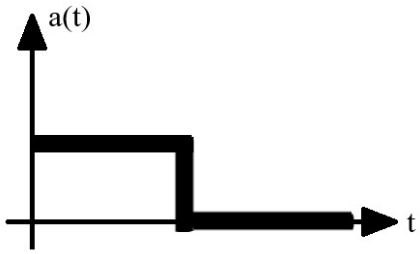
   e) None of the above

4. A block is launched by a compressed spring, giving it an initial speed. The block then slides up a ramp with a rough surface (friction is present), then slides back down. During the block's time on the ramp, when is the magnitude of the block's **acceleration** greatest?
    a) When the block is on its way up the ramp
    b) When the block is at its maximum height on the ramp
    c) When the block is on its way down the ramp
    d) The magnitude of the block's acceleration is constant while the block is on the ramp
    e) The answer depends on the ramp's coefficient of friction

5. A model rocket launched from the surface of the Earth at time $t = 0$ is observed to have its height above the ground $y(t)$ given by the equation
$$y(t) = 2At^2 - Bt^5.$$
At what time t will the rocket reach its **maximum height**?
    a) $\left(\frac{A}{5B}\right)^{1/3}$
    b) $\left(\frac{4A}{5B}\right)^{1/3}$
    c) $\left(\frac{2A}{B}\right)^{1/3}$
    d) $\left(\frac{6A}{B}\right)^{1/3}$
    e) None of the above

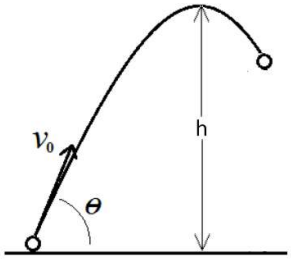
6. A person runs across the xy-plane with a speed of 5 m/s. If the x-component of their velocity is 3 m/s, what is the magnitude of their velocity's **y-component**?
    a) 1 m/s
    b) 1.5 m/s
    c) 2 m/s
    d) 4 m/s
    e) 5.5 m/s

7. The plot on the right shows the acceleration versus time for a certain car. Which of the statements below **could not** describe the car's motion during the time shown?



   a) The car is initially headed in the negative x direction before slowing to a stop.
   b) The car is initially headed in the negative x direction, slows down, turns around, then cruises at a constant speed.
   c) The car speeds up from rest, then cruises at a constant speed.
   d) The car speeds up from rest, then slows to a stop.
   e) The car is initially headed in the positive x direction and speeding up, before cruising at a constant speed.

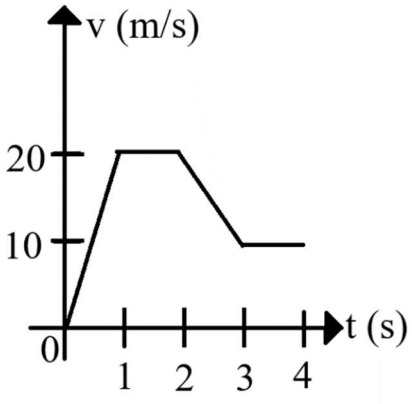
8. A ball is launched from the ground with an initial speed of 50 m/s at an angle 30° above the horizontal. What is the maximum height reached by the ball?



   a) 31.9 m
   b) 63.8 m
   c) 95.7 m
   d) 128 m
   e) 191 m

9. A disk with a radius of 1 meter rotates at a rate of 30 revolutions per minute. What is the magnitude of the centripetal acceleration for a point on the edge of the disk?
   a) $0.25\ m/s^2$
   b) $3.14\ m/s^2$
   c) $9.87\ m/s^2$
   d) $900\ m/s^2$
   e) $35530\ m/s^2$

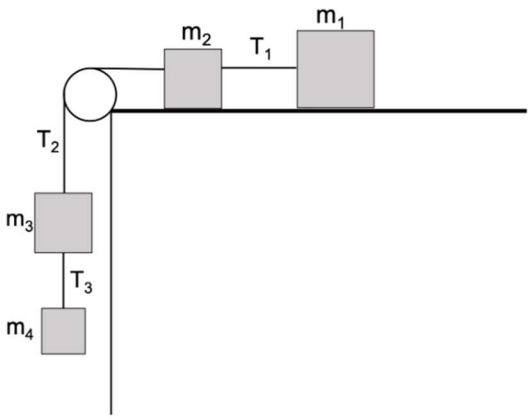
10. The plot on the right shows the velocity of a particle constrained to move in one dimension. If the particle starts at the origin, what is its location at $t = 4$ seconds?



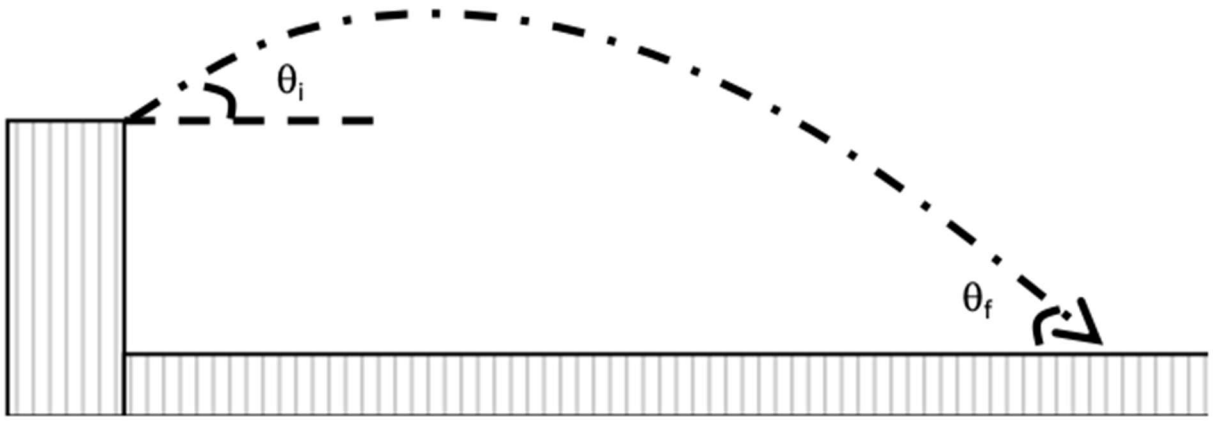
   a) 25 m
   b) 30 m
   c) 55 m
   d) 60 m
   e) None of the above

11. Consider the system shown below. All surfaces are frictionless, the pulleys are massless, and the strings do not stretch or contract. The hanging blocks accelerate downwards. Which of the following statements **must be true**?

a) $m_4 g = T_3$
b) $m_3 g + T_3 > T_2$
c) $T_1 > T_2$
d) $m_2 g + T_1 > T_3$
e) $m_4 + m_3 > m_2 + m_1$



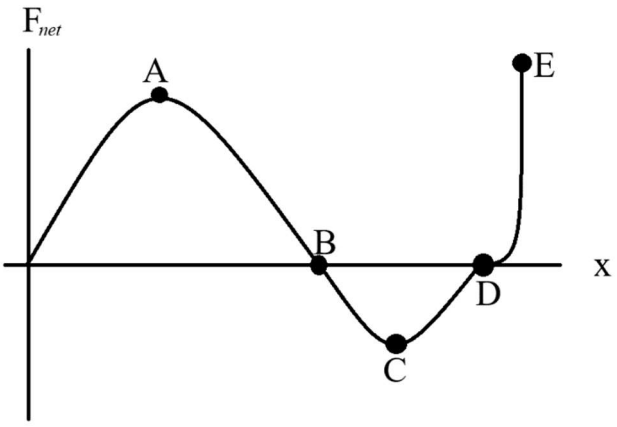
12. A ball is launched off a cliff with initial speed v_i at an angle θ_i with respect to the horizontal. It strikes the ground below with speed v_f at an angle θ_f with respect to the horizontal. Air resistance is negligible. Which of the following statements is **true**?



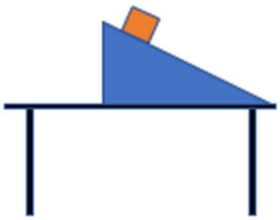
a) $\theta_i = \theta_f$
b) $v_i > v_f$
c) $|v_i sin\theta_i| > |v_f sin\theta_f|$
d) $|v_i cos\theta_i| > |v_f cos\theta_f|$
e) None of the above statements are true.

13. Suppose you drop a feather and a hammer simultaneously from the same height at some point near the surface of the Earth. Which of the following statements is **true**?
    a) The force of gravity on the hammer and its acceleration due to gravity are greater than those for the feather.
    b) The force of gravity is greater on the hammer, but the gravitational acceleration of the two objects is the same.
    c) The force of gravity on both objects is the same, but the feather's acceleration due to gravity is greater.
    d) Both objects experience the same force of gravity and the same gravitational acceleration.

14. The plot below shows the net force on a car as it drives in the positive x-direction. The car starts from rest at the origin. At which point on the car's motion is **its speed greatest**?

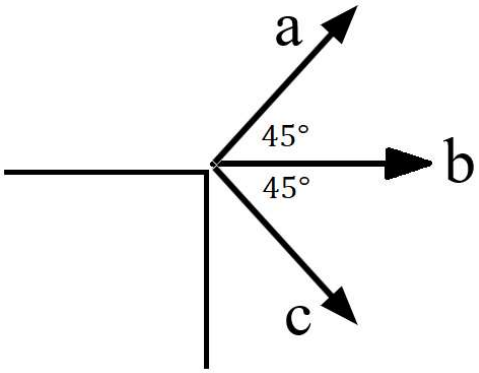


15. A block slides down a rough ramp (with friction), which is on a table, as shown. The ramp makes an angle θ with the horizontal. It takes t_1 seconds to slide down the ramp of length L, starting from rest. What is the **speed** of the block at t_1?



    a) $\frac{L}{t_1}$
    b) $\frac{2L}{t_1}$
    c) $\frac{2L}{t_1} sin\theta$
    d) $\frac{2L}{t_1} cos\theta$
    e) $gt_1 sin\theta$

16. Three identical balls are launched off the top of a building with the same initial speed, as indicated in the diagram. Which ball hits the ground with the **greatest speed**?
    a) The ball thrown at an angle 45° above the horizontal.
    b) The ball thrown directly along the horizontal.
    c) The ball thrown at an angle 45° below the horizontal.
    d) The launch angle doesn't matter.



Problems 17 – 26 are worth 5 points each

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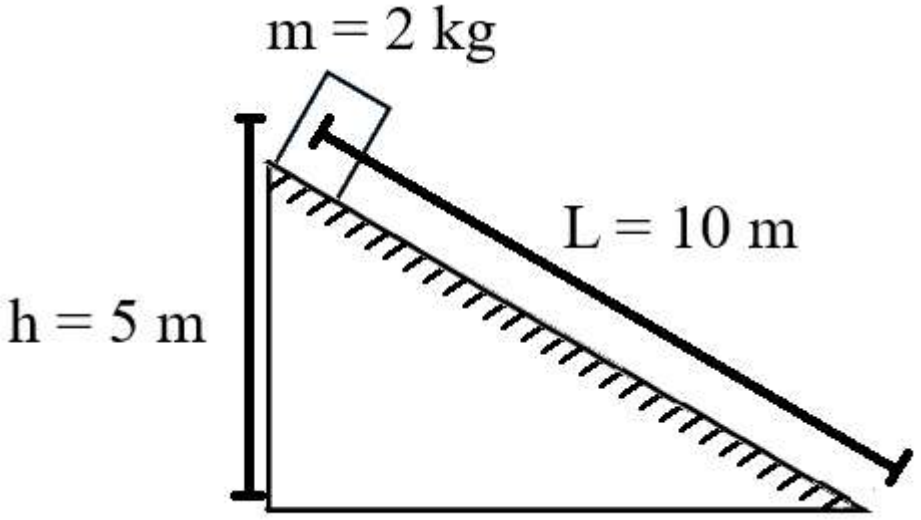
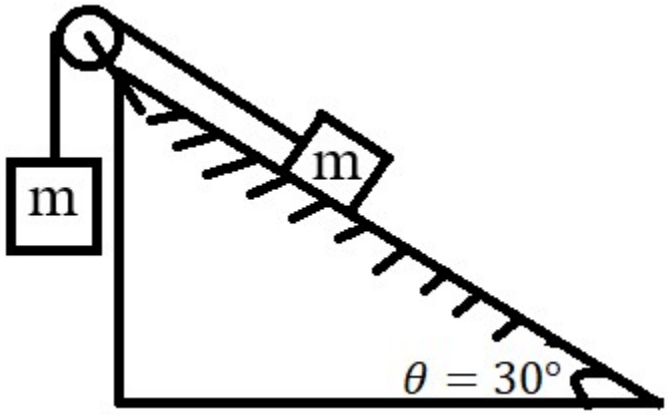
17. A rubber ball of unknown mass is dropped from a height of 2.5 meters. Upon bouncing on the ground, the ball immediately loses one fifth of its speed. How high will the ball rise after bouncing once?
    a) 1.25 meters
    b) 1.6 meters
    c) 1.8 meters
    d) 2.0 meters
    e) 2.5 meters

18. A block of mass 2 kg sits at the top of a 10-meter-long ramp with unknown coefficients of friction. The top of the ramp is 5 meters above the level ground below. Starting from rest, the block slides down the ramp, reaching a speed of 5 m/s at the bottom. What is **the work done by friction** while the block slid down the ramp?



a) -123 J
b) -73 J
c) +73 J
d) +123 J
e) None of the above.

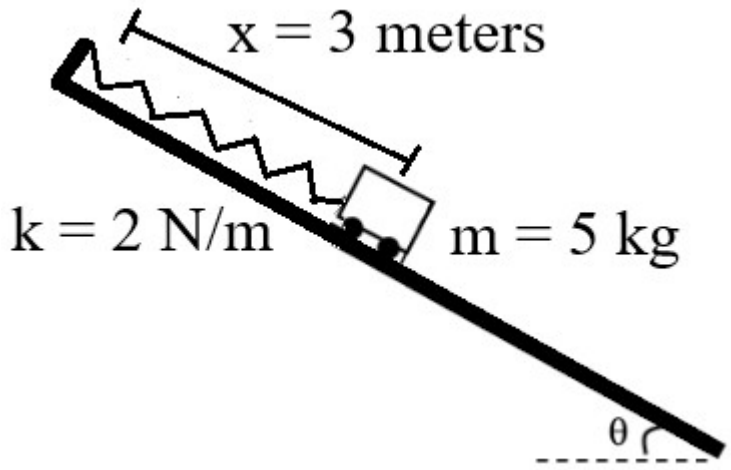
19. Consider the system shown below. Both the hanging block and the block on the incline have the same mass. What is the **minimum** value of the coefficient of static friction between the ramp and the block for the system to **remain at rest**?



a) $\mu_s = 0.27$
b) $\mu_s = 0.58$
c) $\mu_s = 1.15$
d) $\mu_s = 2.0$
e) None of the above

20. Consider two vectors, $\vec{A} = -4\hat{\imath} - 5\hat{\jmath}$ and $\vec{B} = -2\hat{\imath} + 6\hat{\jmath}$. What is the direction of the vector sum $\vec{A} + \vec{B}$, in degrees measured **counterclockwise from the positive x-axis**?
a) $\theta = 9.4°$
b) $\theta = 99°$
c) $\theta = 171°$
d) $\theta = 280°$
e) $\theta = 351°$

21. A frictionless cart of mass $m = 5$ kg is attached to the end of a spring with spring constant $k = 2$ N/m. When one end of the spring is fixed to the top of a ramp as shown below, it is found that the spring must be stretched by 3 meters for the system to be in equilibrium (that is, the cart sits at rest with zero acceleration). What is the value of the angle θ the ramp makes with the horizontal?



a) $\theta = 7.03°$
b) $\theta = 10.6°$
c) $\theta = 79.4°$
d) $\theta = 83.0°$
e) None of the above

22. Consider a horizontal surface with a **<u>nonuniform</u>** coefficient of kinetic friction, $\mu_k = Ax^2$, where A is a constant. A block of mass m is launched in the positive x direction, with speed v_0 at $x = 0$. How far does the block travel before coming to a stop?

a) $\left(\frac{v_0^2}{2gA}\right)^{\frac{1}{3}}$

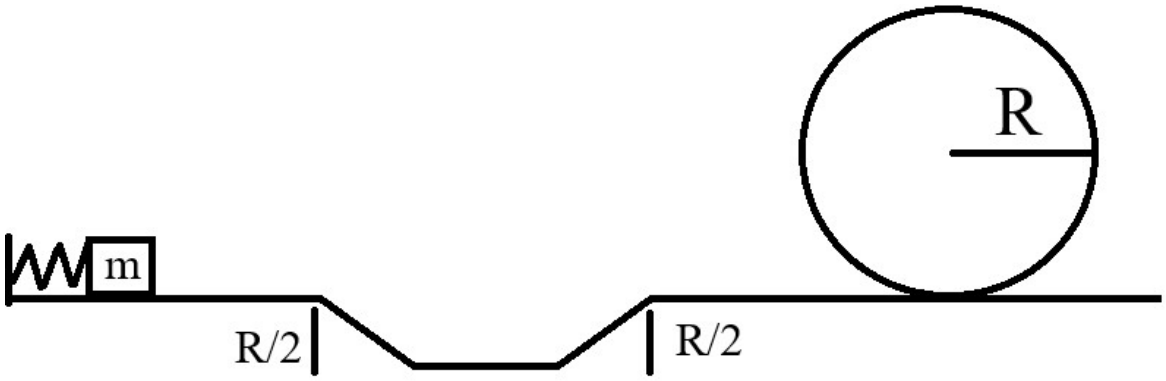
b) $\left(\frac{3v_0^2}{2g}\right)^{\frac{1}{3}}$

c) $\left(\frac{v_0^2}{2g}\right)^{\frac{1}{2}}$

d) $\left(\frac{v_0^2}{gA}\right)^{\frac{1}{2}}$

e) $\left(\frac{v_0^2}{4gA}\right)$

23. A block of mass m compresses a spring with spring constant k by a distance d. The spring is released and the block slides down a slope with height $R/2$, up another slope with height $R/2$, then through a vertical circle loop of radius R. All surfaces are frictionless, and the block remains in good contact with the ground before reaching the loop. What is d if the block **just barely** makes it through the loop?

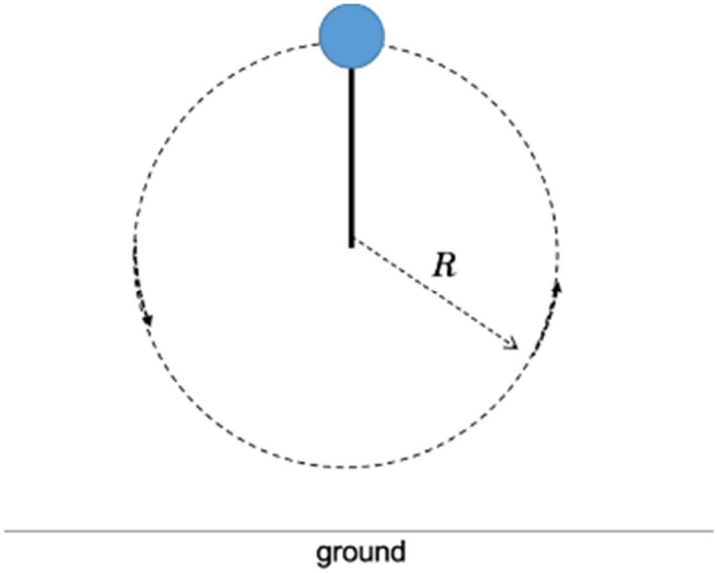


a) $\sqrt{mgR/k}$
b) $\sqrt{2mgR/k}$
c) $\sqrt{3mgR/k}$
d) $\sqrt{4mgR/k}$
e) $\sqrt{5mgR/k}$

24. A conservative force acting on a particle moving in one dimension is given by the equation $F = 6x^2 - 9$. The potential energy associated with this force is equal to zero when $x = 1$. What is the potential energy associated with this force as a function of x?
    a) $U = -12x + 1$
    b) $U = +2x^3 - 9x + 1$
    c) $U = +2x^3 - 9x + 7$
    d) $U = -2x^3 + 9x + 1$
    e) $U = -2x^3 + 9x - 7$

25. A Consider two vectors, $\vec{A} = -2\hat{\imath} - 3\hat{\jmath} - 1\hat{k}$ and $\vec{B} = 4\hat{\imath} + 4\hat{k}$. What is the angle θ between $\vec{A}$ and $\vec{B}$?
    a) $\theta = 34.5°$
    b) $\theta = 65.4°$
    c) $\theta = 75.5°$
    d) $\theta = 125°$
    e) $\theta = 161°$

26. A ball of mass m is swung in a vertical circle of radius R. The tension in the string when the ball is at the **top of the circle** is $21mg$.
What is the speed of the ball at the **bottom of the loop**? Ignore friction and air resistance.



a) $\sqrt{22gR}$
b) $\sqrt{23gR}$
c) $\sqrt{24gR}$
d) $\sqrt{25gR}$
e) $\sqrt{26gR}$