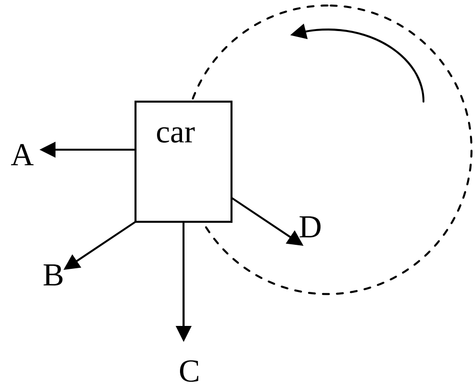
Important Note

The answers to the multiple choice questions shown here are for exam 2B. If your exam is 2A, then the answers are the same but the choices are different.

(M1) A car is going around in a circle initially without sliding. The driver then increases the speed of the car. At some point (see figure) the car slides. Which arrow in the figure gives the direction of the slide?
(A) Arrow A.
(B) Arrow B.
(C) Arrow C.
(D) Arrow D.

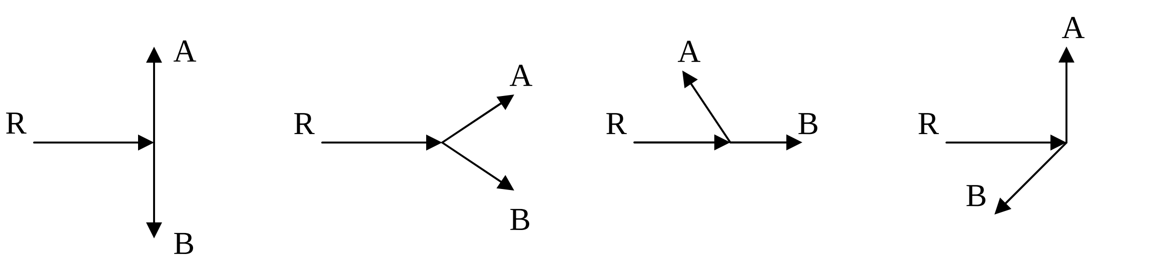


Answer is (C): Arrow C*. From Newton's 1st law, an object will travel in a straight line unless acted on by a force. When the car slides, then this means friction force to the center is unable to keep the car in circular motion. So the car moves in straight line.*

(M2) A ball is tied to a rope and is rotating in a circle. The speed of the ball increases by 1m/s every second. What does this mean for the ball's centripetal acceleration a_R and tangential acceleration a_T?
(A) a_R is constant; a_T is constant.
(B) a_R is constant; a_T is increasing.
(C) a_R is increasing; a_T is constant.
(D) a_R is increasing; a_T is increasing.

Answer is (C): a_R is increasing and a_T is constant*. Since the speed v is increasing, then $a_R=v^2/R$ increases. The increase in v also means there is tangential acceleration. The rate of the increase is 1m/s, which is constant, so a_T is constant.*

(M3) A rocket R is moving to the right. It then explodes into two pieces, A and B. Which of the following figure best describes what happens to the pieces after explosion?



(A) (B) (C) (D)

Answer is (B): *Momentum is conserved. So p_x before = p_x after. (A) does not have p_x after, so it is not correct. Also, p_y before = p_y after. But p_y before = 0, so the only possibility is (B).*

(M4) Which of the following is correct?
(A) Momentum and kinetic energy are conserved in inelastic collisions.
(B) Momentum and kinetic energy are not conserved in inelastic collisions.
(C) Momentum is conserved in inelastic collisions, but kinetic energy is not.
(D) Momentum is not conserved in inelastic collisions; kinetic energy is.

Answer is (C).

(M5) People in Jabal Al Akhdar are at a height h above ground. The total mass of those people is M. Their total potential energy
(A) can have any value. (B) must be Mgh.
(B) must be $-Mgh$. (D) must be zero.

Answer is (A): It can have any value
because the potential energy depends on the choice of the origin, which can be any where.

(M6) An object is in uniform circular motion (constant speed). Consider the following vectors: centripetal force $\boldsymbol{F}$, velocity $\boldsymbol{v}$ and centripetal acceleration $\boldsymbol{a}$. Which of these remains constant?
(A) $\boldsymbol{a}$ and $\boldsymbol{F}$. (B) $\boldsymbol{F}$ and $\boldsymbol{v}$.
(C) $\boldsymbol{a}$, $\boldsymbol{F}$ and $\boldsymbol{v}$. (D) None of these are constant.

Answer is (D): None of these are constant.
These are VECTORS whose directions change in circular motion, so they are NOT constant.

(M7) A force of constant magnitude is applied to an object on a horizontal table. The direction of this force is always in the direction of motion of the object. The object moves away from the origin and then comes back.
(A) The force is conservative because it does not change the gravitational potential energy of the object.
(B) The force is conservative because the total displacement is zero; therefore the total work is zero.
(C) The force is not conservative because work done by the force depends on the path taken by the object.
(D) The force is not conservative because it is not gravity force.

Answer is (c): The force is not conservative because the work done by the force depends on the path taken by the object. *Suppose the object goes in +x direction and then comes back in –x direction. In +x, $W = Fd\cos\theta = Fd$ ($\theta = 0$ because force is in the same direction as the object's motion).In –x, $W = Fd\cos\theta = Fd$ ($\theta = 0$ again). So total $W = Fd + Fd = 2Fd$. Now suppose the object goes in +x, then +y, then –y, then –x. In each direction $W = Fd\cos\theta = Fd$ ($\theta = 0$ for each direction). So total $W = 4Fd$.. The work depends on the path.*

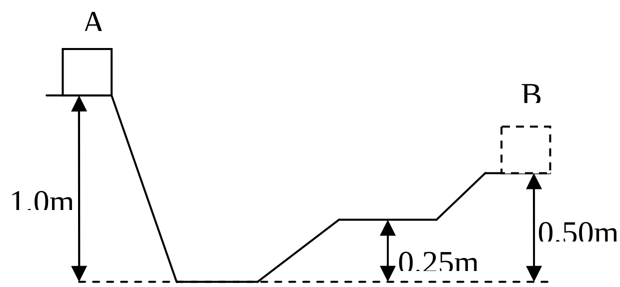
(M8) A man is going in a circle of radius R. He is making 5 rounds per minute at constant speed. His speed is

(A) $\dfrac{\pi R}{6}$ m/s (B) $\dfrac{\pi R}{12}$ m/s (C) $\dfrac{1}{12\pi R}$ m/s (D) $\dfrac{1}{6\pi R}$ m/s

Answer is (A): (πR / 6) m/s. *We have 60s in one minute. The circumference of a circle = $2\pi R$ and speed = (total distance) / (total time), then speed = $(5 \times 2\pi R) / 60 = (\pi R / 6)$ m/s.*

(M9) A block with initial speed of 1.0 m/s starts at point A in the figure. What is its speed at point B? Ignore friction.

(A) 1.0 m/s
(B) 3.3 m/s
(C) 4.0 m/s
(D) 6.2 m/s



Answer is (B): 3.3 m/s. *Use conservation of energy. Using the origin at the bottom, we have at A*
$E_i = mgh_i + mv_i^2 / 2$.
At B we have
$E_f = mgh_f + mv_f^2 / 2$.
Letting $E_i = E_f$, we see that the mass cancels. Using the values given in the problem, we get $v_f = 3.3$ m/s.

(M10) A 2000.0-kg car traveling at 25 m/s to the east hits a 5000.0-kg truck traveling west at 8 m/s. They stick together. After the collision they travel at

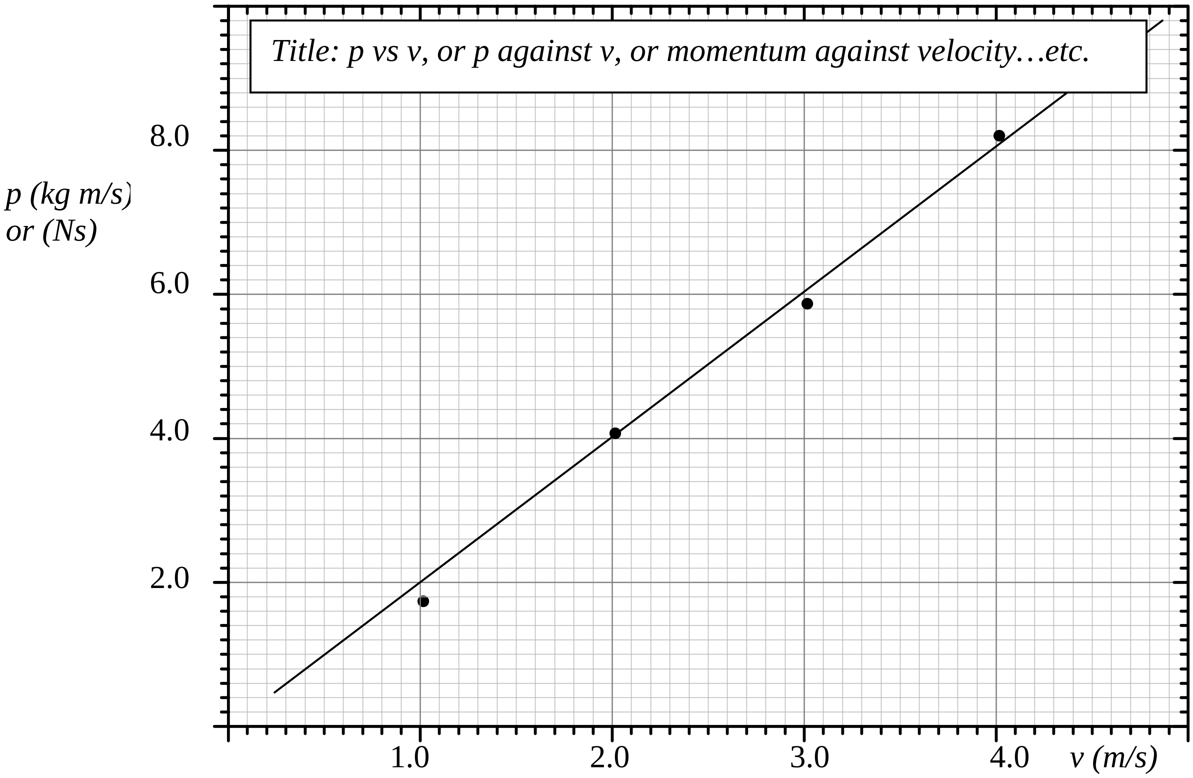
(A) 13 m/s, west. (B) 1.4 m/s, east (C) zero. (D) 2.0 m/s, west.

Answer is (B): 1.4 m/s, east. *Use conservation of momentum. Let us choose the positive direction to the east and negative to the west. Before collision p_i = (2000.0)(25) – (5000.0)(8) = 10000.0 Ns. Since the momentum is positive, then its direction is to the east. So the final momentum, which equals the initial, must also be to the east. So the answer is (B), without needing to calculate the velocity after collision. If you want to, then p_f = (2000.0+5000.0) v = p_i. So v = 10000.0 / 7000.0 = 1.4 m/s.*

(P1) A physics student wanted to measure the mass of a book. So he accelerated the book in straight line and measured its momentum p and speed v. The student obtained the data given in the table below.

p (kg m/s)	v (m/s)
1.8	1.0
4.1	2.0
5.9	3.0
8.2	4.0

(A) In the graph area below, make a graph of momentum against speed of the book, in the same way you learned in the labs. **(5pts)**

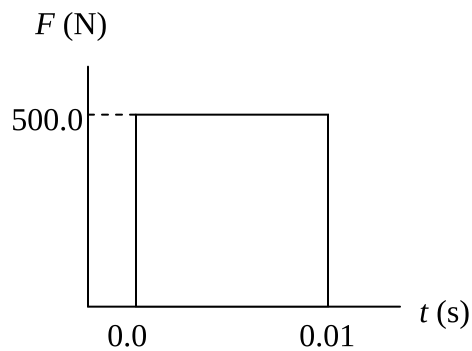


(B) Using the graph, find the mass of the book with **correct number of significant figures. (3pts)**

$p = mv$. So the mass is the slope of the line. Depending on how you draw the best line, the slope you get should be around 2.0 kg (2 significant figures).

(P2) You throw a ball horizontally in the positive direction. The ball hits a wall and you measure the magnitude of force of the wall on the ball. You obtain the graph below. The velocity of the ball after collision is 2.0 m/s in the negative direction.

(A) What is the direction of the force on the ball? **(1pt)**



The ball bounces back in the negative direction. So the force is in the negative direction.

(B) If the mass of the ball is 1.0 kg, calculate its speed before hitting the wall. **(5pts)**

$F\Delta t = p_f - p_i = mv_f - mv_f$. $F = -500.0$ N (the minus sign because the direction of the force is negative). $\Delta t = 0.01$ s, so the impulse is $-500.0 \times 0.01 = -5$ N. $m = 1.0$ kg, so the equation above gives $-5 = v_f - v_i = -2.0 - v_i$ (v_f is negative because its direction is negative). Therefore, $v_f = -2.0 + 5.0 = 3.0$ m/s (positive, as it must be).

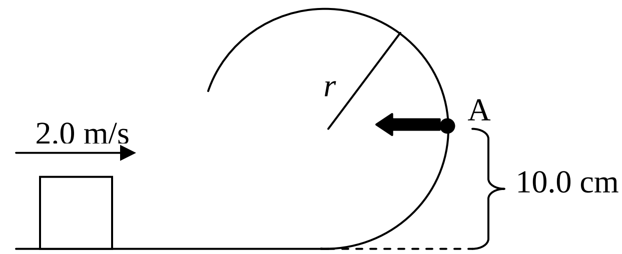
(C) Is the collision elastic or inelastic? **Show your work. (4pts)**

The collision is not elastic because the final speed does not equal the initial speed, so the kinetic energy before and after are not the same. You can, of course, calculate the kinetic energy before and after the collision. You will find they are 4.5 J (before) and 2.0 J (after).

(P3) A block of mass 4.0 kg is moving on a frictionless surface with velocity v = 2.0 m/s in the direction shown in the figure. The block then goes into a frictionless, circular loop of radius r = 10.0 cm.

(A) Calculate the normal force on the block when it reaches height 10.0 cm at point A. **(5pts)**

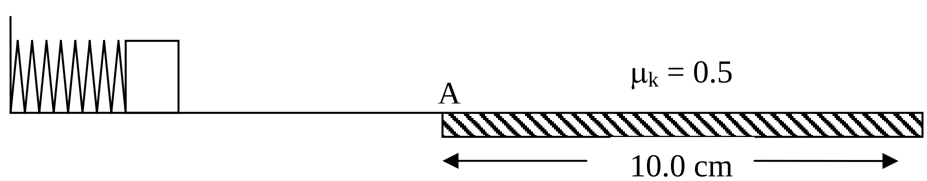
Find v at A by using conservation of energy: $mv^2 / 2 = mv_A^2 / 2 + mgh$. We have $h = 0.10$ m and $v = 2.0$ m/s. This gives $v_A^2 = 2.04\ m^2 / s^2$. At point A, mg is down (it is not along the radius), so it does not add nor subtract to the total radial force. The only radial force left is the normal F_N.
So, $F_N = mv_A^2 / r = (4.0)(2.04) / 0.1 = 81.6$ N.



(B) Draw **on the figure** the direction of this normal force. **(1pt)**

See arrow in figure.

(P4) A horizontal spring (k = 100.0 N/m) is compressed by a 2.0-kg block and then released from rest (see figure). The block first moves on a horizontal frictionless surface. After point A, the block moves on another surface that has friction with $\mu_k = 0.5$ between the block and the surface. The block travels 10.0 cm before it stops. By how much was the spring compressed? **(6pts)**



Use the work-energy theorem and the conservation of energy. Friction does work on the block, which looses its kinetic energy. Therefore, $W_f = \Delta KE = KE_f - KE_i$. But $KE_f = 0$ and $W_f = -Fd$ (negative sign because the angle between displacement and friction is 180^o; $\cos 180^o = -1$). Therefore, $-Fd = -KE_i = -mv_i^2 / 2$. The minus sign cancels and we get $Fd = mv_i^2 / 2$. Before A, the surface is frictionless. This means all the elastic energy of the spring becomes kinetic energy of the block. So, by conservation of energy, we have $kx^2 / 2 = mv_i^2 / 2 = Fd$, or $kx^2 / 2 = Fd$. But, $F = \mu_k F_N = \mu_k mg$; therefore, $kx^2 / 2 = \mu_k mgd$, which gives $x = (2\mu_k mgd / k)^{1/2} = 0.14$ m = 14 cm.