Exam 2 Review Questions
PHY 2425 - Exam 2

Section: 4–1 Topic: Newton's First Law: The Law of Inertia Type: Conceptual

1 According to Newton's law of inertia,

A) objects moving with an initial speed relative to a given frame of reference eventually come to rest relative to the reference frame.
B) whether an object is at rest or is moving with constant velocity depends on the inertial reference frame in which the object is observed.
C) rest is the most natural state of motion.
D) an object at rest in a given frame of reference eventually finds itself in motion relative to the frame of reference.
E) forces always exist in pairs.

Ans: B

Section: 4–1 Topic: Newton's First Law: The Law of Inertia Type: Factual

2 Newton's law of inertia does not describe the behavior of objects

A) in inertial frames of reference.
B) moving with constant velocity relative to a given frame of reference.
C) at rest relative to a given frame of reference.
D) moving in accelerated frames of reference.
E) moving in a straight line at constant speed relative to a given reference frame.

Ans: D

Section: 4–1 Topic: Newton's First Law: The Law of Inertia Type: Factual

3 An inertial reference frame is one in which

A) Newton's first law describes the behavior of matter.
B) the law of inertia is not applicable.
C) there is a great deal of matter.
D) the object of interest is traveling in a circular path.
E) forces do not necessarily exist in pairs.

Ans: A

Section: 4–1 Topic: Newton's First Law: The Law of Inertia Type: Conceptual

4 A physical quantity that is sometimes described as the measure of the resistance of a body to a change in motion is

A) force B) mass C) acceleration D) weight E) friction

Ans: B

Section: 4–1 Topic: Newton's First Law: The Law of Inertia Type: Factual

5 Which of the following statements includes all the essential elements of Newton's first law?

A) A body at rest persists in its state of rest unless acted on by a non-zero net external force.
B) A body persists in its state of rest or of uniform motion in a straight line as long as the net external force remains constant.
C) For every action there is an equal and opposite reaction.
D) A body persists in its state of rest or of uniform motion in a straight line unless acted on by a non-zero net external force.
E) The acceleration of a body is proportional to the net external force acting on it and to the mass of the body.

Ans: D

Section: 4–2 Topic: Force and Mass Type: Conceptual

6 When Newton's first law of motion is mentioned, you should immediately think of

A) $\vec{F}_{net} = m\vec{a}$
B) action-and-reaction forces.
C) inertia.
D) gravitational forces.
E) centripetal acceleration.

Ans: C

Section: 4–3 Topic: Newton's Second Law Type: Conceptual

7 A force accelerates a body of mass *M*. The same force applied to a second body produces three times the acceleration. What is the mass of the second body?

A) *M* B) 3*M* C) *M*/3 D) 9*M* E) *M*/9

Ans: C

Section: 4–3 Topic: Newton's Second Law Type: Conceptual

8 A force accelerates a body of mass *M*. A second body requires twice as much force to produce the same acceleration. What is the mass of the second body?

A) *M* B) 2*M* C) *M*/2 D) 4*M* E) *M*/4

Ans: B

Section: 4–3 Topic: Newton's Second Law Type: Numerical

9 A particle with a mass of 200 g is acted on by a force of 4.5 N. The acceleration of the particle is

A) 90 cm/s^2 B) 2.3 cm/s^2 C) 0.90 km/s^2 D) 23 m/s^2 E) 9.0 m/s^2

Ans: D

Section: 4–3 Topic: Newton's Second Law Type: Numerical

10 A mass of 25 kg is acted on by two forces: $\vec{F}_1$ is 15 N due east, and $\vec{F}_2$ is 10 N due north. The acceleration of the mass is

A) 0.72 m/s^2, 56.3º north of east.
B) 0.20 m/s^2, due east.
C) 0.72 m/s^2, 33.7º north of east.
D) 1.0 m/s^2, 33.7º north of east.
E) 0.20 m/s^2, 56.3º north of east.

Ans: C

Section: 4–3 Topic: Newton's Second Law Type: Numerical

11 A mass m is traveling at an initial speed $v_0 = 25.0$ m/s. It is brought to rest in a distance of 62.5 m by a force of 15.0 N. The mass is

A) 37.5 kg B) 3.00 kg C) 1.50 kg D) 6.00 kg E) 3.75 kg

Ans: B

Section: 4–3 Topic: Newton's Second Law Type: Conceptual

12 An object is moving to the right at a constant speed. Which one of the following statements must be correct?

A) No forces are acting on the object.
B) A larger number of forces are acting on the object to the right than to the left.
C) The net force acting on the object is to the right.
D) No net force is acting on the object.
E) Just one force is acting on the object, and it is acting downward.

Ans: D

Section: 4–3 Topic: Newton's Second Law Type: Conceptual

13 A force F produces an acceleration a on an object of mass m. A force $3F$ is exerted on a second object, and an acceleration $8a$ results. What is the mass of the second object?

A) $3m$ B) $9m$ C) $24m$ D) $(3/8)m$ E) $(8/3)m$

Ans: D

Section: 4–3 Topic: Newton's Second Law Type: Conceptual

14 A 10-N force is applied to mass M. The same force is applied to mass $4M$. The ratio of the acceleration of the smaller mass to the acceleration of the larger mass is

A) 4 to 1 B) 20 to 1 C) 1 to 1 D) 1 to 2 E) 1 to 4

Ans: A

Section: 4–3 Topic: Newton's Second Law Type: Conceptual

15 A fat cat, ever conscious of its weight, walks into an elevator and steps on a scale. The elevator begins to accelerate downward. While the elevator is accelerating, the scale reads

A) more than when the elevator is stationary.
B) more than if the elevator were accelerating upward.
C) less than when the elevator is stationary.
D) a negative value.
E) Insufficient information is given to answer correctly.

Ans: C

Section: 4–3 Topic: Newton's Second Law Type: Numerical

16 A ball of mass 2.0 kg is acted on by two forces, $\vec{F}_1 = 3.0N\,\hat{i} + 4.0N\,\hat{j}$ and $\vec{F}_2 = -5.0N\,\hat{i} + 6.0N\,\hat{j}$. The magnitude of the acceleration is

A) 2.5 m/s^2
B) 3.9 m/s^2
C) 4.6 m/s^2
D) 5.1 m/s^2
E) 5.8 m/s^2

Ans: D

Section: 4–3 Topic: Newton's Second Law Type: Numerical

17 A ball of mass 2.0 kg is acted on by two forces, $\vec{F}_1 = 3.0N\,\hat{i} + 4.0N\,\hat{j}$ and $\vec{F}_2 = -5.0N\,\hat{i} + 6.0N\,\hat{j}$. The acceleration vector of the mass is (in m/s^2)

A) $\vec{a} = 4.0\hat{i} + 5.0\hat{j}$
B) $\vec{a} = 8.0\hat{i} + 10.0\hat{j}$
C) $\vec{a} = 1.0\hat{i} + 5.0\hat{j}$
D) $\vec{a} = -1.0\hat{i} + 5.0\hat{j}$
E) $\vec{a} = 1.0\hat{i} - 5.0\hat{j}$

Ans: D

Section: 4–3 Topic: Newton's Second Law Type: Numerical

18 A ball of mass 2.0 kg is acted on by two forces, $\vec{F}_1 = 3.0N\,\hat{i} + 4.0N\,\hat{j}$ and $\vec{F}_2 = -5.0N\,\hat{i} + 6.0N\,\hat{j}$. At t = 0 s, the particle is at rest at the origin. The position vector at t = 2 s is

A) $\vec{r} = 1.0m\,\hat{i} + 5.0m\,\hat{j}$
B) $\vec{r} = -1.0m\,\hat{i} + 5.0m\,\hat{j}$
C) $\vec{r} = 2.0m\,\hat{i} + 10.0m\,\hat{j}$
D) $\vec{r} = -2.0m\,\hat{i} + 10.0m\,\hat{j}$
E) $\vec{r} = 2.0m\,\hat{i} - 10.0m\,\hat{j}$

Ans: D

Section: 4–3 Topic: Newton's Second Law Type: Numerical

19 A ball of mass 2.0 kg is acted on by two forces, $\vec{F}_1 = 3.0N\,\hat{i} + 4.0N\,\hat{j}$ and $\vec{F}_2 = -5.0N\,\hat{i} + 6.0N\,\hat{j}$. At t = 0 s, the particle is at rest at the origin. The velocity vector at t = 2 s is

A) $\hat{v} = 1.0m/s\,\hat{i} + 5.0m/s\,\hat{j}$

B) $\hat{v} = -1.0m/s\,\hat{i} + 5.0m/s\,\hat{j}$

C) $\hat{v} = -2.0m/s\,\hat{i} + 10.0m/s\,\hat{j}$

D) $\hat{v} = 2.0m/s\,\hat{i} + 10.0m/s\,\hat{j}$

E) $\hat{v} = 1.0m/s\,\hat{i} - 10.0m/s\,\hat{j}$

Ans: C

Section: 4–3 Topic: Newton's Second Law Type: Numerical

20 Rachel has been reading her physics book. She takes her weighing scales into an elevator and stands on them. If her normal weight is 690 N (155 lbs), and the elevator moves upward at $0.25g$ and then down at $0.25g$, what is the difference between the up and down scale readings?

A) 690 N B) 520 N C) 170 N D) 345 N E) 1.04×10^3 N

Ans: D

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Factual

21 The weight of an object is

A) the same as the mass of the object.
B) the quantity of matter in the object.
C) the mass of the object multiplied by the acceleration due to gravity at sea level, regardless of where the object is located.
D) the result of the gravitational force acting on the object.
E) the reading on a spring scale attached to the object.

Ans: D

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Conceptual

22 A body is sent out in space. Which of the following statements is true of this body as it moves away from Earth?

A) The body's mass and weight remain equal.
B) The body's mass remains constant, and its weight decreases.
C) The body's mass decreases, and its weight remains constant.
D) The body's mass and weight decrease.
E) The body's mass decreases, and its weight increases.

Ans: B

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Conceptual

23 A person of weight w is in an upward-moving elevator when the cable suddenly breaks. What is the person's apparent weight immediately after the elevator starts to fall?

A) w B) greater than w C) less than w D) $9.81w$ E) zero

Ans: E

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Numerical

24 An astronaut lands on an Earthlike planet and drops a small lead ball with a mass of 76.5 g from the top of her spaceship. The point of release is 18 m above the surface of the planet and the ball takes 2.5 s to reach the ground. The astronaut's mass on Earth is 68.5 kg. Her weight on the planet is

A) 69.0 N B) 395 N C) 670 N D) 990 N E) 1.02 kN

Ans: B

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Conceptual

25 A shopper steps on an escalator moving downward at a constant speed toward the bargain basement in a large department store. On his way down, the normal force exerted on him by the step of the escalator is

A) greater than his weight when he is off the escalator.
B) equal to his weight when he is off the escalator.
C) less than his weight when he is off the escalator.
D) dependent on how fast the escalator is moving.
E) unknown; insufficient information is given to answer correctly.

Ans: B

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Conceptual

26 The acceleration due to gravity on the moon is only about 1/6 of that on Earth. An astronaut whose weight on Earth is 600 N travels to the lunar surface. His mass as measured on the moon is

A) 600 kg B) 100 kg C) 61.2 kg D) 10.0 kg E) 360 kg

Ans: C

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Numerical

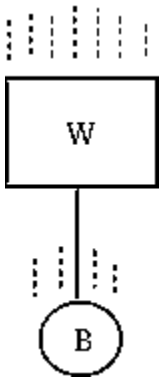
27 Of the following values, which is most nearly equal to the weight of a 1-kg body?

A) 1 N B) 103 dynes C) 2.2 lb D) 0.454 lb E) 2.2 N

Ans: C

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Conceptual

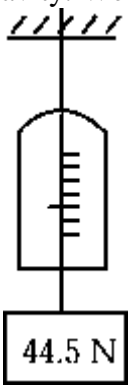
28 The system in the figure consists of a steel ball attached by a cord to a large block of wood. If the system is dropped in a vacuum, the force in the cord is



A) zero.
B) equal to the difference of the masses of B and W.
C) equal to the difference of the weights of B and W.
D) equal to the weight of B.
E) equal to the sum of the weights of B and W.
Ans: A

Section: 4–4 Topic: The Force Due to Gravity: Weight Type: Numerical

29 A 44.5-N weight is hung on a spring scale, and the scale is hung on a string. The string is lowered at a rate such that the entire assembly has a downward acceleration of 4.90 m/s^2. The scale reads



A) 0 N B) 22.2 N C) 44.5 N D) 66.7 N E) 71.2 N
Ans: B

Section: 4–4 Topic: The Force due to Gravity Type: Numerical

30 We all know it makes sense to bend one's knees when dropping from a height. Suppose a very silly 70-kg person were instead to drop down from a height of 1.4 m onto the ground and stop stiffly within a distance of only 0.60 cm. Calculate how many times his own weight is the average force his body feels.
A) 15 B) 24 C) 2.3×10^3 D) 6.1×10^2 E) 2.3×10^2
Ans: E

Section: 4–5 Topic: Contact Forces Type: Conceptual

31 A book is placed on a flat horizontal table. The table exerts a normal force on the book. The origin of the normal force in terms of the fundamental forces is

A) gravitational force.
B) electromagnetic force.
C) weak nuclear force
D) strong nuclear force
E) all the four forces

Ans: B

Section: 4–5 Topic: Contact Forces Type: Conceptual

32 If a force F is required to extend a spring by 20 cm, what force is required to extend it by 30 cm?

A) F B) $(2/3)F$ C) $(3/2)F$ D) $600F$ E) $(3/5)F$

Ans: C

Section: 4–5 Topic: Contact Forces Type: Conceptual

33 If a force F is required to extend a spring a distance $5y$, how far will it be extended by force $3F$?

A) $5y$ B) $(3/5)y$ C) $(5/3)y$ D) $15y$ E) $(3/8)y$

Ans: D

Section: 4–5 Topic: Contact Forces Type: Conceptual

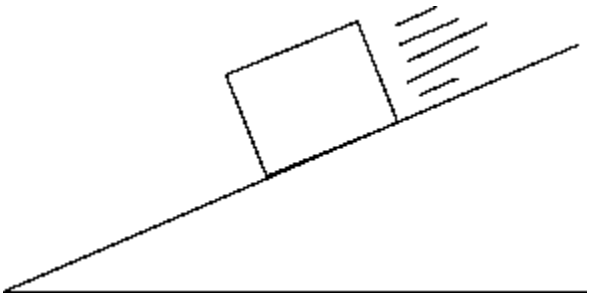
34 The concept of a *field*

A) provides us with a way to understand how a body's presence is known over great distances.
B) is a useful alternative to action at a distance for explaining gravitational forces.
C) is that of space distorted by the presence of an object.
D) is useful in describing electromagnetic interactions as well as gravitational interactions.
E) is described by all of these.

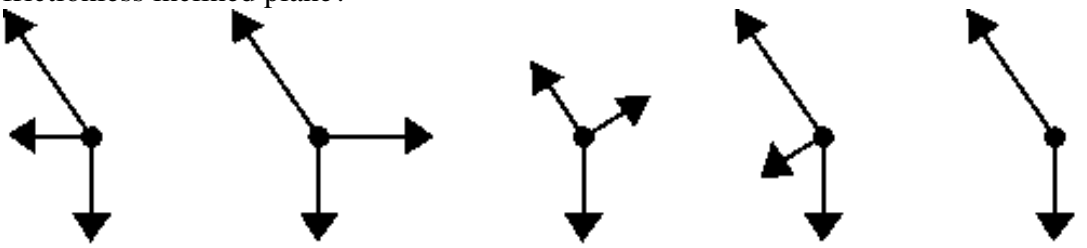
Ans: E

Section: 4–6 Topic: Problem Solving Type: Conceptual

35



Which of the following free-body diagrams represents the block sliding down a frictionless inclined plane?

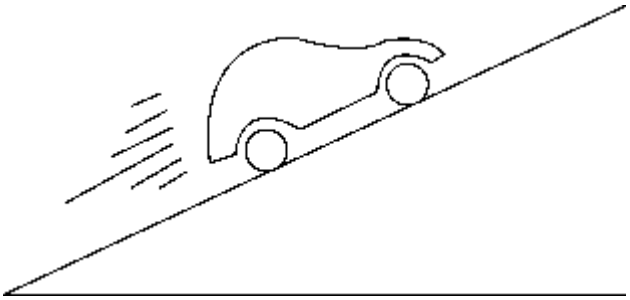


A) 1 B) 2 C) 3 D) 4 E) 5

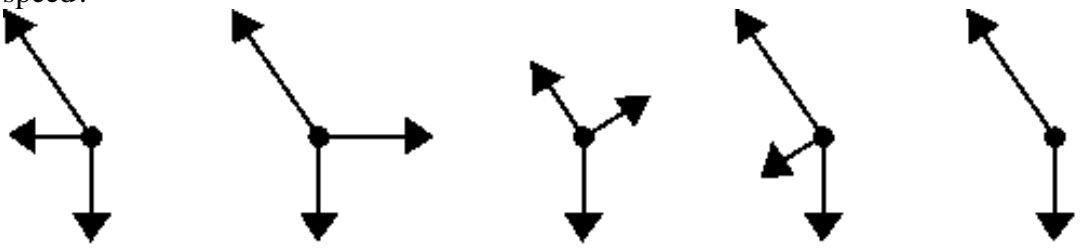
Ans: E

Section: 4–6 Topic: Problem Solving Type: Conceptual

36



Which of the following free-body diagrams represents the car going uphill at a constant speed?



A) 1 B) 2 C) 3 D) 4 E) 5

Ans: C

Section: 4–6 Topic: Problem Solving Type: Numerical

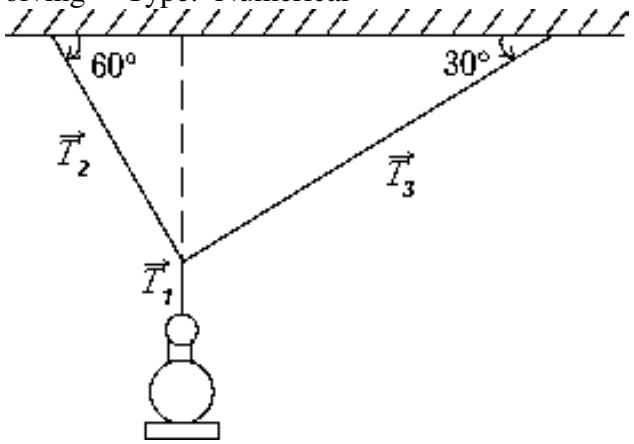
37 A horse-drawn coach is decelerating at 3.0 m/s^2 while moving in a straight line horizontally. A 350-g mass is hanging on a string 1.6 m long from the ceiling of the coach. The angle that the string makes with the vertical is

A) 9.3º toward the front of the coach.
B) 17º toward the front of the coach.
C) 9.3º toward the back of the coach.
D) 2.5º toward the front of the coach.
E) 0º, or straight down.

Ans: B

Section: 4–6 Topic: Problem Solving Type: Numerical

38 A lamp with a mass *m* is suspended from the ceiling by two cords as shown. The ratio of the magnitude of the vertical component of the tension in $\vec{T}_2$ to that in $\vec{T}_3$ is



A) 1:1 B) 1:2 C) $\sqrt{3}$:3 D) 3:2 E) 3:1

Ans: E

Section: 4–6 Topic: Problem Solving Type: Conceptual

39 A boy sits in a tire that is attached to a rope that passes over a pulley fastened to the ceiling and then passes back down to the boy's hands. The weight of the boy plus the tire is *W*. The force with which the boy must pull on the free end of the rope to support his weight in the tire is

A) (1/2)*W* B) *W* C) 2*W* D) (2/3)*W* E) (3/2)*W*

Ans: A

Section: 4–6 Topic: Problem Solving Type: Numerical

40 A vertical rope is attached to an object that has a mass of 40.0 kg and is at rest. The tension in the rope needed to give the object an upward speed of 3.50 m/s in 0.700 s is

A) 592 N B) 390 N C) 200 N D) 980 N E) 720 N

Ans: A

Section: 4–6 Topic: Problem Solving Type: Numerical

41 A particle of mass 1.3 kg is sliding down a frictionless slope inclined at 30º to the horizontal. The acceleration of the particle down the slope is

A) 1.3 m/s^2 B) 9.8 m/s^2 C) 0.5 m/s^2 D) 8.5 m/s^2 E) 4.9 m/s^2

Ans: E

Section: 4–6 Topic: Problem Solving Type: Numerical

42 You want to elope by sliding down a nylon rope made by tying stockings together. The rope will withstand a maximum tension of 300 N without breaking. Your mass is 61.2 kg. The magnitude of the smallest acceleration *a* with which you can slide down the rope is

A) 9.81 m/s^2 B) 4.91 m/s^2 C) zero D) 2.40 m/s^2 E) 19.6 m/s^2

Ans: B

Section: 4–6 Topic: Problem Solving Type: Numerical

43 Three forces, $\vec{X}$, $\vec{Y}$, and $\vec{Z}$, act on a mass of 4.2 kg. The forces are

$\vec{X}$ = 2.0 N acting to the east,

$\vec{Y}$ = 5.0 N acting 45º to the north of east, and

$\vec{Z}$ = 4.0 N acting 30º to the north of west.

The direction of the net acceleration

A) cannot be determined because the acceleration is zero.
B) is 60º north of east.
C) is 70º north of east.
D) is 51º north of east.
E) is 44º north of east.

Ans: C

Section: 4–6 Topic: Problem Solving Type: Numerical

44 Your heart pumps 80 g of blood with each beat. The blood starts from rest and reaches a speed of 0.60 m/s in the aorta. If each beat takes 0.16 s, the average force exerted on the blood is

A) 3.0×10^2 N B) 0.22 N C) 0.16 N D) 0.30 N E) 0.98 N

Ans: D

Section: 4–6 Topic: Problem Solving Type: Conceptual

45 A box sits on an inclined plane without sliding. As the angle of inclination increases, the normal force

A) increases.
B) decreases.
C) does not change.
D) is directed upward.
E) is directed in the direction of the gravitational force.

Ans: B

Section: 4–6 Topic: Problem Solving Type: Conceptual

46 A lamp of mass m hangs from a spring scale that is attached to the ceiling of an elevator. When the elevator is stopped at the fortieth floor, the scale reads mg. What does it read while the elevator descends toward the ground floor at a constant speed?

A) more than mg
B) less than mg
C) mg
D) zero
E) This cannot be answered without knowing how fast the elevator is descending.

Ans: C

Section: 4–6 Topic: Problem Solving Type: Numerical

47 Three forces F_1, F_2 and F_3 act on an object. If $F_1 = 3\text{N}\ i + 5\text{N}\ j + 7\text{N}\ k$, $F_2 = -5\text{N}\ i - 2\text{N}\ j - 2\text{N}\ k$, and the object is moving at constant velocity then the vector force F_3 is

A) $-2\text{N}\ i - 3\text{N}\ j - 5\text{N}\ k$
B) $2\text{N}\ i - 3\text{N}\ j - 5\text{N}\ k$
C) $2\text{N}\ i + 3\text{N}\ j - 5\text{N}\ k$
D) $-8\text{N}\ i - 7\text{N}\ j - 9\text{N}\ k$
E) $8\text{N}\ i + 7\ \text{N}\ j + 9\text{N}\ k$

Ans: B

Section: 4–7 Topic: Newton's Third Law Type: Conceptual

48 An 80-kg man on ice skates pushes a 40-kg boy, also on skates, with a force of 100 N. The force exerted by the boy on the man is

A) 200 N
B) 100 N
C) 50 N
D) 40 N
E) zero unless the boy pushes back

Ans: B

Section: 4–7 Topic: Newton's Third Law Type: Conceptual

49 A body of weight w is in free fall near the surface of Earth. What force does the body exert on the Earth?

A) w B) greater than w C) less than w D) $9.81w$ E) zero

Ans: A

Section: 4–7 Topic: Newton's Third Law Type: Conceptual

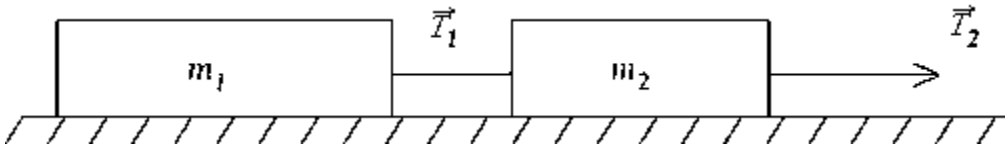
50 A horse exerts a force F on a cart, causing the cart to move with increasing speed. What force does the cart exert on the horse?

A) zero
B) F
C) greater than F
D) less than F
E) The force cannot be determined unless the acceleration is given.

Ans: B

Section: 4–8 Topic: Problems with Two or More Objects Type: Conceptual

51



Two masses, m_1 and m_2, connected by a massless string, are accelerated uniformly on a frictionless surface as shown. The ratio of the tensions $\vec{T}_1/\vec{T}_2$ is given by

A) m_1/m_2 B) m_2/m_1 C) $(m_1 + m_2)/m_2$ D) $m_1/(m_1 + m_2)$ E) $m_2/(m_1 + m_2)$

Ans: D

Section: 4–8 Topic: Problems with Two or More Objects Type: Conceptual

52

A mass $2m$ is attached by a string to another mass m as illustrated. A force of $\vec{N}$ newtons acts on mass m to accelerate the system. The force $\vec{F}$ in the string, which acts on mass $2m$, is

A) $(2/3)N$ B) N C) $2N$ D) $3N$ E) $(3/2)N$

Ans: A

Section: 4–8 Topic: Problems with Two or More Objects Type: Numerical

53 You are riding an elevator that is accelerating upward at 2.20 m/s^2. You have a spring balance accurately calibrated in newtons. When you hang a mass of 10.0 kg on the balance, the reading of the balance is

A) 120 N B) 981 N C) 76.0 N D) 10.0 N E) 9.81 N

Ans: A

Section: 4–8 Topic: Problems with Two or More Objects Type: Numerical

54 An object with a mass $M = 250$ g is on a plane inclined at 30º above the horizontal and is attached by a string to a mass $m = 150$ g. There is no friction and mass m hangs freely and is initially at rest. When mass m has descended a distance $h = 10$ cm, its speed will be

A) 35.0 cm/s B) 7.00 cm/s C) 140 cm/s D) 110 cm/s E) 70.0 cm/s

Ans: A

Section: 4–8 Topic: Problems with Two or More Objects Type: Numerical

55 A mass m is hanging on a string that passes over a pulley and is then attached to another mass $3m$ that is resting on a horizontal table. Neglect friction. Mass m is held motionless and is then released. When it has fallen a distance h, it will have a speed v which can be calculated from the formula

A) $v = \sqrt{(gh/4)}$

B) $v = \sqrt{(gh/2)}$

C) $v = \sqrt{(gh)}$

D) $v = \sqrt{(2gh)}$

E) None of these is correct.

Ans: B

Section: 4–8 Topic: Problems with Two or More Objects Type: Conceptual

56 If two metal blocks of different masses slide freely down the same frictionless incline, which one of the following is true?

A) They have equal accelerations
B) They have unequal accelerations, but the forces acting on them are equal.
C) The more massive block reaches the bottom first.
D) The less massive block reaches the bottom first.
E) None of these is correct.

Ans: A

Section: 4–8 Topic: Problems with Two or More Objects Type: Conceptual

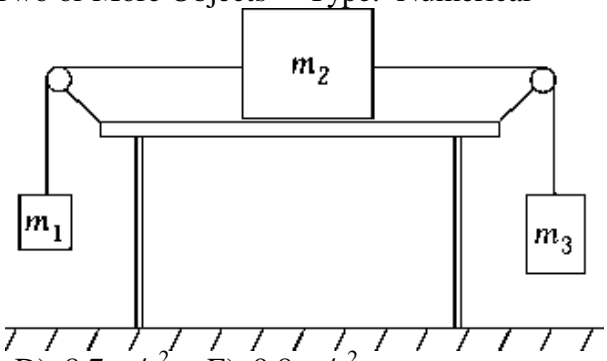
57 A 15-kg block sitting on a smooth table is connected to a free-hanging 5-kg mass by a stretchless, massless cord that passes over a small frictionless pulley. The acceleration of the two-block system is

A) equal to g. B) half of g. C) one-third of g. D) one-fourth of g. E) zero.

Ans: D

Section: 4–8 Topic: Problems with Two or More Objects Type: Numerical

58 For this problem, assume no friction. A mass $m_2 = 3.5$ kg rests on a horizontal table and is attached by strings to masses $m_1 = 1.5$ kg and $m_3 = 2.5$ kg as shown. The masses m_1 and m_3 hang freely. The system is initially held at rest. After it is released, the acceleration of mass m_2 will be

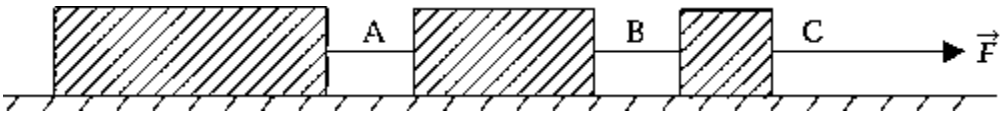


A) zero B) 1.3 m/s^2 C) 5.2 m/s^2 D) 8.7 m/s^2 E) 9.8 m/s^2

Ans: B

Section: 4–8 Topic: Problems with Two or More Objects Type: Conceptual

59



Three boxes are connected by stretchless strings and are pulled by a force $\vec{F}$ as shown in the figure. Which string has to be the strongest so as not to break?

A) A
B) B
C) C
D) A, B, and C must be equally strong.
E) A and B must be equally strong.

Ans: C

Section: 4–8 Topic: Problems with Two or More Objects Type: Conceptual

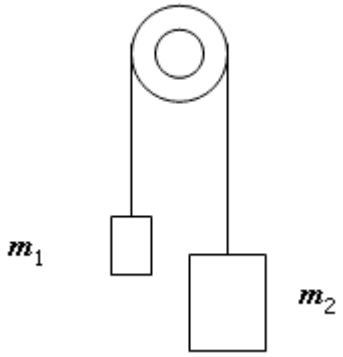
60 Two tug-of-war teams are pulling on the ends of a rope, each team with a force of 1000 N. If the rope does not move, the tension in the rope is

A) 2000 N B) 500 N C) 1000 N D) 0 N E) 2000 kg

Ans: C

Section: 4–8 Topic: Problem Solving with Two or More Objects Type: Numerical

61 Two masses m_1 and m_2 (with $m_2 > m_1$) are connected by a massless rope hung over a frictionless light pulley. If the masses are released then the acceleration of m_2 in the downward direction is given by

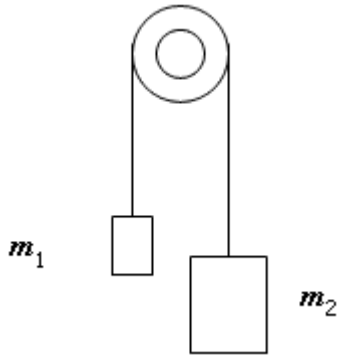


A) $(m_2 - m_1) \times g/(m_1 - m_2)$
B) $(m_2 - m_1) \times g/(m_1 + m_2)$
C) $(m_1 + m_2) \times g/(m_2 - m_1)$
D) $m_2 \times g/(m_1 + m_2)$
E) g

Ans: B

Section: 4–8 Topic: Problem Solving with Two or More Objects
Type: Numerical

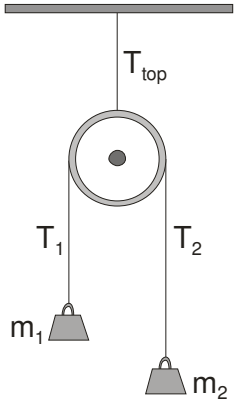
62 Two masses m_1 = 12 kg and m_2 = 35 kg are held connected by a massless rope hung over a frictionless light pulley. If the masses are released then the magnitude of the tension in the string is



A) 343 N B) 58.0 N C) 226 N D) 458 N E) 175 N
Ans: E

Section: 4–8 Topic: Problem Solving with Two or More Objects
Type: Conceptual

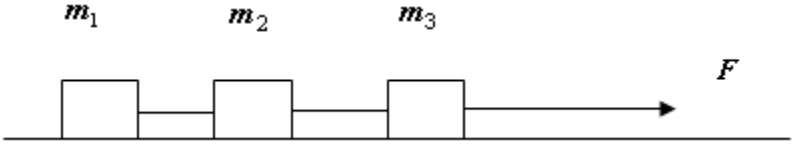
63 A frictionless pulley of negligible mass is hung from the ceiling using a rope, also of negligible mass. Two masses, m_1 and m_2 ($m_1 < m_2$) are connected to the rope over the pulley. The masses are free to drop. The magnitude of the tension T_{top} is ____ the sum of the weights $W_1 = m_1g$ and $W_2 = m_2g$.



A) less than
B) equal to
C) greater than
D) unable to tell
E) depends on T_1 and T_2.
Ans: A

Section: 4–8 Topic: Problems with Three or More Objects Type: Numerical

64



Three blocks are connected by massless cords and rest on a frictionless horizontal surface. The blocks are pulled to the right. Mass $m_1 = 2\ m_2 = 3\ m_3$, with m_1 on the left and m_3 on the right. If the pulling force is equal to 90 N, then the tension in the cord between m_1 and m_2 is
A) 49 N B) 15 N C) 100 N D) 44 N E) 85 N
Ans: A

Section: 4–8 Topic: Problems with Two or More Objects Type: Numerical

65 Three blocks are connected by massless cords and hung by a third massless cord to a beam. Mass $m_1 = 2\ m_2 = 3\ m_3$. Mass m_1 is the lowest block and m_3 is the highest. The tension in the cord between the two highest blocks is

A) $3m_1 \times g/2$ B) $m_1 \times g/2$ C) $m_1 \times g/6$ D) $2m_1 \times g/3$ E) $6m_1 \times g/11$

Ans: A

Section: 5–1 Topic: Friction Type: Numerical

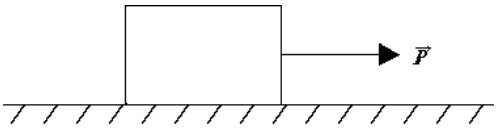
66 A 100-kg block is pushed up a 30º incline that is 10 m long. If the coefficient of friction between the block and the incline is 0.1, the constant force parallel to the incline that is required to move the block from rest at the bottom of the incline to the top in 3 s is approximately

A) 0.49 kN B) 0.085 kN C) 0.22 kN D) 0.80 kN E) 0.58 kN

Ans: D

Section: 5–1 Topic: Friction Type: Numerical

67 A 50-kg block rests on a horizontal surface. The coefficient of static friction $\mu_a = 0.50$. The coefficient of kinetic friction $\mu_k = 0.35$. A force $\vec{P}$ of 250 N is applied as shown.



A) The block remains at rest.

B) The block moves and continues to move at constant velocity.

C) The block accelerates to the right.

D) The block does not move until $\vec{P}$ is increased to greater than 490 N.

E) No conclusions can be drawn concerning the movement of the block from the information given.

Ans: C

Section: 5–1 Topic: Friction Type: Numerical

68 A block is placed on a plane whose angle of inclination is 30º. The coefficients of static and kinetic friction for the block on the inclined plane are both 0.2. The block

A) remains stationary on the inclined plane.

B) accelerates down the inclined plane.

C) travels down the inclined plane at constant velocity.

D) travels up the inclined plane at constant velocity.

E) accelerates up the inclined plane.

Ans: B

Section: 5–1 Topic: Friction Type: Conceptual

69 A tired worker pushes a heavy (100-kg) crate that is resting on a thick pile carpet. The coefficients of static and kinetic friction are 0.6 and 0.4, respectively. The worker pushes with a force of 500 N. The frictional force exerted by the surface is

A) 1000 N B) 600 N C) 500 N D) 400 N E) 100 N

Ans: C

Section: 5–1 Topic: Friction Type: Conceptual

70 Two objects are sliding at the same speed across a wooden surface. The coefficient of kinetic friction between the first object and the surface is twice that between the second object and the surface. The distance traveled by the first object before it stops is *S*. The distance traveled by the second object is

A) impossible to determine without knowing the masses involved.
B) 2*S*
C) *S*/2
D) *S*
E) 4*S*

Ans: B

Section: 5–1 Topic: Friction Type: Conceptual

71 A heavy truck and a light car are traveling at the same speed on the same roadway. If the coefficients of static friction between their tires and the road are the same, which vehicle will be able to stop in the shortest distance? Assume both have the same braking force.

A) the car
B) the truck
C) Both will be able to stop in the same distance.
D) One cannot tell without knowing their coefficients of kinetic friction.
E) One cannot tell without knowing their masses.

Ans: C

Section: 5–1 Topic: Friction Type: Numerical

72 An object with a mass of 5.5 kg is allowed to slide from rest down an inclined plane. The plane makes an angle of 30º with the horizontal and is 72 m long. The coefficient of friction between the plane and the object is 0.35. The speed of the object at the bottom of the plane is

A) 5.3 m/s B) 15 m/s C) 24 m/s D) 17 m/s E) 11 m/s

Ans: D

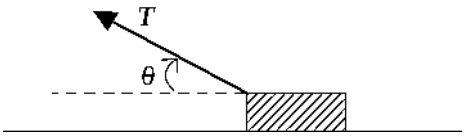
Section: 5–1 Topic: Friction Type: Conceptual

73 A block of wood is pulled by a horizontal string across a rough surface at a constant velocity with a force of 20 N. The coefficient of kinetic friction between the surfaces is 0.3. The force of friction is

A) impossible to determine without knowing the mass of the block.
B) impossible to determine without knowing the speed of the block.
C) 0.3 N
D) 6 N
E) 20 N
Ans: E

Section: 5–1 Topic: Friction Type: Conceptual

74 A block of mass m is pulled in the direction shown in the figure across a rough surface at a constant velocity. The magnitude of the frictional force is



A) $\mu_k mg$ B) $\mu_k T \cos\theta$ C) $\mu_k(T - mg)$ D) $\mu_k T \sin\theta$ E) $\mu_k(mg - T \sin\theta)$
Ans: E

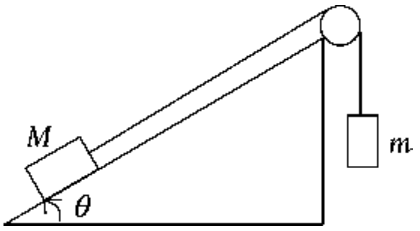
Section: 5–1 Topic: Friction Type: Numerical

75 A mass $M = 5.6$ kg on a horizontal table is pulled by a horizontal string that passes over a frictionless pulley to a free-hanging mass $m = 3.4$ kg. The coefficient of friction between M and the table is 0.28. The acceleration of M is

A) 3.7 m/s^2 B) 2.0 m/s^2 C) 2.2 m/s^2 D) 0.20 m/s^2 E) 0.49 m/s^2
Ans: B

Section: 5–1 Topic: Friction Type: Numerical

76 An object with a mass $M = 250$ g is at rest on a plane that makes an angle $\theta = 30°$ above the horizontal. The coefficient of kinetic friction between M and the plane is $\mu_k = 0.100$. Mass M is attached by a string to another mass, $m = 200$ g, which hangs freely. When mass m has fallen 30.0 cm, its speed is



A) 83 cm/s B) 48 cm/s C) 160 cm/s D) 59 cm/s E) 72 cm/s
Ans: A

Section: 5–1 Topic: Friction Type: Numerical

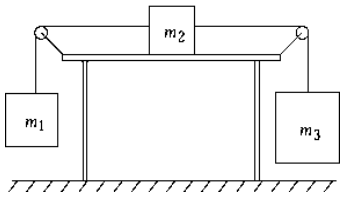
77 A horizontal force $\vec{F}$ acts on a mass m that lies on a horizontal surface. The acceleration of m is $\vec{a}$. The coefficient of kinetic friction μ_k between mass m and the surface can be calculated from

A) $\mu_k = a/g$
B) $\mu_k = (F/mg) - (a/g)$
C) $\mu_k = (F/mg) + (a/g)$
D) $\mu_k = 0$
E) None of these is correct.

Ans: B

Section: 5–1 Topic: Friction Type: Numerical

78 A mass $m_2 = 1.5$ kg rests on a horizontal table. The coefficients of friction between m_2 and the table are $\mu_s = 0.3$ and $\mu_k = 0.25$. The mass m_2 is attached by strings to masses $m_1 = 2.5$ kg and $m_3 = 4.5$ kg as shown. Masses m_1 and m_3 hang freely. The system is initially held at rest. After it is released, the acceleration of m_2 is approximately



A) 1.9 m/s^2 B) 2.4 m/s^2 C) 3.0 m/s^2 D) zero E) 13 m/s^2

Ans: A

Section: 5–1 Topic: Friction Type: Numerical

79 A horizontal force $\vec{F}$ is used to push an object of mass m up an inclined plane. The angle between the plane and the horizontal is θ. The normal reaction force of the plane acting on the mass m is

A) $mg \cos\theta + F \cos\theta$
B) $mg \cos\theta$
C) $mg \cos\theta + F \sin\theta$
D) $mg \cos\theta - F \cos\theta$
E) impossible to determine because the coefficient of friction is not given.

Ans: C

Section: 5–1 Topic: Friction Type: Numerical

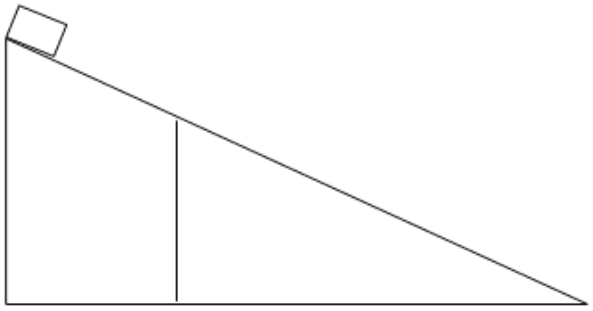
80 A block with a mass of 10 kg is at rest on a horizontal surface. The coefficient of static friction between the block and the surface is 0.30, and the coefficient of kinetic friction is 0.25. A force of 20 N acts on the block toward the left. The magnitude of the frictional force on the block is

A) 10 N B) 20 N C) 0.10 kN D) 30 N E) 3.0 N

Ans: B

Section: 5–1 Topic: Friction Type: Numerical

81 A 2-kg block sits on an incline where the top part of the incline has a coefficient of kinetic friction (μ_k) of 0.70. The bottom section of the plane has $\mu_k = 0.95$. The angle of inclination is 40 degrees. The block is released and travels 10 m along the initial part of the incline and then enters the lower section. Calculate how far the block travels along the second section before it is brought to a stop.



A) 2.7 m B) 21 m C) 23 m D) 13 m E) 260 m
Ans: D

Section: 5–1 Topic: Friction Type: Numerical

82 A 50-kg box is placed in the bed of a truck. The coefficient of friction between the box and the truck bed is 0.54. If the truck is traveling at 87 km/h (~54 mph) then calculate the minimum distance the truck can stop in without the box sliding into the cab.
A) 99 m B) 1.4×10^3 m C) 55 m D) 1.2×10^2 m E) 2.8×10^2 m
Ans: C

Section: 5–2 Topic: Drag Forces Type: Conceptual

83 The net force acting on an object is zero. You can therefore definitely conclude that the object is
A) at rest.
B) moving in a straight line at constant speed.
C) moving in a circle at constant speed.
D) undergoing acceleration.
E) either at rest or moving in a straight line at constant speed.
Ans: E

Section: 5–2 Topic: Drag Forces Type: Numerical

84 An object with a mass of $m = 12.0$ g is falling through a resistive fluid in which g is constant. The retarding frictional force due to the fluid is $F = bv$, where F is the force in newtons, b is a constant, and v is the speed in meters per second. If $F = 3.2 \times 10^{-2}$ N when $v = 16.0$ m/s, the terminal speed of the object falling through the fluid is
A) 0.12 m/s
B) 59 m/s
C) 0.19 km/s
D) 16.0 m/s
E) None of these is correct.
Ans: B

Section: 5–2 Topic: Drag Forces Type: Conceptual

85 As a sky diver falls through the air, her terminal speed
A) depends on her mass.
B) depends on her body's orientation.
C) depends on the local value of the acceleration due to gravity.
D) depends on the density of the air.
E) is described by all of the above.
Ans: E

Section: 5–3 Topic: Motion Along a Curved Path Type: Conceptual

86 When a particle moves in a circle with constant speed, its acceleration is
A) constantly increasing.
B) constant in direction.
C) zero.
D) constant in magnitude.
E) constant in magnitude and direction.
Ans: D

Section: 5–3 Topic: Motion Along a Curved Path Type: Conceptual

87 An object traveling in a circle at constant speed
A) is moving with constant velocity.
B) may be slowing down or picking up speed.
C) experiences no acceleration.
D) experiences an acceleration toward the center of the circle.
E) is described by none of the above statements.
Ans: D

Section: 5–3 Topic: Motion Along a Curved Path Type: Conceptual

88 A car going around a curve of radius R at a speed V experiences a centripetal acceleration a_c. What is its acceleration if it goes around a curve of radius $3R$ at a speed of $2V$?
A) $(2/3)a_c$ B) $(4/3)a_c$ C) $(2/9)a_c$ D) $(9/2)a_c$ E) $(3/2)a_c$
Ans: B

Section: 5–3 Topic: Motion Along a Curved Path Type: Numerical

89 A particle moving with uniform Motion Along a Curved Path has a period of 0.24 s and a speed of 4.2 m/s. The radius of the path of the particle is
A) 16 cm B) 2.6 cm C) 1.0 m D) 0.062 cm E) 1.4 cm
Ans: A

Section: 5–3 Topic: Motion Along a Curved Path Type: Numerical

90 A particle is moving uniformly in a circle with radius 50 cm. The linear speed of the particle is 60 cm/s. The acceleration of the particle has a magnitude of
A) zero B) 36 m/s^2 C) 1.8×10^5 cm/s^2 D) 72 cm/s^2 E) 3.6 m/s^2
Ans: D

Section: 5–3 Topic: Motion Along a Curved Path Type: Numerical

91 A proud new Jaguar owner drives her car at a speed of 25 m/s into a corner. The coefficients of friction between the road and the tires are 0.70 (static) and 0.40 (kinetic). What is the minimum radius of curvature for the corner in order for the car not to skid?

A) 3.5×10^2 m B) 64 m C) 2.1×10^2 m D) 1.6×10^2 m E) 91 m

Ans: E

Section: 5–3 Topic: Motion Along a Curved Path Type: Numerical

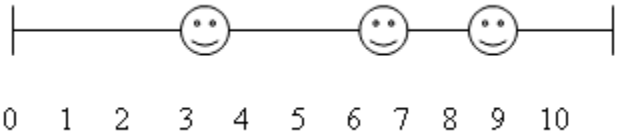
92 A professor likes to demonstrate centripetal force by swinging a bucket of water in the vertical direction. What is the minimum speed he must swing the bucket at the top of the circle if he is not to get drenched? (Assume that his arm is 1 m long.)

A) 1.1 m/s B) 2.1 m/s C) 3.1 m/s D) 4.1 m/s E) 5.1 m/s

Ans: C

Section: 5–5 Topic: The Center of Mass Type: Numerical

93 Three smiley faces are situated along the x axis as follows: m_1 = 5 kg at 3.0 m, m_2 = 3 kg at 6.0 m and m_3 = 2 kg at 8.0 m. Where is the center of mass situated?

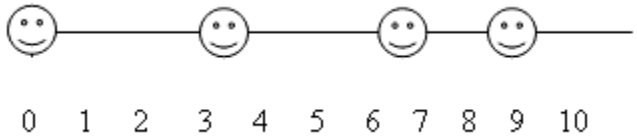


A) 3.9 m B) 4.9 m C) 5.5 m D) 4.1 m E) 5.1 m

Ans: B

Section: 5–5 Topic: The Center of Mass Type: Numerical

94 Four smiley faces are situated along the x axis as follows: m_1 = 5 kg at 0.0 m, m_2 = 3 kg at 4.0 m, m_3 = 3 kg at x m, and m_4 = 2 kg at 8.0 m. If the center of mass is situated at 3.54 m, where is m_3 located?



A) 3.5 m B) 7.0 m C) 6.0 m D) 4.0 m E) 5.0 m

Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

95 A body moves with decreasing speed. Which of the following statements is true?
A) The net work done on the body is positive, and the kinetic energy is increasing.
B) The net work done on the body is positive, and the kinetic energy is decreasing.
C) The net work done on the body is zero, and the kinetic energy is decreasing.
D) The net work done on the body is negative, and the kinetic energy is increasing.
E) The net work done on the body is negative, and the kinetic energy is decreasing.
Ans: E

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

96 Initially a body moves in one direction and has kinetic energy K. Then it moves in the opposite direction with three times its initial speed. What is the kinetic energy now?
A) K B) $3K$ C) $-3K$ D) $9K$ E) $-9K$
Ans: D

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

97 The average marathon runner can complete the 42.2-km distance of the marathon in 3 h and 30 min. If the runner's mass is 75 kg, what is the runner's average kinetic energy during the run?
A) 842 J B) 5.45×10^3 J C) 251 J D) 126 J E) 421 J
Ans: E

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

98 The work expended to accelerate a car from 0 to 30 m/s
A) is more than that required to accelerate it from 30 m/s to 60 m/s.
B) is equal to that required to accelerate it from 30 m/s to 60 m/s.
C) is less than that required to accelerate it from 30 m/s to 60 m/s.
D) can be any of the preceding, depending on the time taken.
E) is described by none of these statements.
Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

99 The kinetic energy of a car is 1.00×10^5 J. If the car's speed is increased by 20 percent, the kinetic energy of the car becomes
A) 4.00×10^3 J
B) 1.20×10^5 J
C) 1.44×10^5 J
D) 1.04×10^5 J
E) unknown; the answer depends on the mass of the car, which is not given
Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

100 A bullet with a mass of 12 g moving horizontally strikes a fixed block of wood and penetrates a distance of 5.2 cm. The speed of the bullet just before the collision is 640 m/s. The average force that the wood exerted on the bullet was

A) 4.7×10^4 N
B) 74 N
C) 4.7×10^6 N
D) unknown; the mass of the wood is required
E) None of these is correct.

Ans: A

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

101 A 5-kg object slides down a frictionless surface inclined at an angle of 30º from the horizontal. The total distance moved by the object along the plane is 10 meters. The work done on the object by the normal force of the surface is

A) zero B) 0.50 kJ C) 0.43 kJ D) 0.58 kJ E) 0.25 kJ

Ans: A

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

102 A force $\vec{F}$ pushes a block along a horizontal surface against a force of friction $\vec{F}_{\text{f}}$. If the block undergoes a displacement ***s*** at constant velocity, the work done by the resultant force on the block

A) is equal to the work done by the force of friction $\vec{F}_{\text{f}}$
B) is given by $W = \vec{F} \cdot \vec{s}$
C) increases the kinetic energy of the block.
D) increases the potential energy of the block.
E) is zero.

Ans: E

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

103 Negative work means

A) the kinetic energy of the object increases.
B) the applied force is variable.
C) the applied force is perpendicular to the displacement.
D) the applied force is opposite to the displacement.
E) nothing; there is no such thing as negative work.

Ans: D

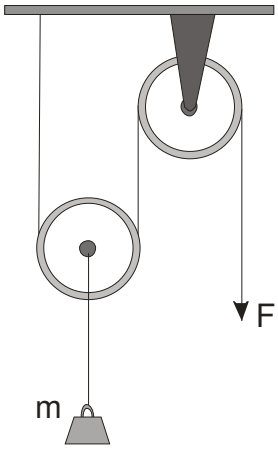
Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

104 A particle moves halfway around a circle of radius *R*. It is acted on by a radial force of magnitude *F*. The work done by the radial force is

A) zero B) FR C) $F\pi R$ D) $2FR$ E) $2\pi R$

Ans: A

Use the figure to the right to answer the next two questions. A light rope runs through two frictionless pulleys of negligible mass. A mass, m, is hung from one of the pulleys and a force, F is applied to one end of the rope so that the mass moves at a constant speed.



Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

105 If the force is applied over a distance, d, the distance the mass moves is

A) 0 B) $\frac{1}{4}\,d$ C) $\frac{1}{2}\,d$ D) d E) $2d$

Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

106 What is the force needed to move the mass at a constant speed?

A) 0 B) $\frac{1}{2}$mg C) mg D) 2mg E) 4mg

Ans: B

Section: 6–1 Topic: Work Done by a Constant Force Type: Conceptual

107 A car and its occupants, with a total mass m, are moving at a speed v relative to an observer on the side of the road. You are driving in another car, also traveling at speed v, and in the same direction as the first car. The kinetic energy of the first car relative to you is

A) 0

B) $\frac{1}{2}\,mv^2$

C) $\frac{1}{2}m(2v)^2$

D) $\frac{1}{2}\,m\,(3v)^2$

E) depends on the mass of your car

Ans: A

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

108 A constant force of 45 N directed at angle θ to the horizontal pulls a crate of weight 100 N from one end of a room to another a distance of 4 m. Given that the vertical component of the pulling force is 12 N, calculate the work done by the force in moving the crate.

A) 4.1×10^2 J B) 48.0 J C) 3.9×10^2 N/m D) 1.7×10^2 J E) 3.9×10^3 J

Ans: D

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

109 Two forces, both of magnitude 12 N and directed 35 degrees either side of the direction of motion, pull a crate 15 m. How much work is done by the forces in moving the crate?

A) 1.8×10^2 J
B) 1.5×10^2 J
C) 2.9×10^2 J
D) 2.9×10^2 N/m
E) 2.1×10^2 J

Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

110 Car drag racing takes place over a distance of a $\frac{1}{4}$ mile (402 m) from a standing start. If a car (mass 1500 kg) could be propelled forward with a pulling force equal to that of gravity, what would be the change in kinetic energy and the terminal speed of the car (in mph) at the end of the race be? (For comparison, a modern, high-performance sports car may reach a terminal speed of just over 100 mph = 44.7 m/s.)

A) 604 kJ and 28.4 m/s
B) 5.92 kJ and 88.9 m/s
C) 5.92 MJ and 7900 m/s
D) 3680 kJ and 70.0 m/s
E) 5.92 MJ and 88.9 m/s

Ans: E

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

111 Kids love to crash their toy cars together. One such collision involves a 0.5 kg car moving at 0.3 m/s colliding with a stationary toy car of mass 0.3 kg. The two toys stick together and move away from the collision point at 0.188 m/s. By what factor is the initial kinetic energy greater than the final kinetic energy?

A) 0.63 B) 1.6 C) 2.5 D) 4.2 E) 1.0 The kinetic energy stays the same.

Ans: B

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

112 What is the difference in work needed to push a 100 kg crate (at constant speed) a distance of 2 m along an inclined plane that is at an angle of 20 degrees with the horizontal, if the coefficient of kinetic friction was equal to 0.20 or zero?

A) 670 N B) 1040 N C) no difference D) 370 N E) 134 N

Ans: D

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

113 In a television tube, an electron starting from rest experiences a force of 4.0×10^{-15} N over a distance of 50 cm. The final speed of the electron is (do not worry about relativistic effects):

A) 4.4×10^{15} m/s
B) 6.6×10^{7} m/s
C) 3.3×10^{7} m/s
D) 1.3×10^{8} m/s
E) 6.6×10^{8} m/s

Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

114 A donkey is attached by a rope to a wooden cart at an angle of 23° to the horizontal. The tension in the rope is 210 N. If the cart is dragged horizontally along the floor with a constant speed of 6 km/h, calculate how much work the donkey does in 35 minutes.

A) 740 kJ B) 290 kJ C) 680 kJ D) 11 kJ E) 0.70 kJ

Ans: C

Section: 6–1 Topic: Work Done by a Constant Force Type: Numerical

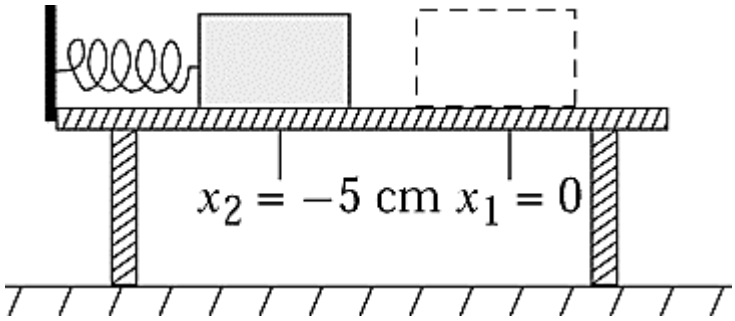
115 What is the work done by a car's braking system when it slows the 1500-kg car from an initial speed of 96 km/h down to 56 km/h in a distance of 55 m?

A) 8.3 kJ B) 20 kJ C) 1.3 MJ D) 2.5 MJ E) 8.3 MJ

Ans: C

Section: 6–2 Topic: Work Done by a Variable Force Type: Numerical

116



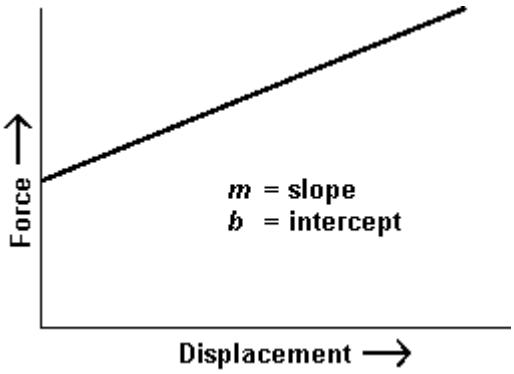
A mass $m = 2.5$ kg is sliding along a frictionless table with initial speed v as shown in the figure. It strikes a coiled spring that has a force constant $k = 500$ N/m and compresses it a distance $x_2 - x_1 = -5.0$ cm. The initial speed v of the block was

A) 0.71 m/s B) 1.0 m/s C) 1.4 m/s D) 0.50 m/s E) 1.7 m/s

Ans: A

Section: 6–2 Topic: Work Done by a Variable Force Type: Numerical

117



The graph represents the force acting on a body plotted against the displacement of the body in the direction of the force. The total work done by the force from $x = 0$ to $x = x$ is

A) m B) $mx^2 + b$ C) $\frac{1}{2} \cdot mx^2 + b$ D) $mx + b$ E) $\frac{1}{2} \cdot mx^2 + bx$

Ans: E

Section: 6–3 Topic: The Scalar Product Type: Numerical

118 If vector $\vec{A} = -2\hat{i} + 3\hat{j}$ and a vector $\vec{B} = 4\hat{i} - 5\hat{j}$, the inner product $\vec{A} \cdot \vec{B}$ is

A) –23 B) 7 C) –7 D) 23 E) 17

Ans: A

Section: 6–3 Topic: The Scalar Product Type: Numerical

119 The angle between the vectors $\vec{A} = -2\hat{i} + 3\hat{j}$ and $\vec{B} = 4\hat{i} - 5\hat{j}$ is approximately

A) 5º B) 47º C) 175º D) 15º E) 26º

Ans: C

Section: 6–3 Topic: The Scalar Product Type: Numerical

120 The angle between the vector $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$ and the y axis is approximately

A) 58º B) 75º C) 17º D) 26º E) 37º

Ans: A

Section: 6–3 Topic: The Scalar Product Type: Numerical

121 A 5-kg object undergoes a displacement $\Delta\vec{s} = 2\hat{i} + 3\hat{j}$. During the displacement, a constant force $\vec{F} = 4\hat{i} - 2\hat{j}$ acts on the object. All values are given in SI units. The work done by the force $\vec{F}$ on this object is

A) 8 J B) –6 J C) 2 J D) 14 J E) –2 J

Ans: C

Section: 6–3 Topic: The Scalar Product Type: Numerical

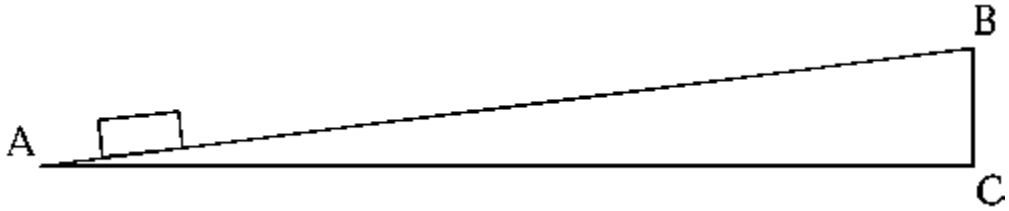
122 A motor is lifting a mass of 35.0 kg at a constant speed of 6.00 m/s. If friction is neglected, the power developed by the motor to do this lifting is

A) 740 W B) 1.5×10^3 W C) 2.1×10^3 W D) 59 W E) 43 W

Ans: C

Section: 6–3 Topic: The Scalar Product Type: Numerical

123



The object in the figure has a mass of 3.45 kg and is pulled up a slope AB, which is 36 m long; the height BC is 3.00 m. There is no friction and the acceleration is constant. The speed v_1 at A is 3.5 m/s whereas the speed v_2 at B is 5.5 m/s. The average power developed by the motor pulling the object is

A) 17 W B) 3.9 W C) 13 W D) 0.13 kW E) 43 W

Ans: A

Section: 6–3 Topic: The Scalar Product Type: Numerical

124 A body is acted upon by a force of 10 N and undergoes a displacement in the direction of the force in accordance with the relation $s = 3t^2 + 2t$, where s is the displacement in meters and t is in seconds. The rate at which the force is doing work at the instant $t = 2$ s is

A) 14 W B) 12 W C) 120 W D) 140 W E) 160 W

Ans: D

Section: 6–3 Topic: The Scalar Product Type: Numerical

125 The power developed by a certain engine is a function of time according to

$$P = 2 + 2t + 3t^2$$

where the units are SI. The work done by the engine in the interval from $t = 0$ to $t = 2$ s is

A) 9 J B) 10 J C) 14 J D) 16 J E) 18 J

Ans: D

Section: 6–3 Topic: The Scalar Product Type: Numerical

126 A body is acted upon by a force of 10 N and undergoes displacement in the direction of the force in accordance with the relation

$$s = 3t^2 + 2t$$

where the units are SI. The rate at which the force is doing work at the instant $t = 2$ s is
A) 14 W B) 12 W C) 120 W D) 140 W E) 160 W
Ans: D

Section: 6–3 Topic: The Scalar Product Type: Numerical

127 As a punishment for being late to a practice session the coach orders her star athlete to run up the stadium steps. The player's mass is 80 kg and it takes one minute for her to run up the 120 steps at a constant rate. If each step is of height 0.5 m, what is the power output of the player?
A) 80.0 W B) 13.0 W C) 1570 W D) 785 W E) 390 W
Ans: D

Section: 6–3 Topic: The Scalar Product Type: Numerical

128 If the average power output of a car engine is the same as a 100-W light bulb, how long would it take a 1200-kg car to go from zero to 96 km/h (60 mph)?
A) 8.5×10^3 s B) 5.5×10^4 s C) 65 s D) 160 s E) 4.3×10^3 s
Ans: E

Section: 6–3 Topic: The Scalar Product Type: Numerical

129 Egyptian pyramid workers push a 1200-kg block up an incline that has an angle of 69 degrees to the vertical, at a constant speed of 0.5 m/s. The coefficient of kinetic friction between the block and the incline surface is 0.44. How much power must the workers supply?
A) 3.1×10^2 W B) 9.3 kW C) 4.5 kW D) 7.9 kW E) 2.4 kW
Ans: C

Section: 6–3 Topic: The Scalar Product Type: Numerical

130 A Blackhawk helicopter is winching up an injured soldier from a danger zone. The soldier and his kit have a mass of 150 kg and are pulled up 50 m in the air at a steady rate. If it takes 30 s to pull the soldier up, how much power has been used by the helicopter's 65% efficient winch engine?
A) 2.5 kW B) 3.8 kW C) 1.6 kW D) 4.1 kW E) 3.2 kW
Ans: B

Section: 6–3 Topic: The Scalar Product Type: Numerical

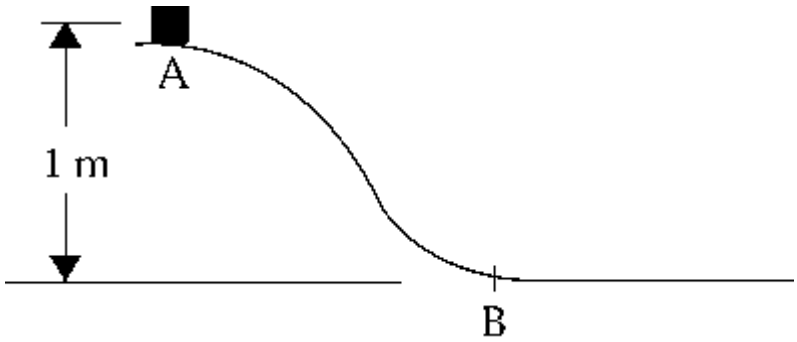
131 What minimum power rating must a water pump have if needs to raise water at 20 kg per minute from a depth of 9 m?

A) 1.76 kW B) 29.4 W C) 106 kW D) 3.0 W E) 180 W

Ans: B

Section: 6–4 Topic: Work –Kinetic-Energy Theorem—Curved Paths Type: Numerical

132



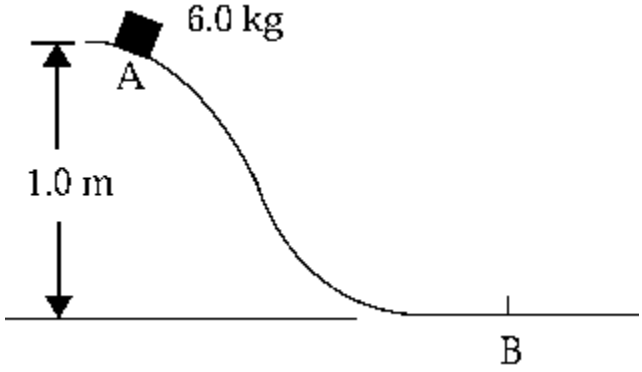
A 6.0-kg block slides from point A down a frictionless curve to point B. After the block passes point B, a friction force opposes the motion of the block so that it comes to a stop 2.5 m from B. Calculate the coefficient of kinetic friction between the block and the surface after position B.

A) 2.5 B) 0.40 C) >0.40 D) 0.40 N E) 2.5 N

Ans: B

Section: 6–4 Topic: Work–Kinetic–Energy Theorem—Curved Paths Type: Numerical

133



A 6.0-kg block slides from rest at position A down a frictionless incline to position B. The speed of the block at B is

A) 3.1 m/s B) 4.4 m/s C) 11 m/s D) 1.8 m/s E) 20 m/s

Ans: B

Section: 7–1 Topic: Potential Energy Type: Conceptual

134 A woman runs up a flight of stairs. The gain in her gravitational potential energy is U. If she runs up the same stairs with twice the speed, what is her gain in potential energy?

A) U B) $2U$ C) $\frac{1}{2}U$ D) $4U$ E) $\frac{1}{4}U$

Ans: A

Section: 7–1 Topic: Potential Energy Type: Conceptual

135 Susana ascends a mountain via a short, steep trail. Sean ascends the same mountain via a long, gentle trail. Which of the following statements is true?

A) Susana gains more gravitational potential energy than Sean.
B) Susana gains less gravitational potential energy than Sean.
C) Susana gains the same gravitational potential energy as Sean.
D) To compare energies, we must know the height of the mountain.
E) To compare energies, we must know the lengths of the two trails.

Ans: C

Section: 7–1 Topic: Potential Energy Type: Conceptual

136 The reference point for gravitational potential energy

A) must be at the initial position of the object.
B) must be at the final position of the object.
C) must be at ground level.
D) must be at the lowest position ever reached by the object.
E) can be chosen arbitrarily.

Ans: E

Section: 7–1 Topic: Potential Energy Type: Conceptual

137 Which of the following statements is true?

A) The kinetic and potential energies of an object must always be positive quantities.
B) The kinetic and potential energies of an object must always be negative quantities.
C) Kinetic energy can be negative but potential energy cannot.
D) Potential energy can be negative but kinetic energy cannot.
E) None of these statements is true.

Ans: D

Section: 7–1 Topic: Potential Energy Type: Numerical

138 A 75-kg man climbs the stairs to the fifth floor of a building, a total height of 16 m. His potential energy has increased by

A) 1.2×10^4 J
B) 5.9×10^4 J
C) 4.7×10^4 J
D) 3.8×10^4 J
E) 5.9×10^3 J

Ans: A

Section: 7–1 Topic: Potential Energy Type: Numerical

139 A 5200-kg cable car in Hong Kong is pulled a distance of 360 m up a hill inclined at 12º from the horizontal. The change in the potential energy of the car is

A) 1.8×10^7 J
B) 1.2×10^7 J
C) 3.8×10^6 J
D) 6.0×10^7 J
E) 1.8×10^6 J

Ans: C

Section: 7–1 Topic: Potential Energy Type: Numerical

140 A block with a mass $M = 4.85$ kg is resting on a slide that has a curved surface. There is no friction. The speed of the block after it has slid along the slide sufficiently far for its vertical drop to be 19.6 m is

A) 19.6 m/s
B) 384 m/s
C) 73 m/s
D) 43.2 m/s
E) The problem cannot be solved because the shape of the curved slide is not given.

Ans: A

Section: 7–1 Topic: Potential Energy Type: Numerical

141 A spring with force constant $k = 300$ N/m is compressed 9.0 cm. What is the potential energy in the spring?

A) 1.2×10^4 J B) 2.4 J C) 2.7×10^4 J D) 27 J E) 1.2 J

Ans: E

Section: 7–1 Topic: Potential Energy Type: Conceptual

142 Which of the following statements is true?

A) Friction is a conservative force and does negative work.
B) Potential energy may be defined by the equation $U(x) = -d\mathrm{F}(x)/dx$
C) The work done by a conservative force between two points depends on the path taken between those points.
D) A conservative force cannot change a body's total energy.
E) The work done by a conservative force while a body moves at constant velocity must be zero.

Ans: D

Section: 7–1 Topic: Potential Energy Type: Conceptual

143

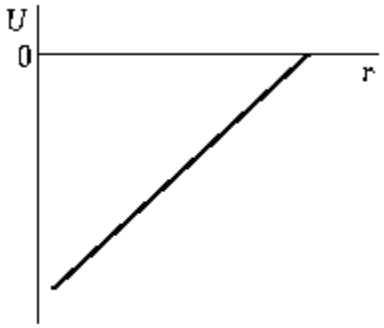


Figure A

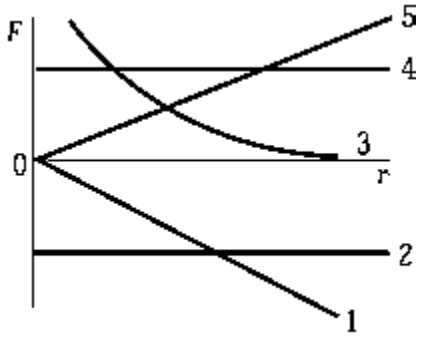


Figure B

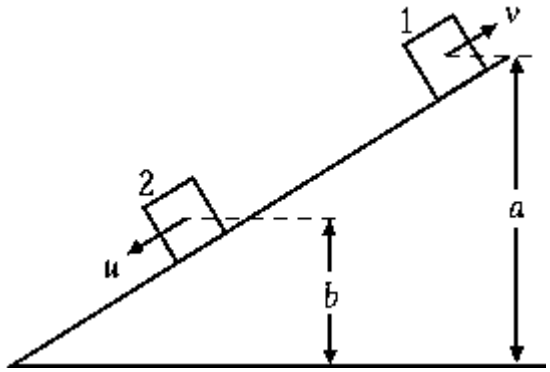
When the potential energy *U(r)* is given as in Figure A, then the force is given in Figure B by curve

A) 1 B) 2 C) 3 D) 4 E) 5

Ans: B

Section: 7–1 Topic: Potential Energy Type: Numerical

144



A block of mass *m* starts from position 1 and moves up a frictionless inclined plane with an initial speed *v*. At some later time the block has moved down the plane and at position 2 has a speed *u*. If *a* and *b* are the heights above the bottom of the plane, the magnitude of *u* can be determined from

A) $u^2 = v^2 - 2g(a - b)$

B) $u^2 = v^2 + 2g(a + b)$

C) $u^2 = v^2 + 2g(a - b)$

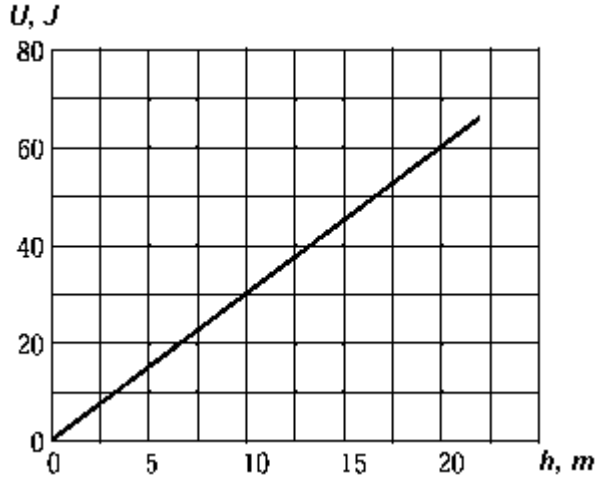
D) $u^2 = v^2 + 2g(b - a)$

E) $u^2 = v^2 + g(a - b)$

Ans: C

Section: 7–1 Topic: Potential Energy Type: Numerical

145



The graph shows a plot of the gravitational potential energy U of a 1-kg body as a function of its height h above the surface of a planet. The acceleration due to gravity at the surface of the planet is

A) 0 m/s^2 B) 9.8 m/s^2 C) 6.0 m/s^2 D) 3.0 m/s^2 E) None of these is correct.

Ans: D

Section: 7–1 Topic: Potential Energy Type: Conceptual

146 According to Quantum Chromodynamics, the force that keeps quarks confined within a proton (or neutron) increases as the separation between the individual quarks increases. Which statement below best represents this scenario?

A) The quarks are tied together by nonstretchable strings.
B) The quarks are tied together by elastic strings.
C) The quarks move independently of each other.
D) The force between the quarks has a $1/r^2$ behavior like gravity.
E) The potential energy of a quark decreases with separation.

Ans: B

Section: 7–1 Topic: Potential Energy Type: Numerical

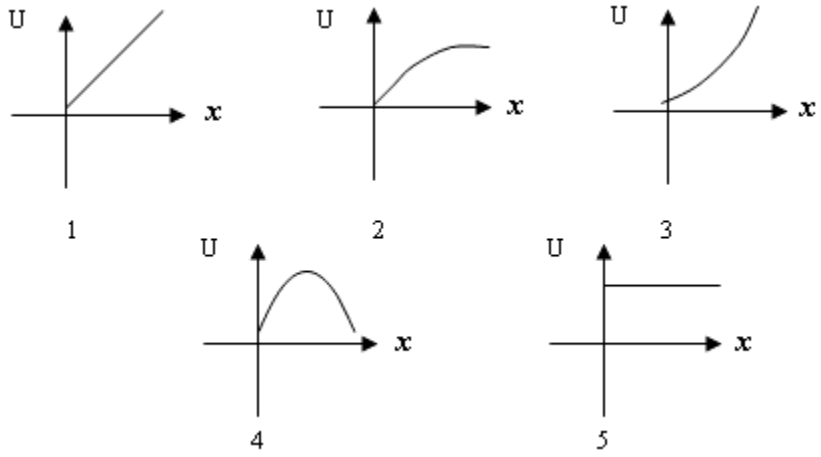
147 In magazine car tests an important indicator of performance is the zero to 60 mph (0 to 96.6 km/h) acceleration time. A time below 6 s is considered to be extremely quick. If a car with mass 1300 kg were dropped vertically from a great height, how long would it take to go from zero to 60 mph and what would the magnitude of the change in gravitational potential energy be during this time? (neglect air resistance)

A) 2.74 s and 17.4 kJ
B) 2.74 s and 468 kJ
C) 2.74 s and 468 MJ
D) 0.37 s and 468 MJ
E) 2.74 s and 17.4 MJ

Ans: B

Section: 7–1 Topic: Potential Energy Type: Conceptual

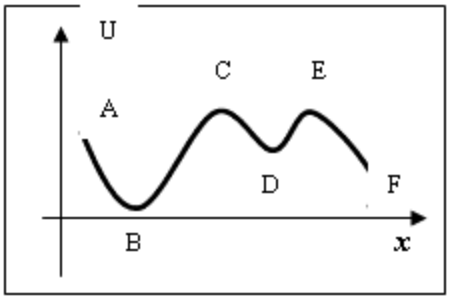
148 Which potential energy versus displacement curve best represents that of an extended spring?



A) 1 B) 2 C) 3 D) 4 E) 5
Ans: C

Section: 7–1 Topic: Potential Energy Type: Conceptual

149 The potential energy function for a conservative force acting in the *x* direction on a particle is shown below. The number of points where the net force on the particle is equal to zero are

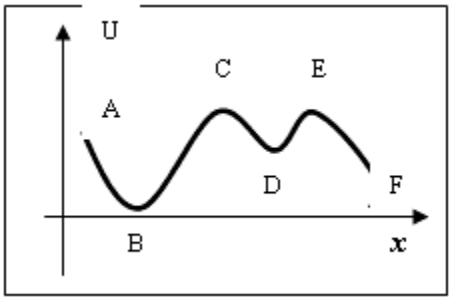


A) B and D.
B) C and E.
C) B, C, D, and E.
D) A and F.
E) any point between C and D.

Ans: C

Section: 7–1 Topic: Potential Energy Type: Numerical

150 The potential energy function for a conservative force acting in the *x* direction is shown in the figure on the right. Where would the particle experience a force directed to the right?



A) between A & B and E & F
B) between B & C and C & D
C) between B & C and D & E
D) at points B and D
E) at points C and E

Ans: A

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

151 The total mechanical energy of any system is

A) always the work done by gravity.
B) the difference between the kinetic and potential energy at any point.
C) the sum of the kinetic and potential energy at any point.
D) the sum of the translational and rotational kinetic energies at any point.
E) the potential energy of a spring at any displacement.

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

152 A body falls through the atmosphere (consider air resistance) gaining 20 J of kinetic energy. How much gravitational potential energy did it lose?

A) 20 J
B) more than 20 J
C) less than 20 J
D) It is impossible to tell without knowing the mass of the body.
E) It is impossible to tell without knowing how far the body falls.

Ans: B

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

153 A projectile of mass *m* is propelled from ground level with kinetic energy of 450 J. At the exact top of its trajectory, its kinetic energy is 250 J. To what height above the starting point does the projectile rise?

A) $\frac{450}{mg}$ m B) $\frac{250}{mg}$ m C) $\frac{700}{mg}$ m D) $\frac{200}{mg}$ m E) $\frac{350}{mg}$ m

Ans: D

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

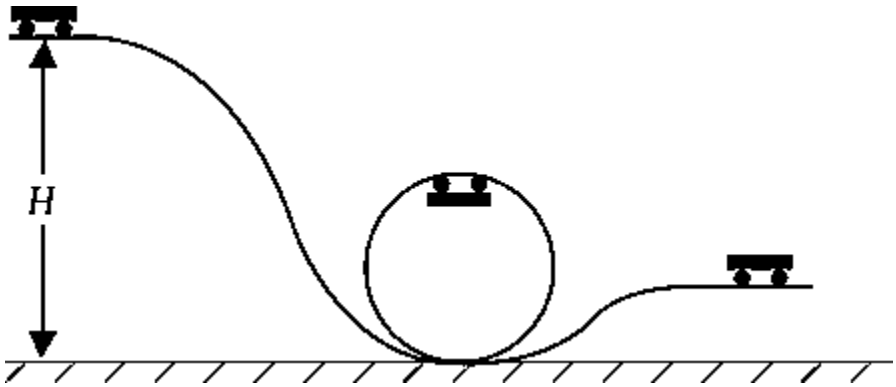
154 A block of mass, *m,* is pushed up against a spring, compressing it a distance *x*, and is then released. The spring projects the block along a frictionless horizontal surface, giving the block a speed *v*. The same spring projects a second block of mass 4*m,* giving it a speed 3*v*. What distance was the spring compressed in the second case?

A) x B) $2x$ C) $3x$ D) $4x$ E) $6x$

Ans: E

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Numerical

155



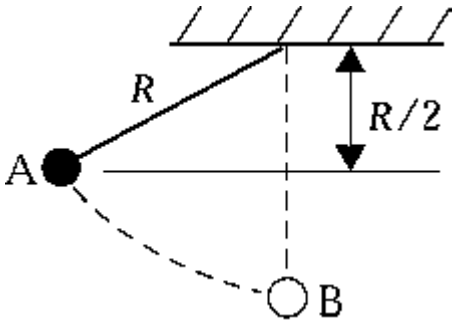
You ride a roller coaster car of mass 1500 kg down a frictionless track a distance H = 23m above the bottom of a loop as shown. If the loop is 15 m in diameter, the downward force of the rails on your car when it is upside down at the top of the loop is

A) 4.6×10^4 N
B) 3.1×10^4 N
C) 1.7×10^4 N
D) 0.98 kN
E) 1.6×10^3 N

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Numerical

156



Release mass *m* on a string from rest at point A. As it passes the lowest point B, the tension in the string is

A) impossible to determine; the answer depends on the length of the string.
B) *mg*
C) 2*mg*
D) 3*mg*
E) None of these is correct.

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Numerical

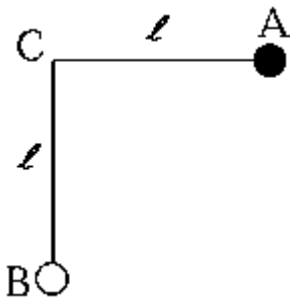
157 A woman on a bicycle traveling at 10 m/s on a horizontal road stops pedaling as she starts up a hill inclined at 3.0º to the horizontal. If friction forces are ignored, how far up the hill does she travel before stopping?

A) 5.1 m
B) 30 m
C) 97 m
D) 10 m
E) The answer depends on the mass of the woman.

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Numerical

158



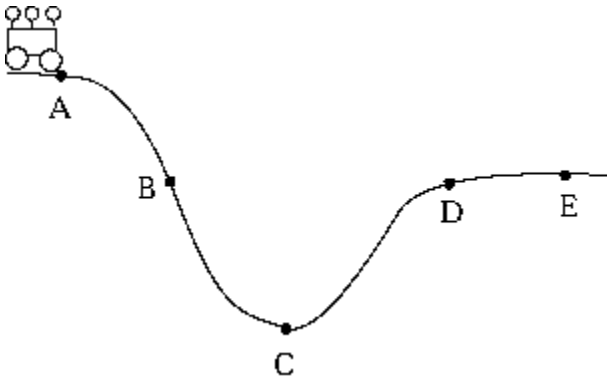
A simple pendulum has a bob of mass M. The bob is on a light string of length l. The string is fixed at C. At position A, the string is horizontal and the bob is at rest. The bob is released from A and swings to B, where the string is vertical. The tension in the string when the bob first reaches B is

A) $\frac{M\sqrt{l/g}}{2\pi}$ B) $2Mg$ C) Mgl D) Mg E) None of these is correct.

Ans: E

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

159



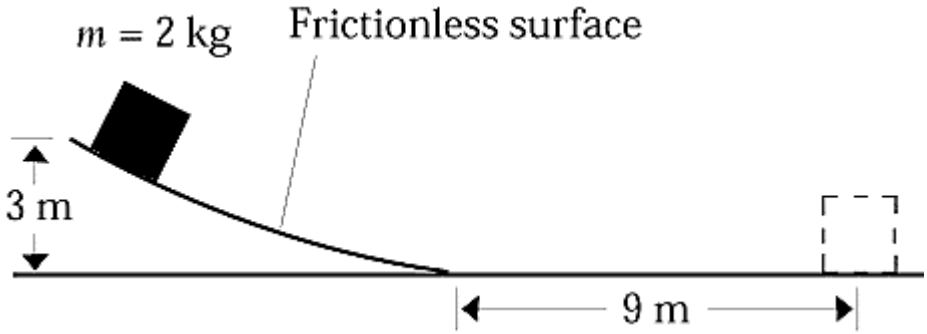
A roller coaster starts from rest at point A. If you ignore friction and take the zero of potential energy to be at C,

A) the kinetic energy of the coaster at D will be equal to its potential energy at A.
B) the kinetic energy of the coaster at E will be equal to its potential energy at C.
C) the kinetic energy of the coaster at C will be equal to its potential energy at A.
D) the kinetic energy of the coaster at B will be equal to its potential energy at C.
E) None of these is correct.

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Numerical

160



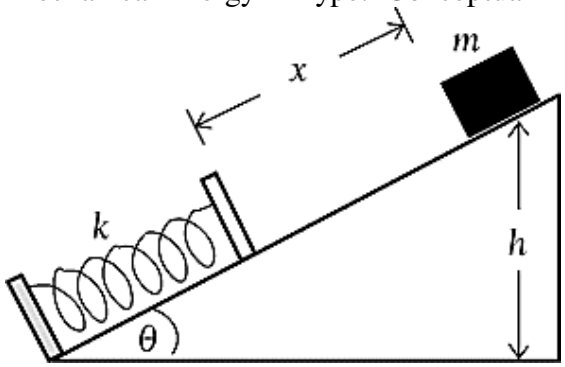
The block shown in the figure is sliding on a frictionless surface. Its speed when it reaches the level portion of the surface on which it is sliding will be

A) 3.14 m/s
B) 7.67 m/s
C) 9.81 m/s
D) 13.3 m/s
E) None of these is correct.

Ans: B

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

161 Assuming the incline to be frictionless and the zero of gravitational potential energy to be at the elevation of the horizontal line,

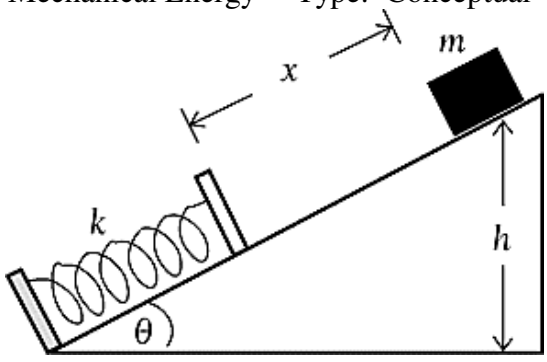


A) the kinetic energy of the block just before it collides with the spring will be equal to *mgh.*
B) the kinetic energy of the block when it has fully compressed the spring will be equal to *mgh.*
C) the kinetic energy of the block when it has fully compressed the spring will be zero.
D) the kinetic energy of the block just before it collides with the spring will be $\frac{1}{2}kx^2$.
E) None of the above statements will be true.

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Conceptual

162 A mass, *m*, slides down a frictionless incline and hits a spring with spring constant k. Find the spring compression when the acceleration of the mass is zero.



A) mg/k
B) mg cos θ/k
C) mg sin θ/k
D) mgh sin θ/(kx)
E) None of the above statements is correct.

Ans: C

Section: 7–2 Topic: The Conservation of Mechanical Energy Type: Numerical

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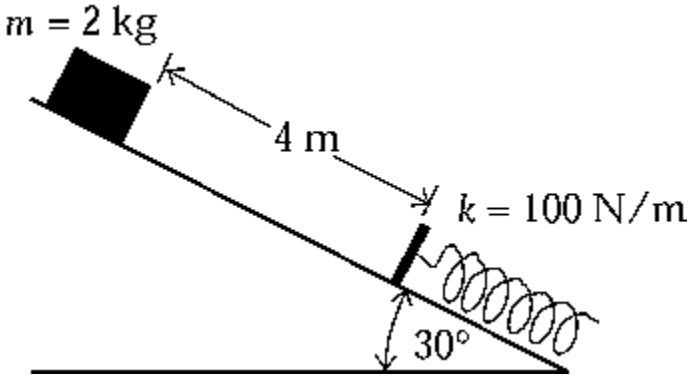


The surface shown in the figure is frictionless. If the block is released from rest, it will compress the spring at the foot of the incline

A) 4.00 m B) 3.24 m C) 1.57m D) 0.989 m E) None of these is correct.

Ans: D

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

164 A 5-kg box is pushed 5 m up a plane that is inclined at 30º with the horizontal. The coefficient of kinetic friction between the box and the plane is 0.20. The change in potential energy of the box is approximately

A) 12.5 J B) 34.2 J C) 123 J D) 345 J E) 403 J

Ans: C

Section: 7–3 Topic: The Conservation of Energy Type: Conceptual

165 The work done by a conservative force between two points is

A) always positive.
B) always dependent upon the time.
C) always independent of the path.
D) zero.
E) never completely recoverable.

Ans: C

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

166 A 4.0-kg block starts from rest and slides 5.0 m down a plane inclined at 60º to the horizontal. The coefficient of kinetic friction between the surface and the block is 0.20. The work done by friction on the block is

A) 98.0 J B) 19.6 J C) 3.92 J D) 3.40 J E) 64.0 J

Ans: B

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

167 A 10-kg box is at the top of a 5-m plane inclined at 37º with the horizontal. The box starts from rest and slides down the plane. The coefficient of kinetic friction is 0.20. The magnitude of the change in the potential energy of the box is

A) 30 kJ B) 0.10 kJ C) 0.29 kJ D) 0.46 kJ E) 0.39 kJ

Ans: C

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

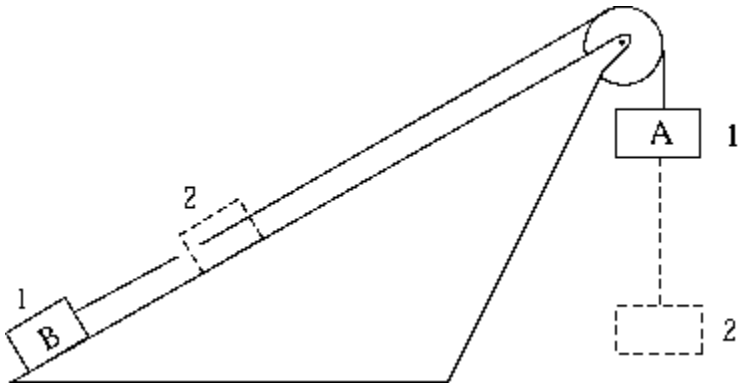
168 A 10-kg box is pushed up a plane inclined at 37º with the horizontal. The box starts from rest and is pushed 5 m along the incline with a uniform acceleration of 2 m/s^2. The coefficient of kinetic friction is 0.20 and the pushing force is parallel to the plane. The increase in the potential energy of the box is

A) 0.10 kJ B) 0.29 kJ C) 0.36 kJ D) 0.46 kJ E) 0.39 kJ

Ans: B

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

169



A system comprising two blocks is shown, one of which is on an inclined plane. The pulley is of negligible mass and is frictionless. The system starts from rest at position 1 and accelerates. Measurements taken when the blocks reach position 2 indicate that

(1) the kinetic energy of block A has changed by 330 J;
(2) the potential energy of block A has changed by 588 J;
(3) the kinetic energy of block B has changed by 110 J; and
(4) the potential energy of block B has changed by 98 J.

The amount of mechanical energy that has been converted to heat because of friction is
A) 12 J B) 50 J C) 258 J D) 478 J E) 710 J
Ans: B

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

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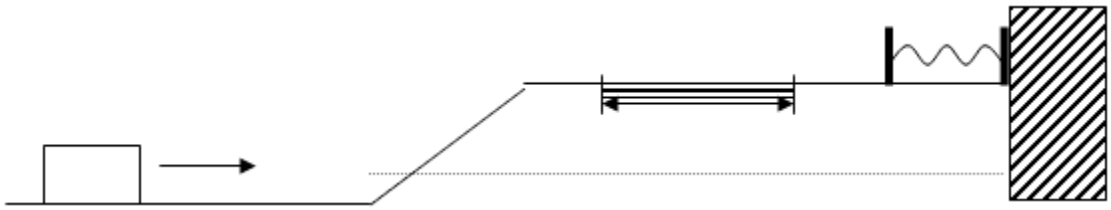

A 5-kg mass with initial velocity 20 m/s slides along a frictionless horizontal surface then up a frictionless ramp (2 m long and at an angle 30 degrees to the horizontal) and onto a second horizontal surface. The block slides over a rough surface 15 m in length ($\mu_k = 0.4$) before moving again on a frictionless surface and then impacting upon an uncompressed spring. If the block compresses the spring a distance 2 m, what is the spring constant *k* for the spring?
A) 304 N/m B) 451 N/m C) 84.0 N/m D) 32.8 N/m E) 353 N/m
Ans: D

Section: 7–3 Topic: The Conservation of Energy Type: Numerical

171 A 5-kg blob of putty is dropped from a height of 10.0 m above the ground onto a light vertical spring the top of which is 5 m above the ground. If the spring constant k = 200 N/m and the blob compresses the spring by 1.50 m, then find the amount of energy lost in sound and thermal energy.

A) 20.0 J B) 169 J C) 266 J D) 438 J E) 94.0 J

Ans: E