Honors Physics Midterm Exam

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Respond fully to each of the following multiple choice and open response questions to the best of your ability. Read all questions carefully, and be sure to answer all parts of multiple-part questions. Write all your answers on your answer sheet. **Do not write on this exam.** You may find the following equations helpful:

$$s = d/t$$
$$a = \Delta v/t$$
$$d = v_i t + 1/2at^2$$
$$v_f^2 = v_i^2 + 2ad$$
$$v_f = v_i + at$$
$$F = ma$$
$$f = \mu N$$
$$p = mv$$
$$J = \Delta p = Ft$$
$$W = Fd$$
$$P = W/t$$
$$PE_g = mgh$$
$$PE_{spring} = 1/2kx^2$$
$$KE = 1/2mv^2$$

There are times when being a whiz at physics can be a definite drawback.

Part A: Matching
For each of the following quantities, select the appropriate unit and whether it is defined as a vector or a scalar quantity:

quantity	unit	Enter 'A' for scalar and 'B' for vector	
mass	1.	15.	A. m
time	2.	16.	B. m/s
distance	3.	17.	C. m/s^2
displacement	4.	18.	D. kgm/s
speed	5.	19.	E. N
velocity	6.	20.	F. W
acceleration	7.	21.	G. J
force	8.	22.	H. kg
momentum	9.	23.	I. s
impulse	10.	24.	
work	11.	25.	
power	12.	26.	
potential energy	13.	27.	
kinetic energy	14.	28.	

Part B: Multiple Choice
Select the best answer to each question. Be sure to answer all questions!

1. Which of the following is closest in length to a yard?
   A. 0.01m
   B. 0.1m
   C. 1m
   D. 10m
   E. 100m

2. A gram is:
   A. 10^{-6} kg
   B. 10^{-3} kg
   C. 1 kg
   D. 10^{3} kg
   E. 10^{6} kg

3. $(5.0 \times 10^{4}) \times (3.0 \times 10^{-6}) =$
   A. 1.5×10^{-3}
   B. 1.5×10^{-1}
   C. 1.5×10^{1}
   D. 1.5×10^{3}
   E. 1.5×10^{5}

4. 1 mi is equivalent to 1609 m so 55 mph is:
   A. 15 m/s
   B. 25 m/s
   C. 66 m/s
   D. 88 m/s
   E. 1500 m/s

5. A particle moves along the x axis from x_i to x_f . Of the following values of the initial and final coordinates, which results in the displacement with the largest magnitude?

   A. x_i = 4m, x_f = 6m

   B. x_i = -4m, x_f = -8m

   C. x_i = -4m, x_f = 2m

   D. x_i = 4m, x_f = -2m

   E. x_i = -4m, x_f = 4m

6. 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. its acceleration multiplied by the time interval

   E. one-half its acceleration multiplied by the time interval.

7. A car starts from Hither, goes 50 km in a straight line to Yon, immediately turns around, and returns to Hither. The time for this round trip is 2 hours. The magnitude of the **average velocity** of the car for this round trip is:

   A. 0

   B. 50 km/hr

   C. 100 km/hr

   D. 200 km/hr

   E. cannot be calculated without the acceleration

8. 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

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

   A. 2.0 s

   B. 4.0 s

   C. 5.0 s

   D. 8.0 s

   E. The time cannot be calculated since the speed is not constant

10. A car starts from rest and goes down a slope with a constant acceleration of $5m/s^2$. After 5s the car reaches the bottom of the hill. Its speed at the bottom of the hill is:

    A. 1 m/s

    B. 12.5 m/s

    C. 25 m/s

    D. 50 m/s

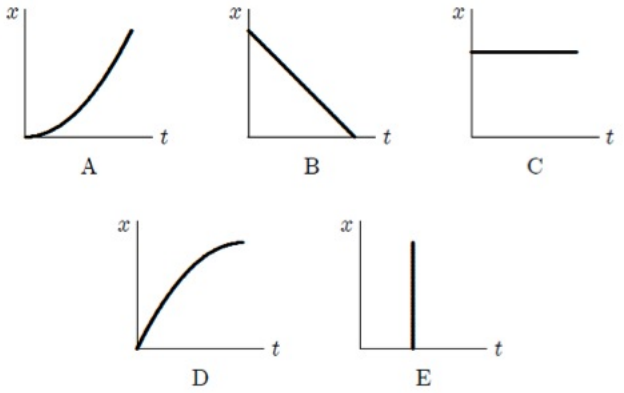
    E. 160 m/s

11. A ball is in free fall. Its acceleration is:
    A. downward during both ascent and descent
    B. downward during ascent and upward during descent
    C. upward during ascent and downward during descent
    D. upward during both ascent and descent
    E. downward at all times except at the very top, when it is zero

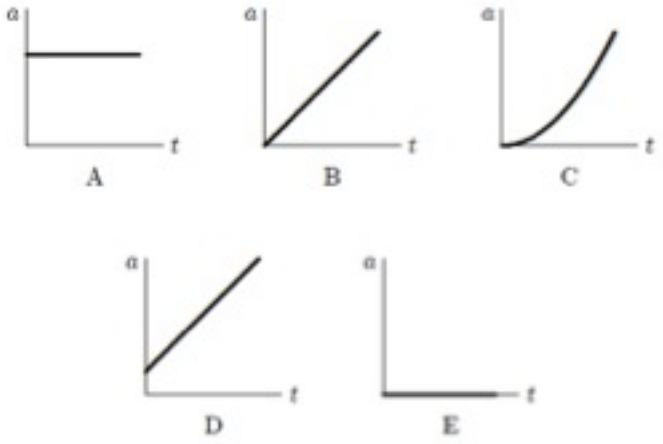
12. Which one of the following statements is correct for a free-falling object released from rest?
    A. The average velocity during the first second of time is 4.9m/s
    B. During each second the object falls 9.8m
    C. The acceleration changes by $9.8 m/s^2$ every second
    D. The object falls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

13. An object is thrown vertically upward at 35 m/s. The velocity of the object 5 s later is approximately:
    A. 7.0 m/s up
    B. 15 m/s down
    C. 15 m/s up
    D. 85 m/s down
    E. 85 m/s up

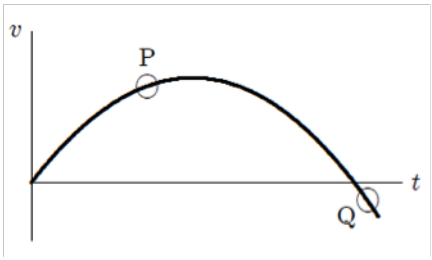
14. Which of the following five coordinate versus time graphs represents the motion of an object moving with a constant nonzero speed?



15. Which of the following five acceleration versus time graphs is correct for an object moving in a straight line at a constant velocity of 20 m/s?



16. The diagram shows a **velocity-time** graph for a car moving in a straight line. At point Q the car must be:

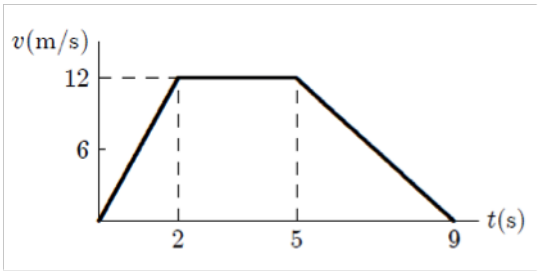


A. moving with zero acceleration
B. traveling downhill
C. traveling below ground-level
D. reducing speed
E. traveling in the reverse direction to that at point P

17. At point P the car must be:

A. moving with zero acceleration
B. climbing the hill
C. accelerating
D. stationary
E. moving at about 45 degrees with respect to the x axis

The following graph represents the straight-line motion of a car.



18. How far does the car travel between t=2s and t=5s?

A. 4m
B. 12m
C. 24m
D. 36m
E. 60m

19. Which of the following statements is true?

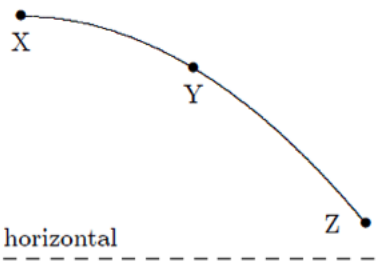
A. The car accelerates, stops, and reverses
B. The car accelerates at 6 m/s^2 for the first 2s
C. The car is moving for a total time of 12 s
D. The car decelerates at 12 m/s^2 for the last 4s
E. The car returns to its starting point when t = 9s

20. A vector of magnitude 20 is added to a vector of magnitude 25. The magnitude of this sum might be:
    A. 0
    B. 3
    C. 12
    D. 47
    E. 50

21. The vector $-\vec{A}$ is:
    A. greater than $\vec{A}$ in magnitude
    B. less than $\vec{A}$ in magnitude
    C. in the same direction as $\vec{A}$
    D. in the direction opposite to $\vec{A}$
    E. perpendicular to $\vec{A}$

22. A stone thrown at an angle from the top of a tall building follows a path that is:
    A. circular
    B. linear
    C. hyperbolic
    D. parabolic
    E. proportional

23. A stone is thrown horizontally and follows the path XYZ shown. The direction of acceleration at point Y is:



    A. ↓
    B. →
    C. ↘
    D. ↙
    E. ↗

24. A bullet shot horizontally from a gun:
    A. strikes the ground much later than one dropped vertically from the same point at the same instant
    B. never strikes the ground
    C. strikes the ground at approximately the same time as one dropped vertically from the same point at the same instant
    D. travels in a straight line
    E. strikes the ground much sooner than one dropped from the same point at the same instant

25. A bomber flying in level flight with constant velocity releases a bomb before it is over the target. Neglecting air resistance, which one of the following is NOT true?

    A. The bomber is over the target when the bomb strikes
    B. The acceleration of the bomb is constant
    C. The horizontal velocity of the plane equals the vertical velocity of the bomb when it hits the target
    D. The bomb travels in a curved path
    E. The time of flight of the bomb is independent of the horizontal speed of the plane

26. In metric system units a force is numerically equal to the _____, when the force is applied to it.

    A. velocity of the standard kilogram
    B. speed of the standard kilogram
    C. velocity of any object
    D. acceleration of the standard kilogram
    E. acceleration of any object

27. A force of 1N is:

    A. 1 kg/s
    B. 1 kg·m/s
    C. 1 kg·m/s^2
    D. 1 kg·m^2/s
    E. 1 kg·m^2/s^2

28. Acceleration is always in the direction:

    A. of the displacement
    B. of the initial velocity
    C. of the final velocity
    D. of the net force
    E. opposite to the frictional force

29. The term mass refers to the same physical concept as:

    A. weight
    B. inertia
    C. force
    D. acceleration
    E. volume

30. Mass differs from weight in that:

    A. all objects have weight but some lack mass
    B. weight is a force and mass is not
    C. the mass of an object is always more than its weight
    D. mass can be expressed only in the metric system
    E. there is no difference

31. A feather and a lead ball are dropped from rest in vacuum on the Moon. The acceleration of the feather is:

A. more than that of the lead ball

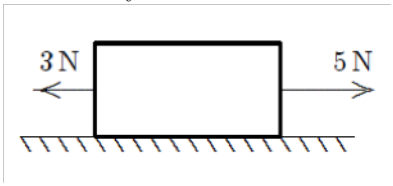
B. the same as that of the lead ball

C. less than that of the lead ball

D. 9.8m/s^2

E. zero since it floats in a vacuum

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



A. 0

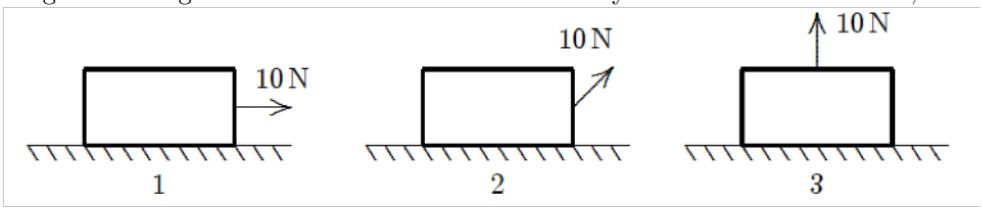
B. 2N, leftward

C. 2N, rightward

D. slightly more than 2N, leftward

E. slightly less than 2N, leftward

33. 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 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

34. Equal forces act on isolated bodies A and B. The mass of B is three times that of A. The magnitude of the acceleration of A is:

A. three times that of B

B. 1/3 that of B

C. the same as B

D. nine times that of B

E. 1/9 that of B

35. A car travels east at constant velocity. The net force on the car is:

A. east

B. west

C. up

D. down

E. zero

36. A 400-N steel ball is suspended by a light rope from the ceiling. The tension in the rope is:
    A. 400N
    B. 800N
    C. zero
    D. 200N
    E. 560N

37. A man weighing 700 N is in an elevator that is accelerating upward at 4m/s^2. The force exerted on him by the elevator floor is:
    A. 71N
    B. 290N
    C. 410N
    D. 700N
    E. 990N

38. The reaction force does not cancel the action force because:
    A. the action force is greater than the reaction force
    B. they act on different bodies
    C. they act in the same direction
    D. the reaction force exists only after the action force is removed
    E. the reaction force is greater than the action force

39. A lead block is suspended from your hand by a string. The reaction to the force of gravity on the block is the force exerted by:
    A. the string on the block
    B. the block on the string
    C. the string on the hand
    D. the hand on the string
    E. the block on Earth

40. A brick slides on a horizontal surface. Which of the following will increase the magnitude of the frictional force on it?
    A. Putting a second brick on top
    B. Decreasing the surface area of contact
    C. Increasing the surface area of contact
    D. Decreasing the mass of the brick
    E. None of the above

41. Why do raindrops fall with constant speed during the later stages of their descent?
    A. The gravitational force is the same for all drops
    B. Air resistance just balances the force of gravity
    C. The drops all fall from the same height
    D. The force of gravity is negligible for objects as small as raindrops
    E. Gravity cannot increase the speed of a falling object to more than 9.8m/s

42. The momentum of an object at a given instant is independent of its:
    A. inertia
    B. mass
    C. speed
    D. velocity
    E. acceleration

43. Two objects, P and Q, have the same momentum. Q has more kinetic energy than P if it:
    A. weighs more than P
    B. is moving faster than P
    C. weighs the same as P
    D. is moving slower than P
    E. is moving at the same speed as P

44. A 1.0-kg ball moving at 2.0m/s perpendicular to a wall rebounds from the wall at 1.5m/s. The change in the momentum of the ball is:
    A. zero
    B. 0.5Ns away from wall
    C. 0.5Ns toward wall
    D. 3.5Ns away from wall
    E. 3.5Ns toward wall

45. When you step on the accelerator to increase the speed of your car, the force that accelerates the car is:
    A. the force of your foot on the accelerator
    B. the force of friction of the road on the tires
    C. the force of the engine on the drive shaft
    D. the normal force of the road on the tires
    E. none of the above

46. A 2.5-kg stone is released from rest and falls toward Earth. After 4.0 s, the magnitude of its momentum is:
    A. 98 kgm/s
    B. 78 kgm/s
    C. 39 kgm/s
    D. 24 kgm/s
    E. zero

47. A man is marooned at rest on level frictionless ice. In desperation, he hurls his shoe to the right at 15m/s. If the man weighs 720N and the shoe weighs 4.0N, the man moves to the left with a speed of:
    A. 0
    B. 2.1×10^{-2}m/s
    C. 8.3×10^{-2}m/s
    D. 15m/s
    E. 2.7×10^{3}m/s

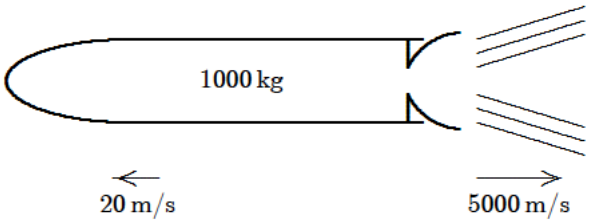
48. A projectile in flight explodes into several fragments. The total momentum of the fragments immediately after this explosion:

    A. is the same as the momentum of the projectile immediately before the explosion
    B. has been changed into kinetic energy of the fragments
    C. is less than the momentum of the projectile immediately before the explosion
    D. is more than the momentum of the projectile immediately before the explosion
    E. has been changed into radiant energy

49. The thrust of a rocket is:

    A. a gravitational force acting on the rocket
    B. the force of the exiting fuel gases on the rocket
    C. any force that is external to the rocket-fuel system
    D. a force that arises from the reduction in mass of the rocket-fuel system
    E. none of the above

50. A 1000-kg space probe is motionless in space. To start moving, its main engine is fired for 5 s during which time it ejects exhaust gases at 5000m/s. At the end of this process it is moving at 20m/s. The approximate mass of the ejected gas is:



    A. 0.8kg
    B. 4 kg
    C. 5 kg
    D. 20 kg
    E. 25 kg

51. The physical quantity impulse has the same dimensions as that of:

    A. force
    B. power
    C. energy
    D. momentum
    E. work

52. A students life was saved in an automobile accident because an airbag expanded in front of his head. If the car had not been equipped with an airbag, the windshield would have stopped the motion of his head in a much shorter time. Compared to the windshield, the airbag:

    A. causes a much smaller change in momentum
    B. exerts a much smaller impulse
    C. causes a much smaller change in kinetic energy
    D. exerts a much smaller force
    E. does much more work

53. 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

54. Which of the following is NOT a correct unit for work?
    A. erg
    B. ft·lb
    C. watt
    D. newton·meter
    E. joule

55. A boy holds a 40-N weight at arms length for 10 s. His arm is 1.5m above the ground. The work done by the force of the boy on the weight while he is holding it is:
    A. 0
    B. 6.1J
    C. 40 J
    D. 60 J
    E. 90 J

56. A 2-kg object is moving at 3m/s. A 4-N force is applied in the direction of motion and then removed after the object has traveled an additional 5m. The work done by this force is:
    A. 12 J
    B. 15 J
    C. 18 J
    D. 20 J
    E. 38 J

57. A 1-kg block is lifted vertically 1m by a boy. The work done by the boy is about:
    A. 1 ft·lb
    B. 1 J
    C. 10 J
    D. 0.1J
    E. zero

58. 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 speed V on the moon is:
    A. 6:1
    B. 36:1
    C. 1:1
    D. 1:6
    E. 1:36

59. The amount of work required to stop a moving object is equal to:
    A. the velocity of the object
    B. the kinetic energy of the object
    C. the mass of the object times its acceleration
    D. the mass of the object times its velocity
    E. the square of the velocity of the object

60. 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

61. The mechanical advantage of any machine is:
    A. the efficiency of the machine
    B. the work done by the machine
    C. the ratio of the work done by the machine to the work expended on it
    D. the ratio of the force exerted by the machine to the force applied to it
    E. the ratio of the force applied to the machine to the force exerted by it

62. In raising an object to a given height by means of an inclined plane, as compared with raising the object vertically, there is a reduction in:
    A. work required
    B. distance pushed
    C. friction
    D. force required
    E. value of the acceleration due to gravity

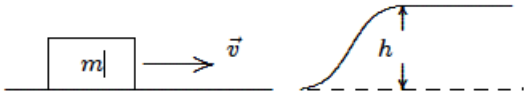
63. A watt is:
    A. kg $\cdot$m/s^3
    B. kg$\cdot$m^2/s
    C. kg$\cdot$m^2/s^3
    D. kg$\cdot$m/s
    E. kg$\cdot$m^2/s^2

64. A woman lifts a barbell 2.0m in 5.0 s. If she lifts it the same distance in 10 s, the work done by her is:
    A. four times as great
    B. two times as great
    C. the same
    D. half as great
    E. one-fourth as great

65. A person holds an 80-N weight 2m above the floor for 30 seconds. The power required to do this is:
    A. 80W
    B. 40W
    C. 20W
    D. 10W
    E. none of these

66. A golf ball is struck by a golf club and falls on a green three meters above the tee. The potential energy of the ball is greatest:
    A. just before the ball is struck
    B. just after the ball is struck
    C. just after the ball lands on the green
    D. when the ball comes to rest on the green
    E. when the ball reaches the highest point in its flight

67. For a block of mass m to slide without friction up the rise of height h shown, it must have a minimum initial kinetic energy of:



    A. gh
    B. mgh
    C. $gh/2$
    D. $mgh/2$
    E. $2mgh$

68. A 0.50-kg block attached to an ideal spring with a spring constant of 80N/m oscillates on a horizontal frictionless surface. The total mechanical energy is 0.12 J. The greatest extension of the spring from its equilibrium length is:
    A. 1.5 x 10^{-3} m
    B. 3.0 x 10^{-3} m
    C. 0.039m
    D. 0.054m
    E. 18m

69. A 0.50-kg block attached to an ideal spring with a spring constant of 80N/m oscillates on a horizontal frictionless surface. The total mechanical energy is 0.12 J. The greatest speed of the block is:
    A. 0.15m/s
    B. 0.24m/s
    C. 0.49m/s
    D. 0.69m/s
    E. 1.46m/s

70. For what contribution to physics was the 2013 Nobel Prize awarded?

A. the discovery of accelerating expansion of the Universe

B. the development of multiscale models for complex chemical systems

C. the discovery of photon

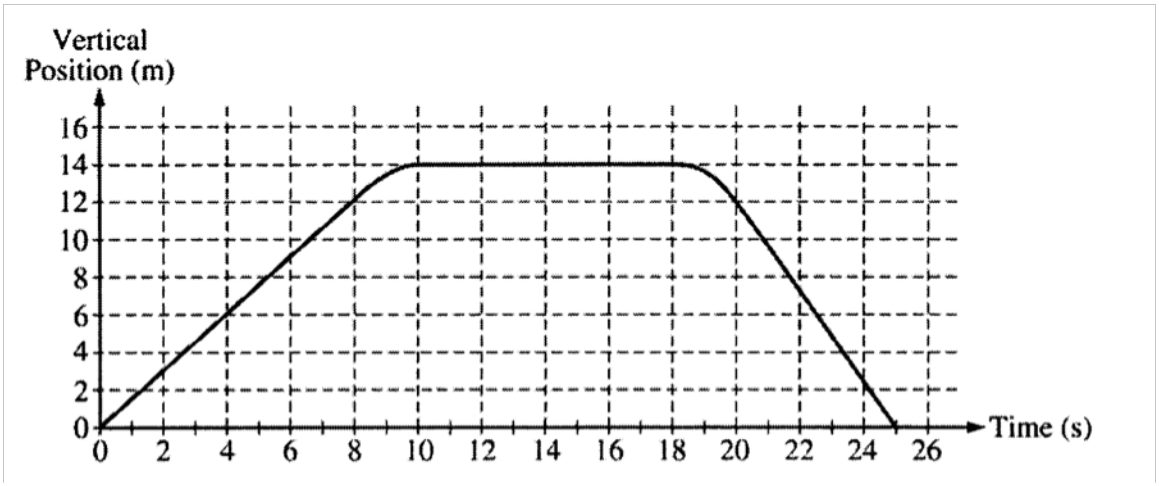
D. the discovery of the Higgs particle that contributes to our understanding of the origin of mass

E. the discovery of a neutrino that travels faster than the speed of light

Part C: Open Response

Answer both of the following open response questions. Partial credit will be given for your thought process, so be sure to answer all parts and show as much work as possible.

71. The vertical position of an elevator as a function of time is shown.

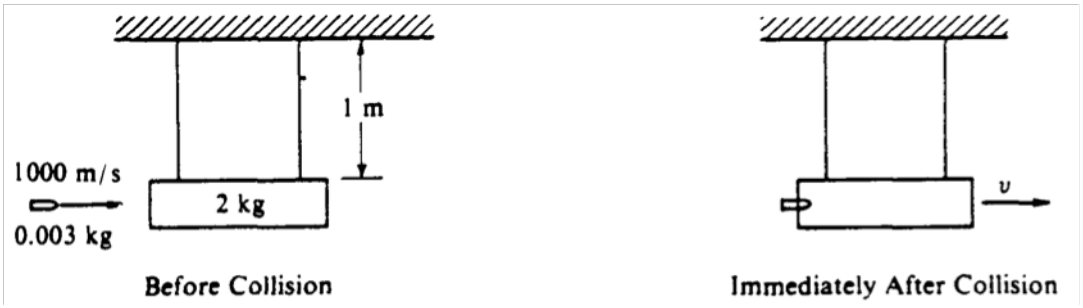


i. On the grid provided, graph the velocity of the elevator as a function of time.

ii. Calculate the average acceleration for the time period t = 8 s to t = 10 s.

iii. On the box provided that represents the elevator, draw a vector to represent the direction of this average acceleration.

72. A 2kg block initially hangs at rest at the end of two 1m strings of negligible mass. A 0.003kg bullet, moving horizontally with a speed of 1000m/s, strikes the block and becomes embedded in it. After the collision, the bullet/ block combination swings upward, but does not rotate.



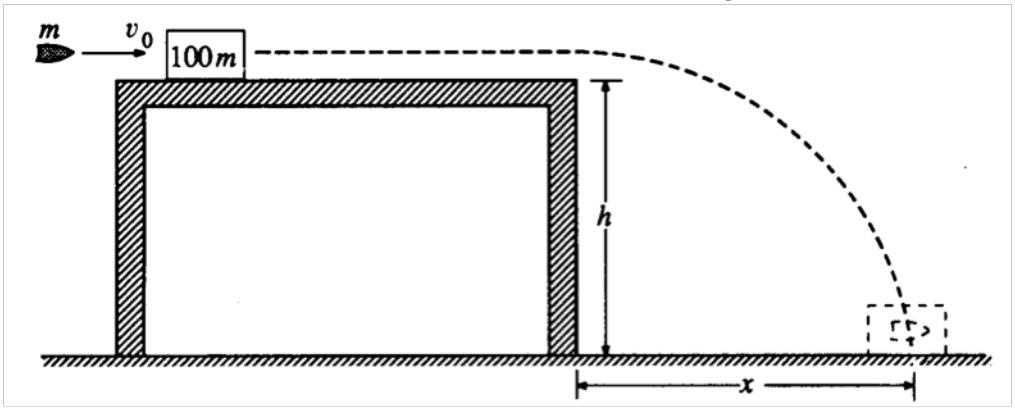
i. Calculate the kinetic energy of the bullet before the collision.

ii. Calculate the speed v of the bullet/ block combination just after the collision.

iii. Assuming total mechanical energy is conserved, calculate the maximum vertical height above the initial rest position reached by the bullet/block combination.

Part D: Bonus
If you have enough time, consider the following bonus question:

A bullet of mass m is moving horizontally with speed v_o when it hits a block of mass 100m that is at rest on a horizontal frictionless table. The surface of the table is a height h above the floor. After the impact, the bullet and the block slide off the table and hit the floor a distance x from the edge of the table.



Derive an expression for the range achieved by the bullet-block system in terms of m, h, and v_o.