Twentieth SLAPT Physics Contest
Southern Illinois University Edwardsville
April 30, 2005

Mechanics Test

Please answer the following questions on the supplied answer sheet. You may write on this test booklet, but only the answer sheet will be scored.

1. The average speed of a moving object during a given interval of time is always:
   A. the magnitude of its average velocity over the interval
   B. the distance covered during the time interval divided by the time interval
   C. one-half its speed at the end of the interval
   D. the magnitude of its acceleration multiplied by the time interval
   E. one-half the magnitude of its acceleration multiplied by the time interval.

2. Two automobiles are 150 kilometers apart and traveling toward each other on a straight road. One automobile is moving at 60 km/h and the other is moving at 40 km/h mph. In how many hours will they meet?
   A. 2.5
   B. 2.0
   C. 1.75
   D. 1.5
   E. 1.25

3. A ball rolls up a slope. At the end of three seconds its velocity is (20 cm/s) and at the end of eight seconds its velocity is 0. Its average acceleration from the third to the eighth second is:
   A. 2.5 cm/s^2
   B. 4.0 cm/s^2
   C. 5.0 cm/s^2
   D. 6.0 cm/s^2
   E. 6.67 cm/s^2

4. Of the following situations, which one is impossible?
   A. A body having velocity east and acceleration east
   B. A body having velocity east and acceleration west
   C. A body having zero velocity and non-zero acceleration
   D. A body having constant acceleration and variable velocity
   E. A body having constant velocity and variable acceleration

5. Throughout a time interval, while the speed of a particle increases as it moves along the x axis, its velocity and acceleration:

A. might be in the positive and negative x directions, respectively
B. might be in the negative and positive x directions, respectively
C. might both be in the negative x direction
D. might be in the negative x direction and zero, respectively
E. might be in the positive x direction and zero, respectively

6. A racing car traveling with constant acceleration increases its speed from 10 m/s to 50m/s over a distance of 60 m. How long does this take?

A. 2.0s
B. 4.0s
C. 5.0s
D. 8.0s
E. The time cannot be calculated since the speed is not constant

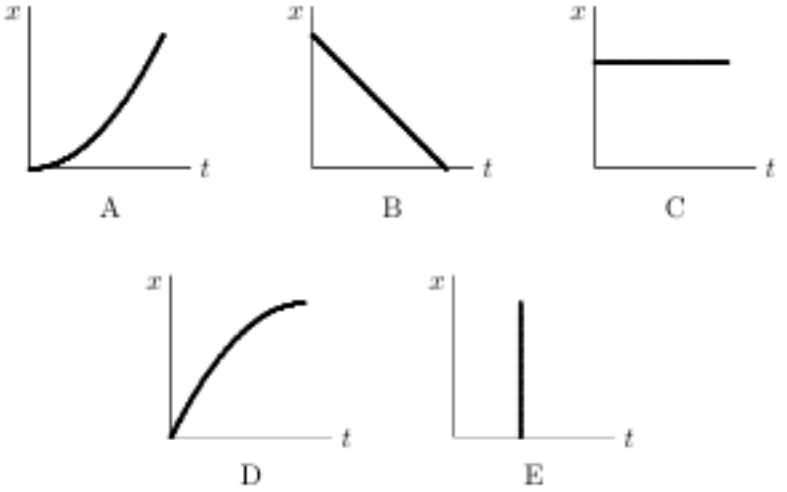
7. A car moving with an initial velocity of 25 m/s north has a constant acceleration of 3 m/s^2 south. After 6 seconds its velocity will be:

A. 7 m/s north
B. 7 m/s south
C. 43 m/s north
D. 20 m/s north
E. 20 m/s south

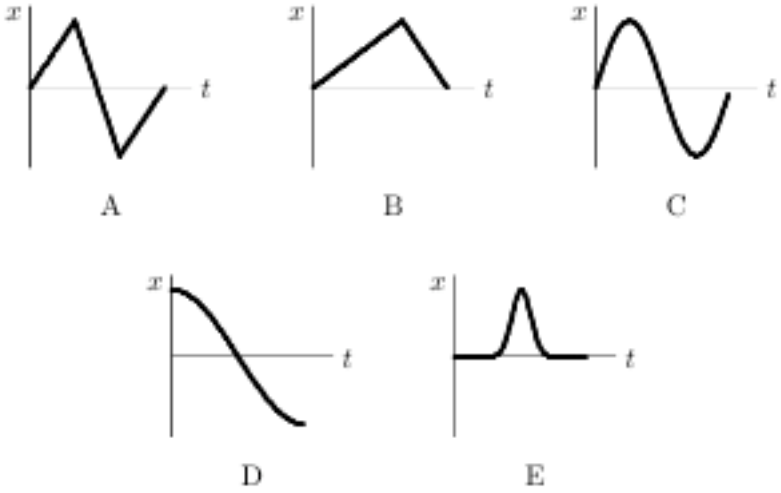
8. At a stop light, a truck traveling at 15 m/s passes a car as the car starts from rest. The truck travels at constant velocity and the car accelerates at 3 m/s^2. How much time will it take for the car to catch up to the truck?

A. 5 s
B. 10 s
C. 15 s
D. 20 s
E. 25 s

9. Which of the following five coordinate versus time graphs represents the motion of an object moving with a constant nonzero speed?



10. A car accelerates from rest on a straight road. A short time later, the car decelerates to a stop and then turns around and returns to its original position in a similar manner, by first speeding up and then slowing to a stop. Which of the following five coordinate versus time graphs best describes the motion?



11. A 1-kg mass is attached to a compressed spring and the spring is released. If the mass initially has an acceleration of $5.6 m/s^2$, the initial force of the spring has a magnitude of:

A. 2.8N
B. 5.6N
C. 11.2N
D. 0
E. an undetermined amount

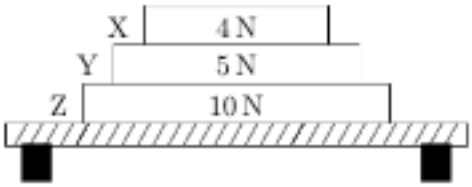
12. The block shown moves with constant velocity on a horizontal surface. Two of the forces acting on the block are shown. A frictional force exerted by the surface is the only other horizontal force acting on the block. The frictional force is:

A. 0
B. 2 N, leftward
C. 2 N, rightward
D. slightly more than 2 N, leftward
E. slightly less than 2 N, leftward

13. A car travels east at constant velocity. The net force on the car is:
A. east
B. west
C. up
D. down
E. zero

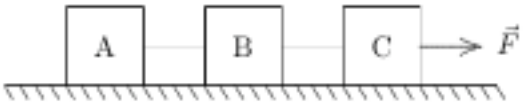
14. A 6-kg object is moving south. A net force of 12 N north on it will result in the object having an acceleration of:
A. 2 m/s^2, north
B. 2 m/s^2, south
C. 6 m/s^2, north
D. 18 m/s^2, north
E. 18 m/s^2 , south

15. Three books (X, Y, and Z) rest on a table. The gravitational force on each book is indicated. The net force on book Y is:



A. 4 N down
B. 5 N up
C. 9 N down
D. zero
E. none of these

16. Three blocks (A, B, C), each having mass M, are connected by strings as shown. Block C is pulled to the right by a force F that causes the entire system to accelerate. Neglecting friction, the net force on block B is:



A. zero
B. F/3
C. F/2
D. 2 F/3
E. F

17. Which one of the following statements is correct for an object released from rest?
A. The magnitude of the average velocity during the first second of time is 4.9m/s
B. During each second the object falls 9.8m
C. The magnitude of the acceleration changes by 9.8m/s^2 every second
D. The object falls 9.8 m during the first second of time
E. The acceleration of the object is proportional to its weight

18. At a location where g =9.80 m/s^2, an object is thrown vertically down with an initial speed of 1.00 m/s. After 5.00 s the object will have traveled:
A. 125 m
B. 127.5m
C. 245 m
D. 250 m
E. 255 m

19. A stone is thrown vertically upward with an initial speed of 19.5 m/s. It will rise to a maximum height of:
A. 4.9m
B. 9.8m
C. 19.4m
D. 38.8m
E. none of these

20. An object is shot from the back of a railroad flatcar moving at constant 40 km/h on a straight horizontal road. The launcher is aimed upward, perpendicular to the bed of the flatcar. The object falls:
A. in front of the flatcar
B. behind the flatcar
C. on the flatcar
D. either behind or in front of the flatcar, depending on the initial speed of the object
E. to the side of the flatcar

21. A car rounds a 20-m radius curve at 10 m/s. The magnitude of its acceleration in is:

A. 0
B. 0.20 m/s^2
C. 5.0 m/s^2
D. 40 m/s^2
E. 400 m/s^2

22. A Ferris wheel with a radius of 8.0 m makes 1 revolution every 10 s. When a passenger is at the top, essentially a diameter above the ground, he releases a ball. How far from the point on the ground directly under the release point does the ball land?

A. 0
B. 1.0 m
C. 8.0 m
D. 9.1 m
E. 16 m

23. An object moves in a circle. If the mass is tripled, the speed halved, and the radius unchanged, then the centripetal force must change by a factor of:

A. 3/2
B. 3/4
C. 9/4
D. 6
E. 12

24. Two forces are applied to a 5.0-kg crate; one is 6.0 N to the north and the other is 8.0 N to the west. The magnitude of the acceleration of the crate is:

A. 0.50 m/s^2
B. 2.0 m/s^2
C. 2.8 m/s^2
D. 10 m/s^2
E. 50 m/s^2

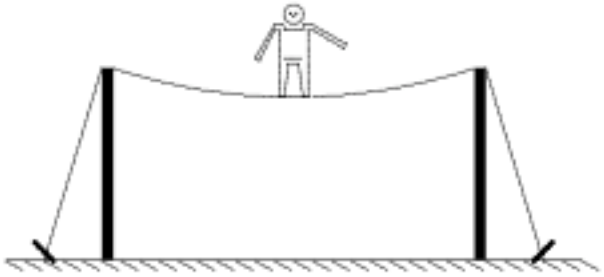
25. A 400-N steel ball is suspended by a light rope from the ceiling. The tension in the rope is:

A. 400 N
B. 800 N
C. zero
D. 200 N
E. 560 N

26. A heavy steel ball B is suspended by a cord from a block of wood W. The entire system is dropped through the air. Neglecting air resistance, the tension in the cord is:

A. zero
B. the difference in the masses of B and W
C. the difference in the weights of B and W
D. the weight of B
E. none of these

27. A circus performer of weight W is walking along a "high wire" as shown. The tension in the wire:



A. is approximately W
B. is approximately W/2
C. is much less than W
D. is much more than W
E. depends on whether he stands on one foot or two feet

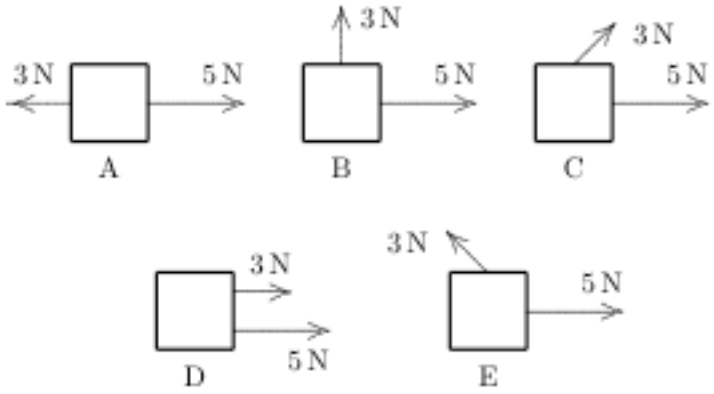
28. A crane operator lowers a 16, 000-N steel ball with a downward acceleration of 3 m/s^2. The tension force of the cable is:

A. 4900 N
B. 11, 000 N
C. 16, 000 N
D. 21, 000 N
E. 48, 000 N

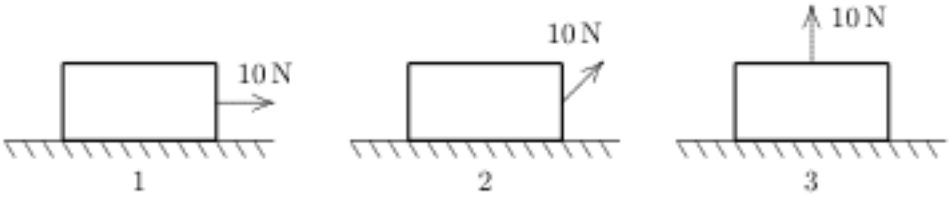
29. A 90-kg man stands in an elevator that has a downward acceleration of 1.4 m/s^2 . The force exerted by him on the floor is about:

A. zero
B. 90 N
C. 760 N
D. 880 N
E. 1010 N

30. Two forces, one with a magnitude of 3 N and the other with a magnitude of 5 N, are applied to an object. For which orientations of the forces shown in the diagrams is the magnitude of the acceleration of the object the least?

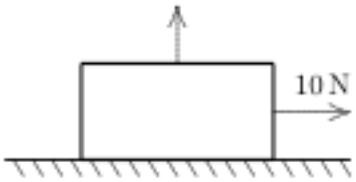


31. A crate rests on a horizontal surface and a woman pulls on it with a 10-N force. Rank the situations shown below according to the magnitude of the normal force N exerted by the surface on the crate, least to greatest.



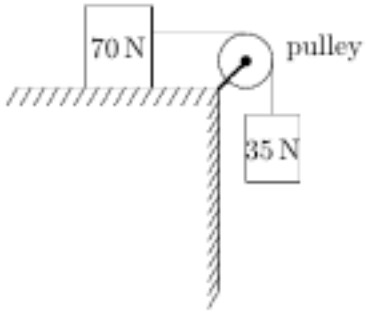
A. 1, 2, 3
B. 2, 1, 3
C. 2, 3, 1
D. 1, 3, 2
E. 3, 2, 1

32. A crate with a weight of 50 N rests on a horizontal surface. A person pulls horizontally on it with a force of 10 N and it does not move. To start it moving, a second person pulls vertically upward on the crate. If the coefficient of static friction is 0.4, what is the smallest vertical force for which the crate moves?



A. 4 N
B. 10 N
C. 14 N
D. 25 N
E. 35 N

33. A 70-N block and a 35-N block are connected by a string as shown. If the pulley is massless and the surface is frictionless, the magnitude of the acceleration of the 35-N block is:



A. 1.6 m/s^2
B. 3.3 m/s^2
C. 4.9 m/s^2
D. 6.7 m/s^2
E. 9.8 m/s^2

34. The speed of a 4.0-N hockey puck, sliding across a level ice surface, decreases at the rate of 0.61 m/s^2. The coefficient of kinetic friction between the puck and ice is:

A. 0.062
B. 0.41
C. 0.62
D. 1.2
E. 9.8

35. A horizontal shove of at least 200 N is required to start moving a 800-N crate initially at rest on a horizontal floor. The coefficient of static friction is:

A. 0.25
B. 0.125
C. 0.50
D. 4.00
E. none of these

36. A 64-kg woman stands on frictionless level ice, with a 0.10-kg stone at her feet. She kicks the stone with her foot so that she acquires a velocity of 0.0017 m/s in the forward direction. The velocity acquired by the stone is:

A. 1.1m/s forward
B. 1.1m/s backward
C. 0.0017 m/s forward
D. 0.0017 m/s backward
E. none of these

37. A 4.0-N puck is traveling at 3.0m/s. It strikes a 8.0-N puck, which is stationary. The two pucks stick together. Their common final speed is:

A. 1.0m/s
B. 1.5m/s
C. 2.0m/s
D. 2.3m/s
E. 3.0m/s

38. A boy holds a 40-N weight at arm's length for 10 s. His arm is 1.5 m above the ground. The work done by the force of the boy on the weight while he is holding it is:

A. 0 J
B. 6.1J
C. 40 J
D. 60 J
E. 90 J

39. An object of mass 1 g is whirled in a horizontal circle of radius 0.5 m at a constant speed of 2m/s. The work done on the object during one revolution is:

A. 0 J
B. 1 J
C. 2 J
D. 4 J
E. 16 J

40. Camping equipment weighing 6000 N is pulled across a frozen lake by means of a horizontal rope. The coefficient of kinetic friction is 0.05. The work done by the campers in pulling the equipment 1000 m at constant velocity is:

A. 3.1×10^4J
B. 1.5×10^5J
C. 3.0×10^5J
D. 2.9×10^6J
E. 6.0×10^6J

41. Which of the following bodies has the largest kinetic energy?

A. Mass 3M and speed V
B. Mass 3M and speed 2V
C. Mass 2M and speed 3V
D. Mass M and speed 4V
E. All four of the above have the same kinetic energy

42. The weight of an object on the moon is one-sixth of its weight on Earth. The ratio of the kinetic energy of a body on Earth moving with speed V to that of the same body moving with the same speed on the Moon is:

A. 6:1
B. 36:1
C. 1:1
D. 1:6
E. 1:36

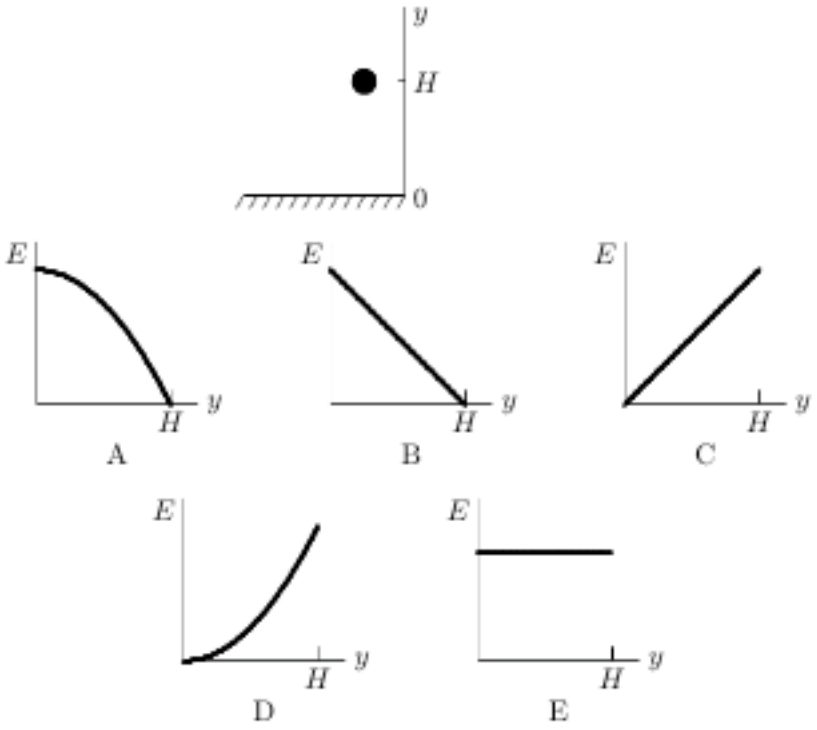
43. A 2-kg block is attached to a horizontal ideal spring with a spring constant of 200 N/m. When the spring has its equilibrium length the block is given a speed of 5 m/s. What is the maximum elongation of the spring?

A. 0
B. 0.05 m
C. 0.5 m
D. 10 m
E. 100 m

44. A 50-N force is the only force on a 2-kg object that starts from rest. When the force has been acting for 2 s the rate at which it is doing work is:

A. 75 W
B. 100 W
C. 1000 W
D. 2500 W
E. 5000 W

45. A ball is held at a height H above a floor. It is then released and falls to the floor. If air resistance can be ignored, which of the five graphs below correctly gives the mechanical energy E of the Earth-ball system as a function of the altitude y of the ball?



46. A 0.50-kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. The total mechanical energy is 0.12 J. The greatest speed of the block is:

A. 0.15 m/s
B. 0.24 m/s
C. 0.49 m/s
D. 0.69 m/s
E. 1.46 m/s

47. Whenever an object strikes a stationary object of equal mass:

A. the two objects cannot stick together
B. the collision must be elastic
C. the first object must stop
D. momentum is not necessarily conserved
E. none of the above

48. Two identical carts travel at 1 m/s in opposite directions on a common horizontal surface. They collide head-on and are reported to rebound, each with a speed of 2 m/s. Then:

A. momentum was not conserved; therefore, the report must be false
B. if some other form of energy were changed to kinetic during the collision, the report could be true
C. if the collision were elastic, the report could be true
D. if friction were present, the report could be true
E. if the duration of the collision were long enough, the report could be true

49. If a wheel turns with constant rotational speed then:

A. each point on its rim moves with constant translational velocity
B. each point on its rim moves with constant translational acceleration
C. the wheel turns through equal angles in equal times
D. the angle through which the wheel turns in each second increases as time goes on
E. the angle through which the wheel turns in each second decreases as time goes on

50. The center of gravity coincides with the center of mass:

A. always
B. never
C. if the center of mass is at the geometrical center of the body
D. if the gravitational field strength is uniform over the body
E. if the body has a uniform distribution of mass