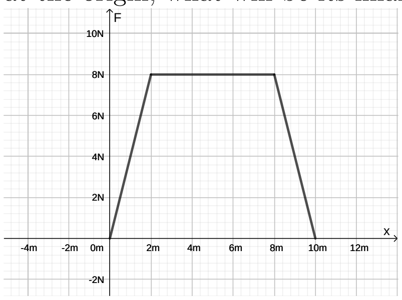
AP Exam 2, Part 1: MC

Full Name, Period, AP/Honors:

Remember to budget your time. You will only have about 3 minutes for each MC. **If you require clarification of what is being asked in a problem, please ask.**

1 Multiple choice

1. You have the following plot of net force as a function of position. If the 2kg object was initially at rest at the origin, what will be its final speed when it reaches 10m?



   A. 0
   B. 8 $\frac{\text{m}}{\text{s}}$
   C. 10 $\frac{\text{m}}{\text{s}}$
   D. 64 $\frac{\text{m}}{\text{s}}$
   E. None of the above.

2. Earth and the sun experience an attractive gravitational force of F. The Sun is about 1000 Jupiter masses. The sun in a distance of about 8 light-minutes from the Earth. At its closest point to Earth, Jupiter is about 32 light-minutes from Earth. What should be the ratio of the gravitational force between Earth and Jupiter to the force between the Earth and Sun?

   A. $\frac{1}{4} \times 10^3 F$
   B. $16 \times 10^{-3} F$
   C. $4 \times 10^{-3} F$
   D. $\frac{1}{16} \times 10^3 F$
   E. $\frac{1}{16} \times 10^{-3} F$

3. You use a spring with coefficient k to launch an object with mass m straight horizontally from a height y. If the spring was compressed by some distance x_1, how far will the object travel before hitting the ground?

   A. $x_1 \sqrt{\frac{ykg}{4m}}$
   B. $x_1 \sqrt{\frac{2ym}{kg}}$
   C. $x_1 \sqrt{\frac{2ym}{kg}}$
   D. $x_1^2 \sqrt{\frac{2ykg}{m}}$
   E. $x_1 \sqrt{\frac{2yk}{mg}}$

4. Which of these statements are definitely true? **Select two answers.**

   A. 2 objects with the same mass and same kinetic energy have the same momentum

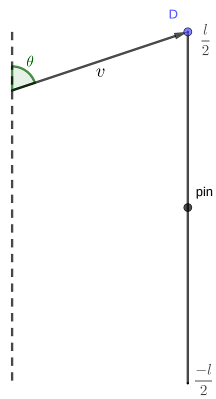
   B. 2 objects with the same mass and same momentum have the same kinetic energy

   C. 2 objects with the speed for the same time have the same displacement

   D. 2 objects with the same displacement over the same time had the same average velocity

   E. 2 objects with the same kinetic energy and different momentum have different masses

5. A ball with mass m_b that is traveling with a speed v collides perfectly in-elastically with a rod of length l and mass $M_r >> m_b$ pinned in the center. After the collision, the rod is spinning with an angular speed ω. Find the angle that the velocity makes with the vertical (θ in the diagram). You may assume that regardless of the angle, the object always hits the exact end of the rod (in other words the starting height is being changed, not the impact position). There is no gravity or friction.



   A. $\theta = \arcsin\left(\frac{1}{6}\frac{M_l}{m_b}\frac{l\omega}{v}\right)$

   B. $\theta = \arcsin\left(\frac{1}{12}\frac{M_l}{m_b}\frac{l\omega}{v}\right)$

   C. $\theta = \arccos\left(\frac{1}{6}\frac{M_l}{m_b}\frac{l\omega}{v}\right)$

   D. $\theta = \arccos\left(\frac{1}{12}\frac{M_l}{m_b}\frac{l\omega}{v}\right)$

   E. $\theta = 0$ rad

6. Which of these provides both a correct explanation for the following scenario? Two cars with very different masses impact each other. The driver of the much larger vehicle is fine, while the driver of the much smaller vehicle sustains a serious neck injury.

   A. Since every action has an equal and opposite reaction, the car and truck have the same acceleration. This means that the larger vehicle absorbs more of the force, so less goes into the driver.

   B. Since the forces on the large and small vehicle are equal, the large vehicle will have less acceleration. Thus the driver of the large vehicle stops faster and sustains less injuries.

   C. The change in kinetic energies of the large and small vehicles are the same. Since the kinetic energy is effectively spread over the whole vehicle, including the driver, the driver of the larger car receives less.

   D. The change in momentum of the small vehicle is larger, this results in more momentum transfer to the individual in the smaller vehicle.

   E. None of these options correctly explain this result.

7. A very tall man and a much shorter woman stand so that their bodies are vertical and each of them has their legs together. They push their palms into one another with arms straight out. Due to the height difference, the woman's arms slope upward and the man's slope downward. The man has stronger arms than the woman, but they are otherwise identical. Assuming neither moves their feet, who will be knocked off balance first?

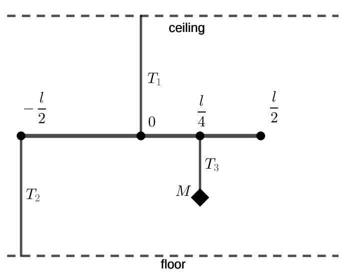
   A. The woman.

   B. The man

   C. It will be equal

   D. We need to know how much stronger the man is.

8. A bar with mass M extends from $-\frac{l}{2}$ to $\frac{l}{2}$ as shown. It is held up by a string in the center. A mass M is hung from the beam by a string attached at $\frac{l}{4}$. A second string that is just long enough to reach from the beam to the floor is attached at $\frac{-l}{2}$. Find the tension T_1.



   A. Mg

   B. $2Mg$

   C. $\frac{5}{2}Mg$

   D. $3Mg$

   E. The bar would not be stable in this arrangement.

9. You have two variables z and w. They are related by $z = w^{\alpha}k$. Since this is an empirical relation, α is very unlikely to be an integer. How would you find α?

   A. Plot $\ln\left(\frac{z}{k}\right)$ against $\ln w$. The slope will be α

   B. Plot z against k. Take the log of the slope. That will be α.

   C. Plot $\frac{w}{k}$ against z. The slope will be α

   D. Plot $\ln z$ against $\ln k$. Take the log of the slope. That will be α.

10. Two children with masses $3M$, and $5M$ are standing on a friction-less skating rink that is tilted at an angle θ from the horizontal. They are initially at rest. They are throwing a ball with mass $m_b << M$ back and forth between them at very high speeds (so that the momentum change of the children is not necessarily negligible when they throw the ball). After a time, t, the kids finish their game, and the larger child is holding the ball. What is the change in speed of the center of mass of the system that consists of both children, but **NOT** the ball?

    A. 0

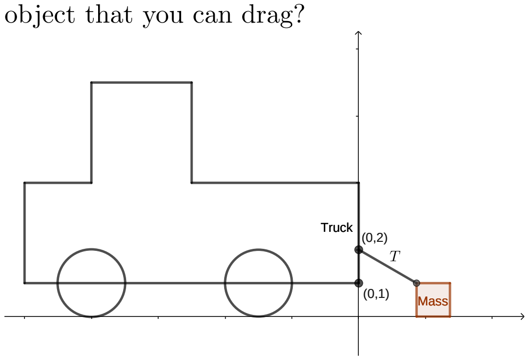
    B. $gt\sin\theta$

    C. $8gt\sin\theta$

    D. $-gt\sin\theta$

    E. We need to know what speed the ball was thrown with to answer.

11. You have a rope that can handle a maximum tension of $T = 50$ N before snapping. You tie one end to a mass placed on the ground. You tie the other end to the back of a truck so that the tie point is exactly 1m higher off the ground than the tie point on the dragging mass. If the rope is 2 m long, and you plan to drag the mass across ground with a kinetic friction coefficient of $\frac{1}{2}$. What is most massive object that you can drag?



    A. 5 kg

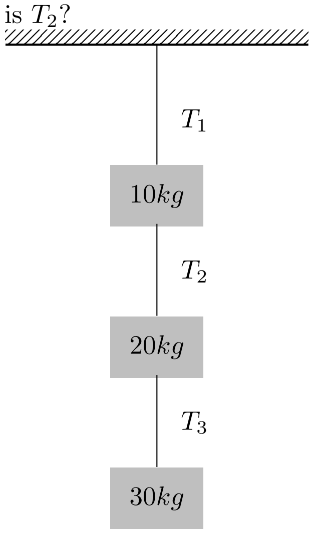
    B. $(5\sqrt{2} + \frac{1}{4})$ kg

    C. $(5\sqrt{3} + \frac{5}{2})$ kg

    D. 10 kg

    E. $\frac{10}{\sqrt{3}}$ kg

12. You build the following setup in an elevator accelerating downwards at 5 $\frac{\text{m}}{\text{s}^2}$ near Earth's surface. What is T_2?



A. 100 N

B. 250 N

C. 350 N

D. 500 N

E. 750 N

13. A car and a truck have the following accelerations, velocities, and initial positions. At what time do they collide?

- Car
  - $\vec{r}_c(0) = 23.3\ \text{m}\hat{\text{x}} + 15.7\ \text{m}\hat{\text{y}} + 21.3\text{m}\hat{\text{z}}$
  - $\vec{v}_c(0) = 6\ \frac{\text{m}}{\text{s}}\hat{\text{x}} - 3\ \frac{\text{m}}{\text{s}}\hat{\text{y}} + 0\ \frac{\text{m}}{\text{s}}\hat{\text{z}}$
  - $\vec{a}_c = 5\ \frac{\text{m}}{\text{s}^2}\hat{\text{x}} + 3\ \frac{\text{m}}{\text{s}^2}\hat{\text{y}} + 0\ \frac{\text{m}}{\text{s}^2}\hat{\text{z}}$
- Truck
  - $\vec{r}_t(0) = 15.3\ \text{m}\hat{\text{x}} + 31.7\ \text{m}\hat{\text{y}} + 5.3\text{m}\hat{\text{z}}$
  - $\vec{v}_t(0) = 8\ \frac{\text{m}}{\text{s}}\hat{\text{x}} - 7\ \frac{\text{m}}{\text{s}}\hat{\text{y}} + 0\ \frac{\text{m}}{\text{s}}\hat{\text{z}}$
  - $\vec{a}_t = 5\ \frac{\text{m}}{\text{s}^2}\hat{\text{x}} + 3\ \frac{\text{m}}{\text{s}^2}\hat{\text{y}} + 2\ \frac{\text{m}}{\text{s}^2}\hat{\text{z}}$

A. $t = 1$ s

B. $t = 2$ s

C. $t = 3.7$ s

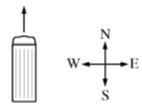
D. $t = 4$ s

E. They don't collide

The following is a single page out of a previous AP exam. The problems are pretty average difficulty.

14. A newly discovered planet is found to have density $\frac{2}{3}\rho_E$ and radius $2R_E$, where ρ_E and R_E are the density and radius of Earth, respectively. The surface gravitational field of the planet is most nearly

(A) 1.7 N/kg
(B) 3.3 N/kg
(C) 6.7 N/kg
(D) 13 N/kg

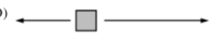


15. A bus is initially traveling north at a constant speed, as shown in the figure above. As the bus starts to make a left turn without changing speed, a passenger notices that a box on the floor starts sliding toward the right side of the bus. Which of the following top views of the box, when correctly labeled, would best represent all of the horizontal forces exerted on the box as it starts sliding?

(A) 

(B) 

(C) 

(D) 

The last problem is from an old AP exam. I have simplified the wording a bit, clarified that they intended you to only consider angles less than 90° and switched from 4 answer choices to 5, but it is otherwise unaltered.

16. Objects are thrown with a fixed initial speed v at different angles θ measured from the horizon. At some constant height h above the launch point, every object's speed is measured, call this speed v_h. v_h is plotted on a graph against θ. Which of the following will describe the relationship between v_h and θ? Consider only the range $0° \leq \theta \leq 90°$. Assume that all objects tested actually reach height h, and neglect air resistance.

    A. v_h will not depend on θ
    B. v_h will increase to some maximum value, then decrease
    C. v_h will always increase with increasing θ
    D. v_h will decrease to some minimum value, then increase
    E. v_h will have multiple minima or maxima on this interval