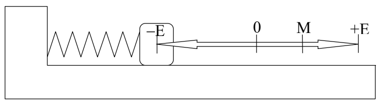
A mass is oscillating back and forth on a spring as shown. Position 0 is the unstretched position of the mass. At which point is the magnitude of the force on the mass maximum?

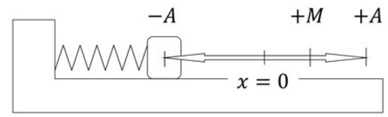


A) 0

B) $\pm M$

C) $\pm E$

A mass is oscillating back and forth on a spring as shown. Position 0 is the unstretched position of the mass. At which point is the elastic potential energy maximum?

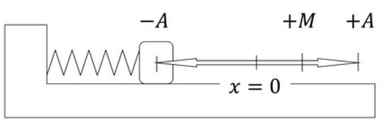


A) $x = 0$

B) $x = \pm M$

C) $x = \pm A$

A mass is oscillating back and forth on a spring as shown. Position 0 is the unstretched position of the mass. At which point is the kinetic energy maximum?

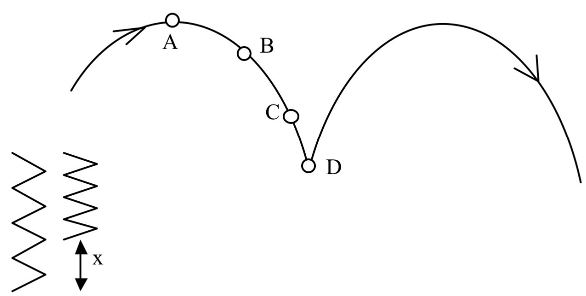


A) 0

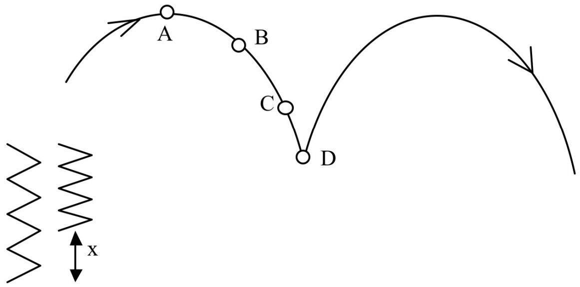
B) $\pm M$

C) $\pm A$

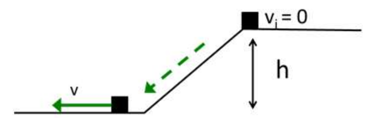
The tip of the nose of a pogo stick rider moves along the path shown. The maximum compression of the pogo stick spring is x. At what point(A, B, C or D) is the elastic potential of the spring energy a maximum?



The tip of the nose of a pogo stick rider moves along the path shown. The maximum compression of the pogo stick spring is x. At what point is the gravitational potential energy a maximum?



A mass slides down a rough ramp (with friction) of height h. Its initial speed is zero. Its final speed at the bottom of the ramp is v. While the mass is descending, its total mechanical energy (KE+PE) …

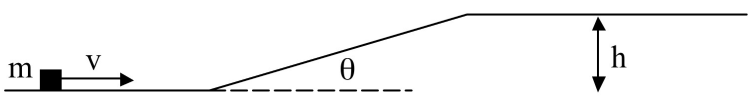


A) Increases

B) Decreases

C) Remains constant

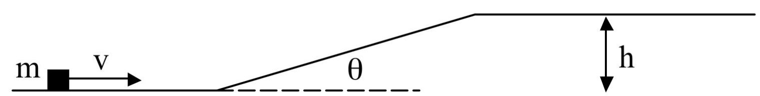
A block of mass m with initial speed v slides up a frictionless ramp of height h inclined at an angle θ as shown. Assume **no friction**. True or False: Whether the block makes it to the top of the ramp depends on the mass of block.



A) True

B) False

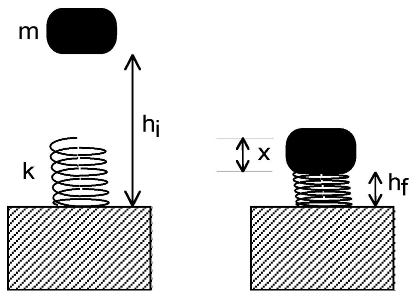
A block of mass m with initial speed v slides up a ramp of height h inclined at an angle θ as shown. Assume there **IS** friction. True or False: Whether the block makes it to the top of the ramp depends on the angle θ.



A) True

B) False

A mass m is dropped from rest from a height h_i above a table top on which sits on a spring with spring constant k. The mass compresses the spring by a maximum amount x and stops for an instant at a height h_f. There is no friction in this problem Which of the following equations correctly expresses conservation of energy and allows one to solve for the compression x of the spring?



A) $mgh_i + ½ mv^2 = ½ kx^2$

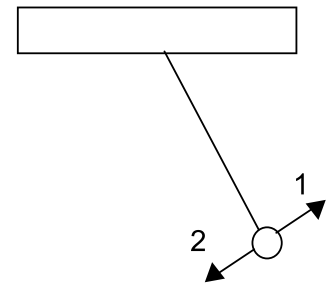
B) $mgh_i = ½ kx^2 + mgh_f$

C) $mgh_i + ½ kx^2 = mgh_f$

D) $mg(h_F - h_i) = ½ mv^2 + ½ kx^2$

E) None of these

A pendulum is launched in two different ways. During both launches, the bob is given an initial speed of 3.0 m/s and the same initial angle from the vertical. On launch 1, the speed is upwards, on launch 2, the speed is downwards. Assume no friction. Which launch will cause the pendulum to swing the largest angle from the equilibrium position on the left side?

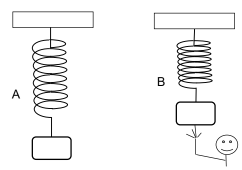


A) Launch 1

B) Launch 2

C) Both launches give the same maximum displacement.

A "system" consists of a mass m hanging from a spring (spring constant k) and the Earth as shown. In situation A, the mass is hanging freely, at rest, so the spring is stretched beyond its relaxed length. In situation B, the mass is also stationary, but the spring is now at its relaxed length, because an alien from Planet X has lifted the mass and is holding it up. In which situation is the total energy of the mass/spring/earth system bigger?

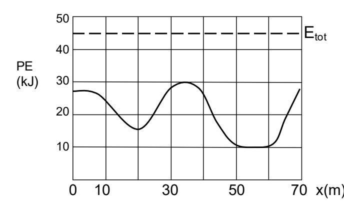


A) A

B) B

C) Same in both

A cart rolls on a frictionless track. The total mechanical energy (KE + PE) is 45 kJ. What is KE_{max} over this stretch of track?



A) 55 kJ

B) 10 kJ

C) 45 kJ

D) 35 kJ

E) None of these

PhET sim. I move the zero of potential energy up to the starting point of the skateboarder (skateboarder still starts from rest). The total energy E_{tot} of the system is now…

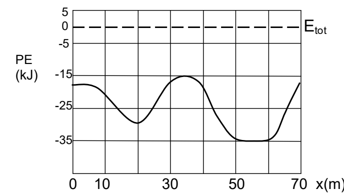
A) zero.

B) positive.

C) negative.

D) depends on the position of the skateboarder.

A cart rolls on a frictionless track. The total mechanical energy (KE + PE) is 0 kJ. What is KE_{max} over this stretch of track?



A) -35 kJ

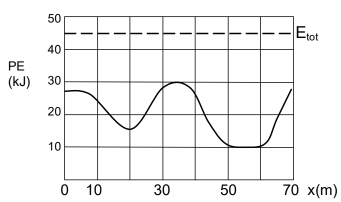
B) -15 kJ

C) 15 kJ

D) 35 kJ

E) None of these

A cart rolls on a frictionless track. The total mechanical energy (KE + PE) is 45 kJ. When the KE is minimum (at 35 m), what is the direction of acceleration?



A) up

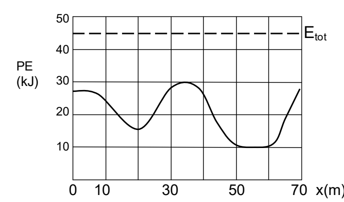
B) down

C) right

D) left

E) acceleration is zero

A cart rolls on a frictionless track. The total mechanical energy (KE + PE) is 45 kJ. When the KE is maximum (over this stretch of track), what is the direction of acceleration?



A) up

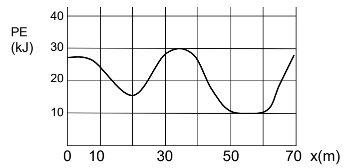
B) down

C) right

D) left

E) acceleration is zero

A cart rolls to the right on a frictionless track. If the KE of the cart when it is at $x = 20$ m is 20 kJ, will it make it over the hill?

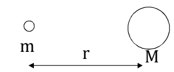


A) Yes

B) No

C) Not enough information

Two spherical masses m and M are distance r apart. The distance between their centers is halved (decreased by a factor of 2). What happens to the magnitude of the force of gravity between them? The force increases by a factor of …



A) $\sqrt{2}$

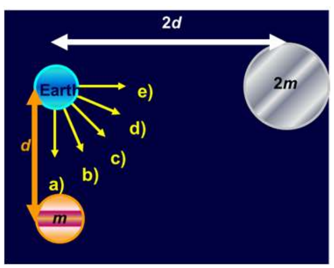
B) 2

C) $2\sqrt{2}$

D) 4

E) 8

A planet of mass m is a distance d from Earth. Another planet of mass $2m$ is a distance $2d$ from Earth. Which force vector best represents the direction of the total gravitation force on Earth?



Planet X has the same mass as the Earth, but 1/2 the radius. (So, Planet X is more dense than Earth). What's the free-fall acceleration due to gravity on Planet X?

A) g_E (same as Earth)

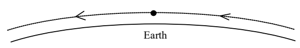
B) $2g_E$

C) $4g_E$

D) $\frac{1}{4}g_E$

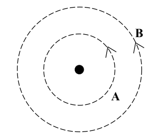
E) None of these

A satellite is in circular orbit at an altitude of 100 miles above the Earth's surface. The satellite's pre-launch weight is its weight measured on the ground. The magnitude of the force of gravity on the satellite in orbit is…



A) slightly greater than its pre-launch weight.
B) the same as its pre-launch weight.
C) slightly less than its pre-launch weight.
D) much less than its pre-launch weight, but not zero.
E) zero.

Two satellites, A and B, are in circular orbit around earth. The distance of satellite B from the Earth's center is twice that of satellite A. What is the ratio of the magnitudes of the accelerations of A to B: $a_A/a_B = \cdots$

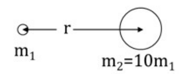


A) 1
B) 2
C) 4
D) ½
E) ¼

Kepler's 3rd law says the ratio T^2/r^3 is a constant for all the planets. The period T of the Earth is 1 year. An astronomical unit (1 A.U.) is defined as the mean distance from the Earth to the Sun. What is the period of an asteroid in circular orbit around the Sun with radius $\mathrm{r} = 2$ A.U.?

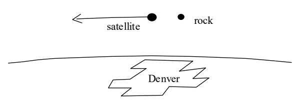
A) 2 yrs
B) 3 yrs
C) $2^{3/2} = 2.83$ yrs
D) $2^{2/3} = 1.59$ yrs
E) None of these

At a particular instant, two asteroids in inter-galactic space are a distance $r = 20$ km apart. Asteroid 2 has 10 times the mass of asteroid 1. The magnitudes of the accelerations of asteroids 1 and 2 are a_1 and a_2, respectively. What is the ratio a_1/a_2?



A) 10
B) 1/10
C) 1
D) Not enough information

At time $t = 0$, a satellite in circular orbit about the Earth is 300 mi directly over Denver, traveling west at 16,000 mph. At the same time, a rock is released from rest 300 miles above the city, very near the satellite. True or false: Immediately after release $|\vec{a}_{\text{rock}}| = |\vec{a}_{\text{satellite}}|$?



A) True

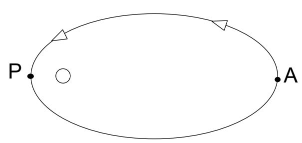
B) False

For a small mass m on the surface of a (non-rotating) planet of mass M and radius R, is it always true that $GMm/_{R^2} = mg$ (where g is the local acceleration of free-fall)?

A) Yes, this is always true regardless of whether the mass m is in free-fall or not.

B) No, this is not always true.

A planet in elliptical orbit around a star moves from the point in its orbit furthest from the star (A) to the closest point (P). The work done by gravity during this movement is...

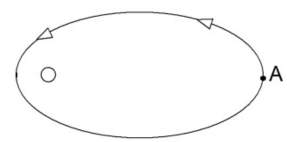


A) zero

B) positive

C) negative

A planet in elliptical orbit around a star executes one complete orbit starting from point A ***and returning to A***. The work done by gravity during this movement is...



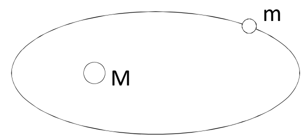
A) zero

B) positive

C) negative

A small planet of mass m is in elliptical orbit about a large star of mass M. Which of the following statements is **always** true as the planet orbits the star?

1. The direction of the acceleration of the planet is toward the star.
2. The magnitude of the acceleration of the planet is a = v^2/r ,where v is the speed of the planet and r is the distance between the planet and the star.
3. The magnitude of the force between the planet and the star is constant.
4. The speed of the planet is constant.



A) All are true always.

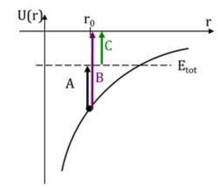
B) None are true always.

C) Only 1 and 2 are true always.

D) Only 1 is true always.

E) Some other combination.

The gravitational PE, $U(r) = -\frac{GMm}{r}$ of a two mass system ($m \ll M$) is plotted. Mass M is stationary at the origin. Mass m is at $r = r_0$. Also shown is the total energy E_{tot}. Which arrow represents the KE of mass m?



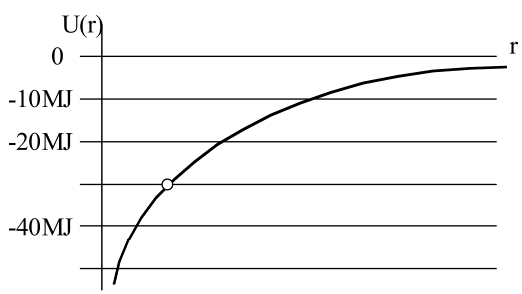
A) A

B) B

C) C

D) None of these

The gravitational potential energy of a rock near a star is shown in the diagram. When the rock is at the position shown, it has a kinetic energy of 25MJ. Will the rock escape to infinity or is it bound in orbit about the star?



A) Escape

B) It is bound in orbit

C) impossible to tell

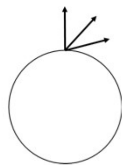
A projectile is fired from an airless world with a speed $v = v_{\text{escape}}$. What is the total energy ($E_{\text{tot}} = \text{KE} - GMm/r$) of the projectile?

A) $E_{\text{tot}} = 0$

B) $E_{\text{tot}} < 0$

C) $E_{\text{tot}} > 0$

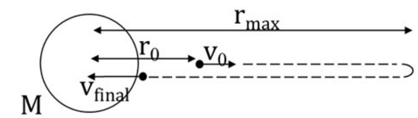
Does escape speed depend on launch angle? That is, if a projectile is given an initial speed v_0, is it more likely to escape an (airless, non-rotating) planet, if fired straight up than if fired at an angle?



A) Yes

B) No

To get r_{max}, what conservation of energy equation should you use?



A) $\frac{1}{2}m{v_0}^2 - \frac{GMm}{r_0} = -\frac{GMm}{r_{\text{max}}}$

B) $\frac{1}{2}m{v_0}^2 - \frac{GMm}{r_0} = \frac{1}{2}m{v_{\text{final}}}^2 - \frac{GMm}{r_{\text{max}}}$

C) $\frac{1}{2}m{v_0}^2 = -\frac{GMm}{r_{\text{max}}}$

D) $\frac{GMm}{r_0} = \frac{GMm}{r_{\text{max}}}$

E) None of these

A projectile is fired straight up from the surface of an airless planet (radius R) with the escape velocity v_{esc} (so, the projectile barely escapes the planet's gravity and it asymptotically approaches ∞ distance and 0 speed.) What is the projectile's speed when it is a distance $4R$ from the planet's center ($3R$ from the surface)? Ignore the gravity of the Sun and other planets.

A) $\frac{1}{2}v_{\text{esc}}$

B) $\frac{1}{4}v_{\text{esc}}$

C) $\frac{1}{9}v_{\text{esc}}$

D) $\frac{1}{3}v_{\text{esc}}$

E) None of these

A projectile is fired straight up from the surface of an airless planet (mass M, radius R) with speed v_0. Derive an expression for the projectile's speed when it is a distance $4R$ from the planet's center ($3R$ from the surface)?

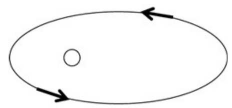
A) $v_0 - \sqrt{\frac{3}{2}\frac{GM}{R}}$

B) $v_0 - \sqrt{\frac{GM}{R}}$

C) $\sqrt{{v_0}^2 - \frac{GM}{R}}$

D) $\sqrt{{v_0}^2 - \frac{3}{2}\frac{GM}{R}}$

A planet is in elliptical orbit around the Sun. The zero of PE (or "U") is chosen at $r = \infty$, so that $U(r) = -\frac{GMm}{r}$. How does the magnitude of U (note that $|U| = -U$) compare to KE?



A) $|U| > \mathrm{KE}$

B) $|U| < \mathrm{KE}$

C) $|U| = \mathrm{KE}$

A projectile is fired straight up from the surface of an airless planet (radius R) with the escape velocity v_{esc} (so, the projectile barely escapes the planet's gravity and it asymptotically approaches ∞ distance and 0 speed.) What is the projectile's speed when it is a distance $4R$ from the planet's center ($3R$ from the surface)? Ignore the gravity of the Sun and other planets.

A) $\frac{1}{2}v_{\mathrm{esc}}$

B) $\frac{1}{4}v_{\mathrm{esc}}$

C) $\frac{1}{9}v_{\mathrm{esc}}$

D) $\frac{1}{3}v_{\mathrm{esc}}$

E) None of these