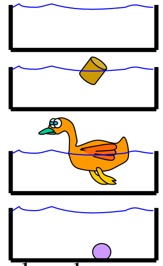
Imagine you are in space, at rest, 1000km above Earth's surface. What will happen to you?

1. Remain at rest as there is no gravity above the atmosphere.
2. Remain at rest as you are in a weightless state and therefore gravity is zero.
3. Gravity is negligible but non-zero and it will take a long time for you to fall back to Earth.
4. Gravity is substantial and you will quickly fall back to Earth.

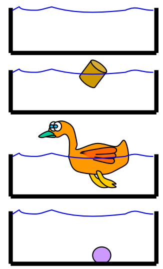
Now that you know gravity in space is substantial. At 1000km above Earth's surface, gravity is 7.33ms^{-2}. Imagine that you are inside a spaceship orbiting the Earth 1000 km above Earth's surface. You weigh yourself on bathroom scales.
What reading would you expect and why?

1. As gravity is substantial, the reading on the scales would be just slightly less than that measured on Earth's surface.
2. Although gravity is substantial, you feel weightless when orbiting in space, so your mass must be zero, hence the reading on the scales is zero.
3. Gravity is substantial and it acts to cause the spaceship and everything inside to freefall around Earth. Therefore, objects inside are relatively at rest and hence the reading on the scales is zero.
4. Gravity is substantial, however, for the spaceship to stay in orbit it must have a large orbital speed (> 7kms^{-1}) and therefore it counteracts with gravity and hence a zero reading on the scales.



Q1. Four identical open-top containers filled to the brim with water. The first, second, third and forth containers have: **Just water, a floating cork, a floating toy duck, and a sunken marble,** respectively. The containers are now placed on separate weighing scales without spilling water.
How do the readings on the weighing scales compare? Select one of the following:

1. **All weights are equal**. By Archimedes's Principle, the weight of the displaced water equals the weight of the immersed object.
2. **Container with marble is the heaviest, and the others have equal weight**. Since the marble sank, while the duck and the cork are floating, this implies the averaged weight of the marble container is greatest, while the averaged weight of the others are the same.
3. **Weight of container with duck > cork > marble > water alone**. Because the amount of water displaced by the duck is greatest, then the cork and then the marble.
4. **Weight of container with marble > water > duck or cork,** because the density of the marble is the greatest (it sank), while the density of water is greater than both the duck and the cork (floating). More information is required to determine the weight difference between duck and cork.



Q2. Now that you know the weight of the container with the steel marble is the largest, while the others are equal in weight, which of the following descriptions of the "excess weight'' of the container with the marble is **incorrect?**

1. The weight of the marble is larger than the buoyant force. The excess weight is equal to this excess downward force.
2. The marble is in contact with the bottom of the container. The excess weight is equal to the contact (normal) force supplied by the container.
3. The marble is in contact with the bottom of the container. In such situations, the buoyant force is negligible. The excess weight is equal to the weight of the marble.

You stand facing forward during a bus trip, and the bus driver suddenly slams on the brakes. Which way do you tend to fall over?

1. Forwards, according to Newton’s 1st law, only your feet are in contact with the bus, your body keeps on moving forwards while your feet slow down with the bus.
2. Backwards, according to Newton’s 2nd law, the applied force from the bus changes your forward momentum in the direction of the deceleration of the bus (backwards).
3. Forwards, according to Newton’s 3rd law, the backward force applied to stop the bus causes an equal and opposite forward reaction force on you.

Which is the BEST way to stand to maintain balance during sudden stops: your body facing forwards, backwards or sideways (legs apart)?

1. Forwards, you can take a step forward to stop yourself from falling.
2. Backwards, you can lean towards the backward direction of the bus to counter-act falling forwards.
3. Sideways legs apart, to maximize the range your centre of mass can shift before you fall.
4. No matter which way you stand, you still cannot stop yourself from falling.

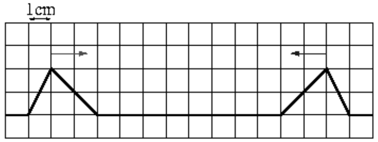
A man and his seven-year-old child are facing each other on ice skates on ice (frictionless). With their hands, they push off against one another. How does the magnitude of the pushing force experienced by the child (F_c) compare with that experienced by the father (F_f).

1) $F_c < F_f$, because F=ma and mass of father is greater than that of the child.
2) $F_c = F_f$, because action equals reaction according to Newton's 3rd law.
3) $F_c > F_f$, because the mass of father is greater than that of the child, the amount of force that the father can exert on the child is much greater than that of the child.
4) None of the above, to compare the force magnitudes we need to know the associated accelerations first.

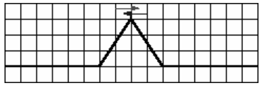
Now that you know the forces experienced by the father and the child are equal. If the man and his seven-year-old child were initially standing in the middle of a 200m wide frozen lake. After pushing off against one another, they each start to move off towards opposite edges of the lake. Who shall reach the edge of the lake first? Ignoring all forms of friction.

1) The child will reach the edge first. As the forces experienced by the father and the child are equal, the smaller mass child will have a larger acceleration, and therefore reach the edge first.
2) Both father and child reaches the edge simultaneously. As the forces experienced by the father and the child are equal, the forces act to accelerate them equally, and therefore they'll both reach the edge at the same time.
3) The father will reach the edge first. As the forces experienced by the father and the child are equal, the larger mass father has larger kinetic energy and accelerates faster towards the edge.

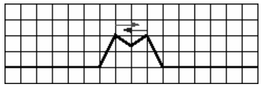
Two pulses on a long rope are travelling towards each other, each moving at a speed of 100 cm/s. The diagram on the right shows the rope at time t=0s. Select the drawing below that correspond to the shape of the rope 0.05s later.



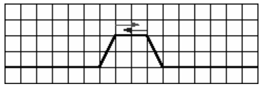
1) Waves superimpose and add.



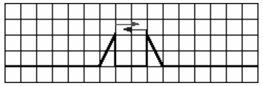
2) Waves superimpose and add.



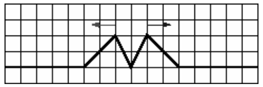
3) Waves superimpose and add.



4) Waves superimpose and cancel.



5) Waves collide and reflect.



Water rises up a glass capillary tube, when will it stop rising?

1. When the upward adhesive force is balanced by the downward weight force of the water.
2. When the upward surface tension force is balanced by the downward weight force of the water.
3. When the upward cohesive force is balanced by the downward weight force of the water.
4. When the upward capillary force is balanced by the downward weight force of the water.
5. When the pressure inside and outside of the capillary tube are in equilibrium.

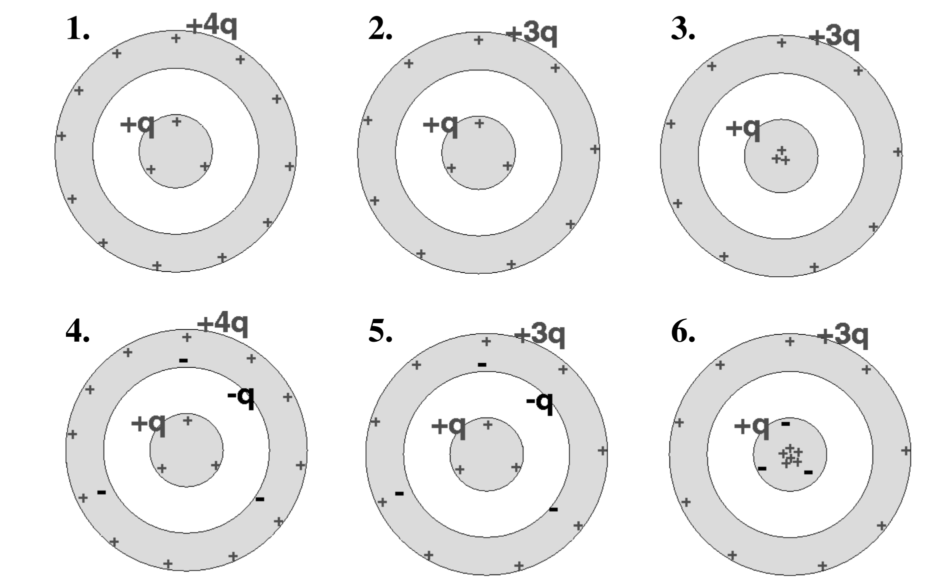
A taut string is attached to a distant wall. A lecturer holding the unattached end moves his hand up and down to create a pulse travelling towards the wall. The lecturer now wants to produce a pulse that takes a <u>longer time</u> to reach the wall. Different ways of achieving this are considered below, select the best answer.

1. He should move his hand up and down more slowly. According to $v = f\lambda$, as frequency decreases, velocity decreases, hence increasing the time taken for the wave to reach the wall.
2. He should move his hand up and down more slowly. According to $T = 1 / f$, as frequency decreases, period increases.
3. He should displace his hand a greater distance up and down but at the same speed. Increasing the amplitude increases the total distance the wave must complete before reaching the wall, therefore increasing the time taken for the wave to reach the wall.
4. He should displace his hand a lesser distance up and down but at the same speed. Decreasing the amplitude with the same speed will decrease the frequency and hence increase the period.
5. None of the above would produce a pulse that takes a longer time to reach the wall.

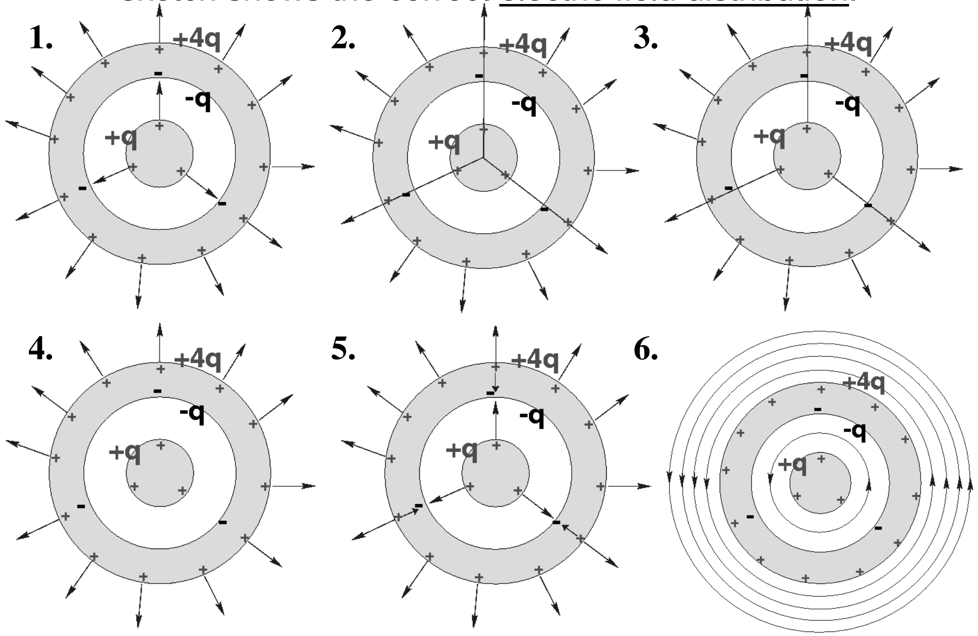
Would changing the density of the rope produce a pulse that takes a <u>longer time</u> to reach the wall? Choose the best answer from the following.

1. He should use a heavier string of the same length, under the same tension. According to $v = (\tau/\mu)^{1/2}$, as linear density (μ) increases, the velocity decreases, hence increasing the time taken for the wave to reach the wall.
2. He should use a lighter string of the same length, under the same tension. According to $v = (\tau/\mu)^{1/2}$, as linear density (μ) decreases, the velocity increases, but $v = f\lambda$, increasing the velocity decreases the frequency, since $T = 1 / f$, as frequency decreases, period increases.
3. None of the above would produce a pulse that takes a longer time to reach the wall.

A solid copper sphere with **+q** charge is surrounded by a hollow copper sphere with **+3q** charge. Which of the following sketch shows the correct charge distribution.



A solid copper sphere with **+q** charge is surrounded by a hollow copper sphere with **+3q** charge. Which of the following sketch shows the correct electric field distribution.



Does water rise to greater heights in coarse or fine grained sands?

A. Higher in fine grained sands, as the spaces between fine grained sands are smaller and water-height is inversely proportional to capillary tube size.

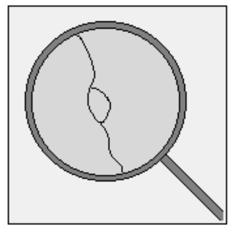
B. Higher in fine grained sands, as the total surface area is higher in fine grained sands, therefore provides a greater line of contact.

C. Higher in coarse grained sands. The spaces are larger in coarse grained sands, so the average density (sand + water) is smaller in the water-coarse grained sand fluid. Therefore there is lesser average weight force pulling down and hence a greater height.

D. Higher in coarse grained sands, as the greater frictional forces in coarse grained sands provides a larger adhesive force.

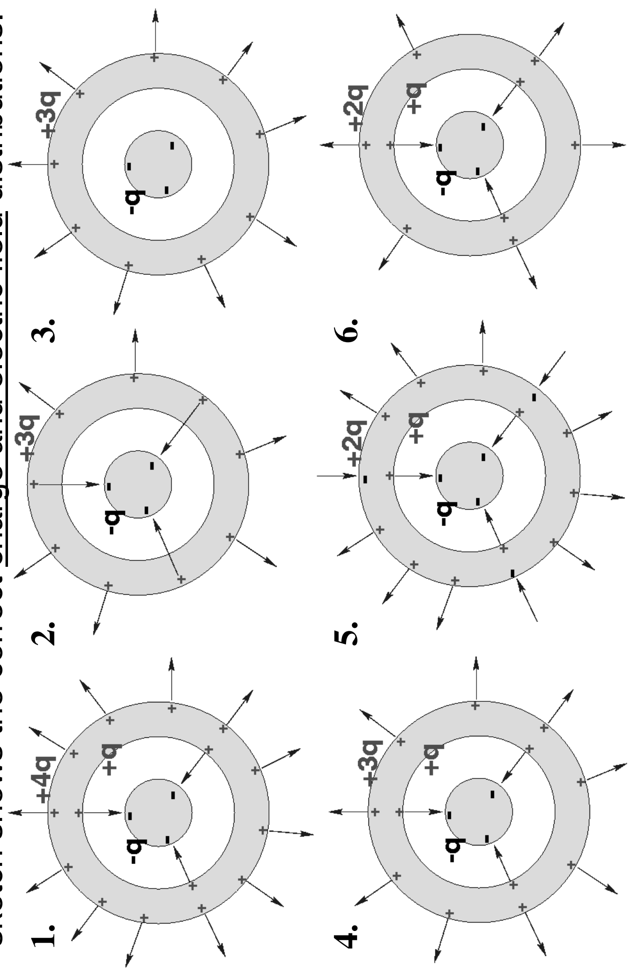
1. Only A is correct.
2. Only B is correct.
3. Only C is correct.
4. Only D is correct.
5. Both A and B are correct.
6. Both C and D are correct.

A wire frame has a soap film across and is supporting a loop of thread. How does the thread stay suspended ***loosely*** in the film?



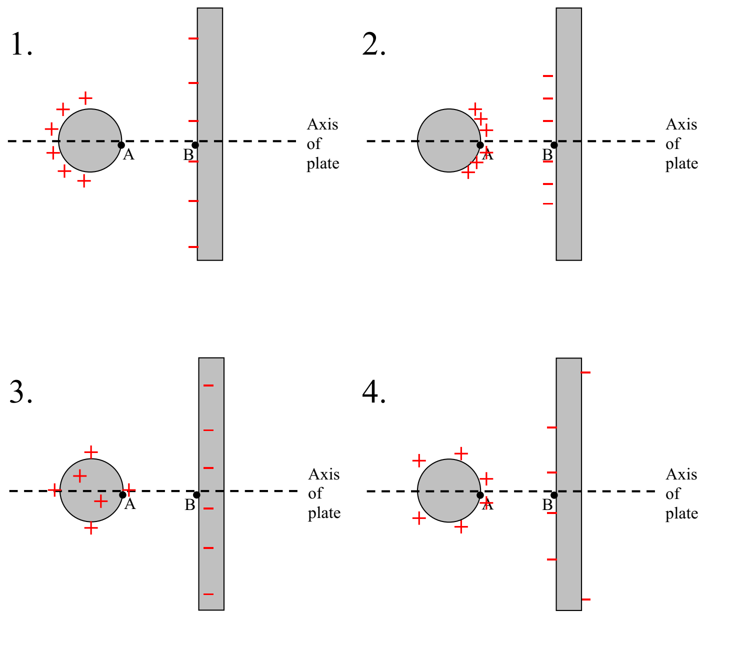
1. The thread is floating in the soap film, suspended by buoyancy force.
2. The adhesive forces on the thread are equal in all sides of the thread and therefore no net force acting on the thread.
3. The internal and external pressures of the soap film are equal and therefore no net force acting on the thread.

A solid copper sphere with **-q** charge is surrounded by a hollow copper sphere with **+3q** charge. Which of the following sketch shows the correct charge and electric field distributions.



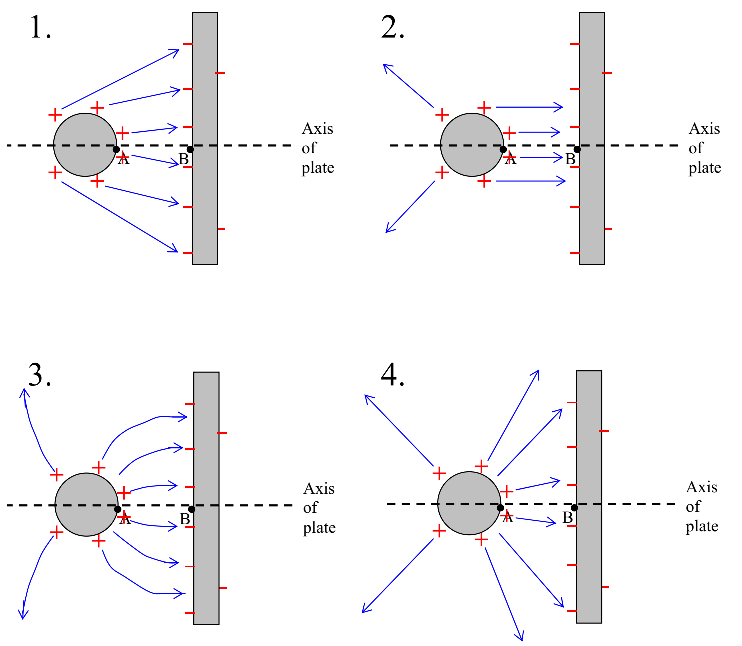
A spherical steel ball is placed near a large circular plate so that the centre of the ball lies along the axis of the plate. A **positive charge** is placed on the ball, while an **equal negative charge** lies on the plate.

1/ Where is the charge is located on the each?



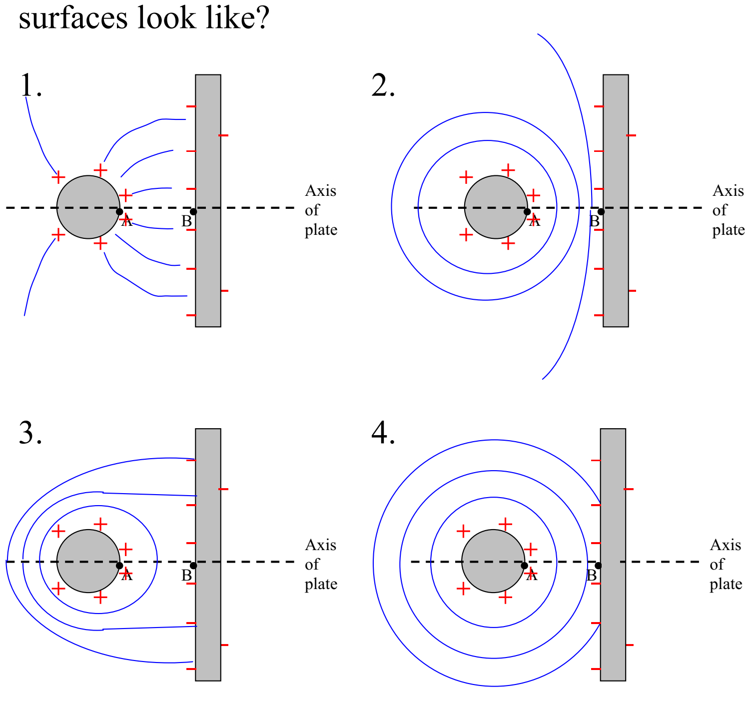
5. None of the above

2/ Using field lines, approximately what does the field look like?



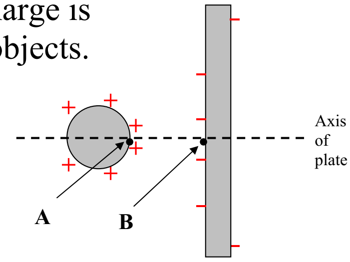
5. None of the above

3/ Approximately what do the equipotential surfaces look like?

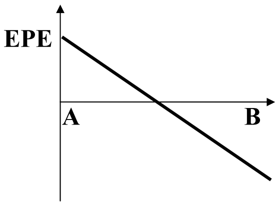


5. None of the above

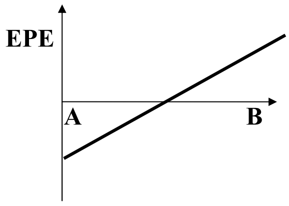
4/ A small *negative* test charge is brought between the two objects. How does this object's *potential energy* vary as it is moved from A to B?



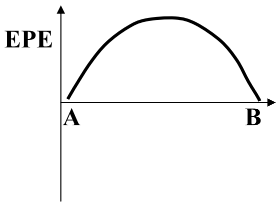
1.



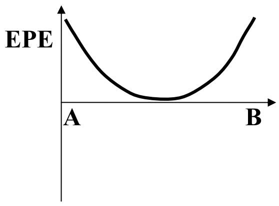
2.



3.



4.

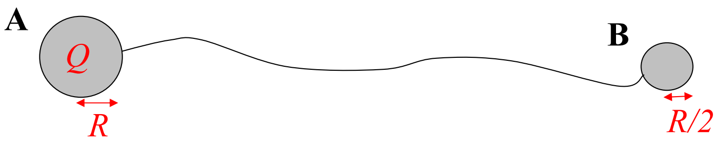


5. None of the above

5/ **A** is solid conducting sphere of radius R has an excess charge Q. The electrical potential at the surface of the sphere is

$$V = \frac{Q}{4\pi\varepsilon_o R}$$

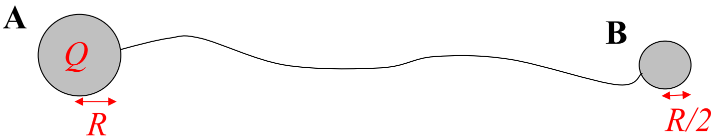
A second *uncharged* conducting sphere **B** of radius $R/2$ is brought to a distance >> R from the first sphere.



The two spheres are connected by a fine wire. What can you say about the electrical potential of each of the two spheres now they are connected?

1. Both potentials are zero.
2. Potential of A is *twice* the potential of B.
3. Potential of A is *half* the potential of B.
4. Potential of A is *equal to* the potential of B.
5. None of the above

6/

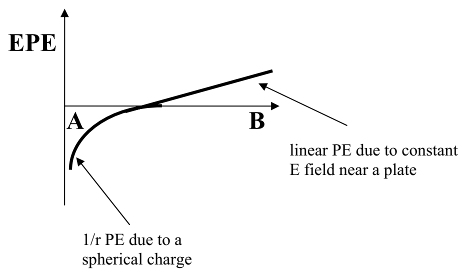


What can you say about the relative magnitude of the charges on the two spheres?

1. Both charges are zero.
2. Charge on A is twice the charge on B.
3. Charge on A is half the charge on B.
4. Charge on A is equal to the charge on B.
5. None of the above

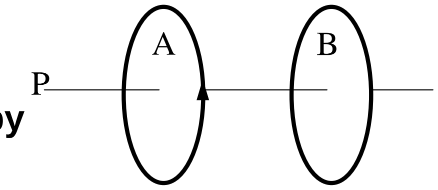
Answers:

1/ answer = 4
2/ answer = 3
3/ answer = 2
4/ answer = 5
approx. shape 2 is obviously close



5/ answer = 4
6/ answer = 2 potentials at surface equal then formula implies half R needs half Q

If the current in loop-A is kept constant with time, could current be induced in loop-B by any of the following actions?



A. Translating loop-B towards or away from loop-A.

B. Rotating loop-B along the axis through P, in the same or opposite direction as the current in loop-A.

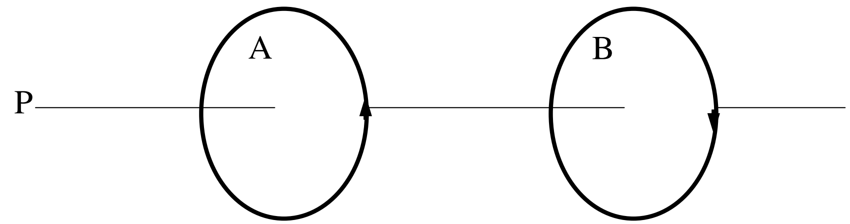
C. Increasing or decreasing the size of loop-A or loop-B.

1. A only.
2. B only.
3. C only.
4. All three.
5. A and B.
6. A and C.
7. B and C.
8. None of the three.

A beam of electrons is directed through two narrowly spaced slits towards a phosphorescent screen. The electrons create an interference pattern (bright and dark bands) on the screen which demonstrates the wave nature of electrons. Which of the following alteration to this experiment would demonstrate the particle nature of electrons.

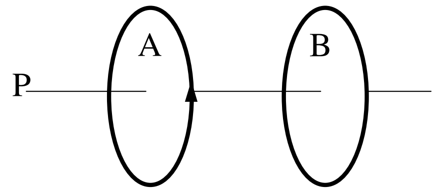
1. Fire electrons one at a time, this results in single spots on the screen showing that each electron-screen interaction is localized, hence it's a particle.
2. Place detectors at the "exit" of both slits to show that the electron do not travel through both slits simultaneously, and hence it is not a wave but a particle.
3. de Broglie's wavelength of the electron tells us the length scale we must look to see the wave nature of the electron, therefore if the slit widths are increased then we'll observe the particle nature of the electron.

The two circular loops in the diagram below have their planes parallel to each other. As viewed from point-P, the current in loop-A is anti-clockwise, and the current is clockwise in loop-B. If the current in loop-B is induced by the current in loop-A, how does the current in loop-A change with time?



1. The current in loop-A must be increasing with time.
2. The current in loop-A must be decreasing with time.
3. The current in loop-A must be constant with time.

If now the current in loop-A is <u>decreasing</u> with time, what direction will the induced magnetic field be in loop-B, and why?



1. The direction of the induced current is independent of the inducing current. Therefore, the induced current in loop-B is clockwise as in the previous case, and the induced magnetic field is <u>directed away from P</u>.
2. According to Lenz's Law, the direction of the induced magnetic field is opposite to the direction of the inducing magnetic field. Therefore, the induced magnetic field is <u>directed away from P</u>.
3. According to Lenz's Law, the direction of the induced magnetic field will be in the same direction as the inducing magnetic field. Therefore, the induced magnetic field is <u>directed towards P</u>.
4. There will not be any induced current nor induced magnetic field in loop-B when the current in loop-A is decreasing.

In the photoelectric effect, it is observed that when the target is illuminated with light of longer wavelength than the cutoff wavelength of the particular metal, no electron is emitted, regardless of the intensity of the light. From this observation the following conclusions are drawn, which one is <u>INCORRECT</u>?

1. This observation is consistent with the particle theory of light, because longer wavelength means the energy is not high enough to free electrons from the metal surface, as $E=hc/\lambda$.
2. This observation is consistent with the particle theory of light, as it shows that the energy of light is absorbed in packets of photons.
3. This observation is inconsistent with the wave theory of light, because in the wave theory, intensity is proportional to energy of the wave.

In the photoelectric effect, it is observed that when the target is illuminated with light of shorter wavelength than the cutoff wavelength, the stopping potential is found to increase linearly with the frequency of light. From this observation the following conclusions are drawn, which one is <u>INCORRECT</u>?

1. This observation is consistent with the particle theory of light, as the linear increase of the stopping potential with frequency indicates a larger amount of emitted electrons because $E=hf$.
2. This observation is consistent with the particle theory of light, as the frequency of light is increased, the energy of the emitted electron also increased.
3. This observation is inconsistent with the wave theory of light, because in the wave theory, the energy of the emitted electrons should not depend on the wavelength of the incident light.

Magnitudes

1.

Two stars of apparent brightness (in magnitudes) –0.04 and +1.33 are too close to be resolved by the naked eye. What is the combined brightness (in magnitudes) of the two stars?

1. -1.37
2. -0.31
3. +0.23
4. +0.65
5. +1.29

2.

If these stars are 1.33 pc distant, what is the *absolute* magnitude of the brighter star?

1. -1.37
2. -0.31
3. +1.29
4. +4.34
5. +9.96

3.

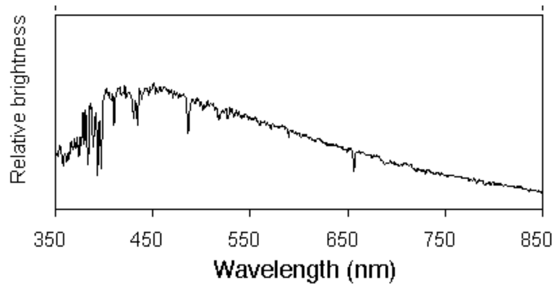
Approximately how far away is the most distant thing you can see with the naked eye?

1. 10^0 pc
2. 10^2 pc
3. 10^4 pc
4. 10^6 pc
5. 10^8 pc

Spectra

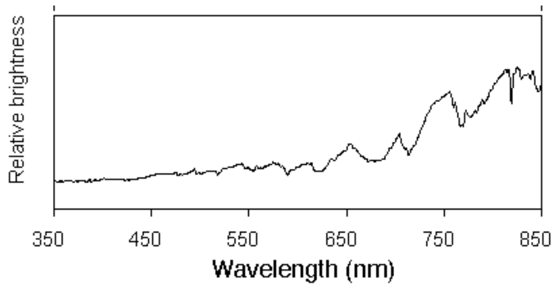
4.

The diagram shows a low resolution spectrum of a star. What is the spectral class of this star?



1. O
2. A
3. F
4. K
5. M

5.
The diagram shows a low resolution spectrum of a star.
What is the spectral class of this star?



1. O
2. A
3. F
4. K
5. M

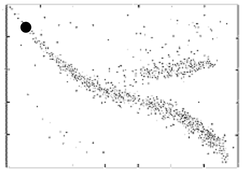
Spectral Lines

6.
In what spectral class of star would you expect to find spectral lines due to HeII (i.e. singly ionised helium)?

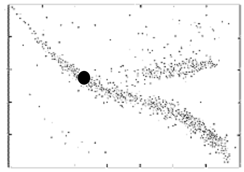
1. O
2. A
3. F
4. K
5. M

Hertzsprung-Russell diagrams

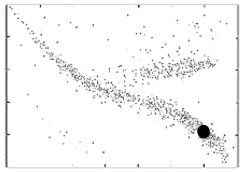
7.
Where on the HR diagram would you expect to find the star in the previous question?



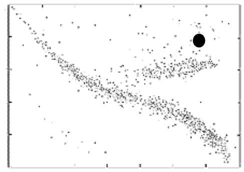
1.



2.



3.



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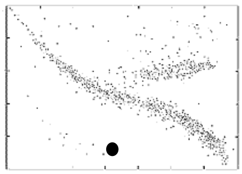
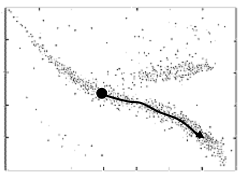


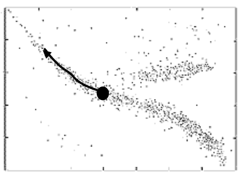
5.

Stellar Evolution

8.
A star begins life on the Main Sequence at the point shown.
How will this star evolve on the HR diagram in the next 2 billion years?



1.



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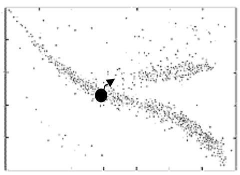

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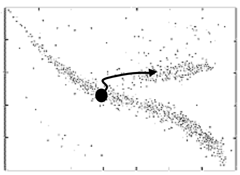

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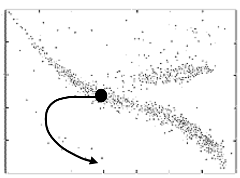
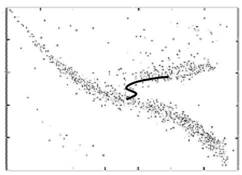


5.

9.
What would you expect the path across the HR diagram of a 1.5 solar mass star to look like over 5 billion years after its arrival on the Main Sequence?



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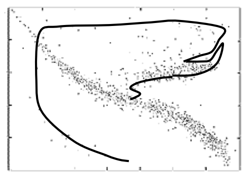

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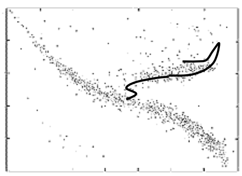

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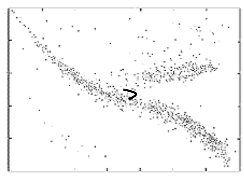

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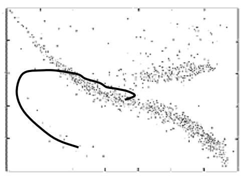
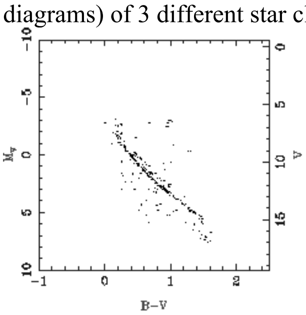


5.

Star Clusters

10.
The following are the HR diagrams (colour-magnitude diagrams) of 3 different star clusters.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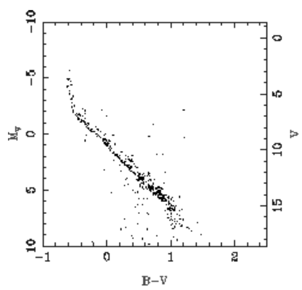
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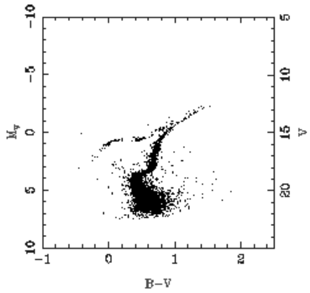
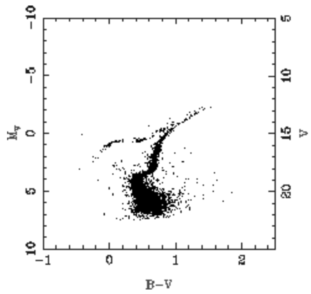

3.

Which, if any, of these cluster is the youngest one?

1. 1
2. 2
3. 3
4. Depends on their distance
5. There’s no way to tell

11.
Estimate the age of the cluster in this HR diagram.



1. 100 million years
2. 300 million years
3. 1 billion years
4. 3 billion years
5. 10 billion years

12.
What would you expect to be the ultimate fate of a star that began life with 5 times the mass of the Sun?

1. white dwarf
2. red giant
3. black hole
4. neutron star
5. red dwarf

Solutions

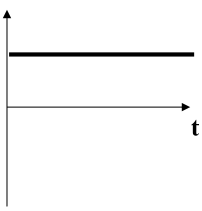
1 **2**
2 **4**
3 **4**
4 **3**
5 **5**
6 **1**
7 **1**
8 **3 - MS lifetime an A5 2Mo star is 2 by**
9 **2 - M44 660 my, M45 100 my, M3 10 gy**
10 **2 - M45 100 my, M44 660 my, M3 10 gy**
11 **5 - M3 10 gy**
12 **4**

The acceleration of objects due to gravity is constant near the ground. Motion under gravity is a very important case of **constant acceleration**.

How do we represent the motion of dropped ball?

- Consider motion in the vertical direction only.
- Assume distances are measured from the ground – zero is ground level and anywhere above the ground is a positive distance.

What does a graph of acceleration v. time look like?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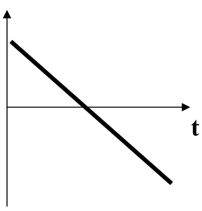
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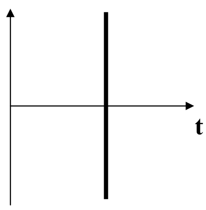
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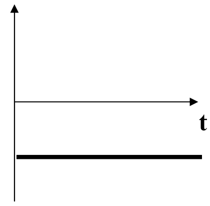
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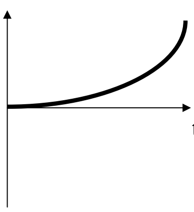
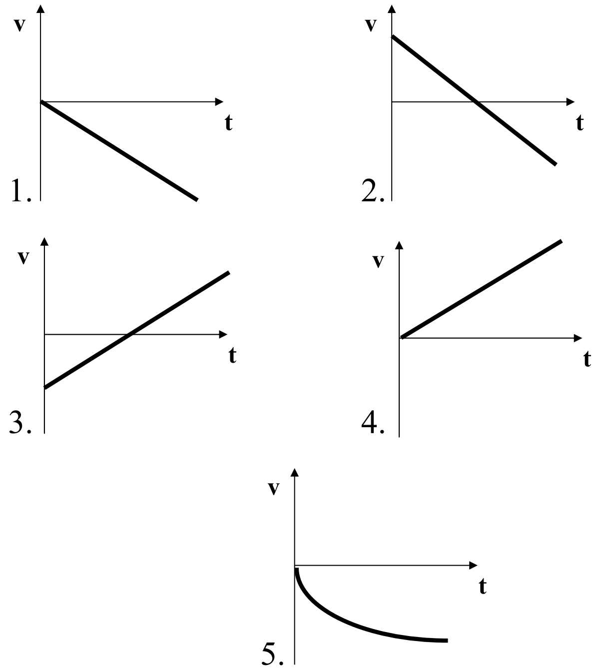
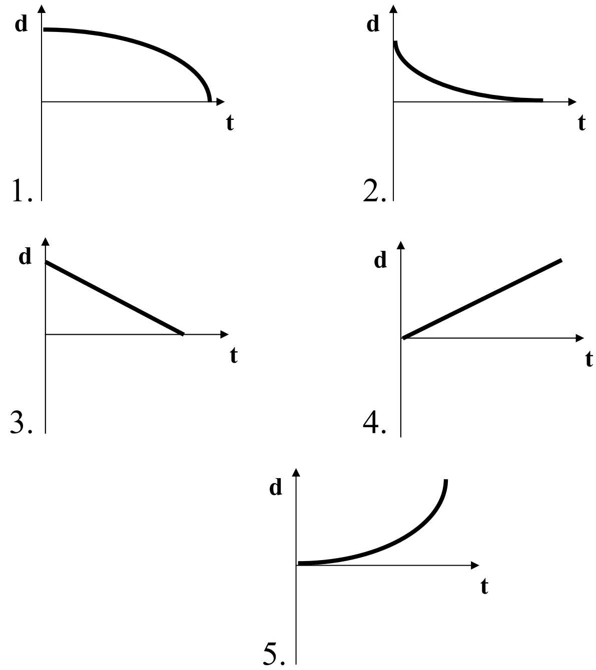

5.

What does a graph of velocity v. time look like?

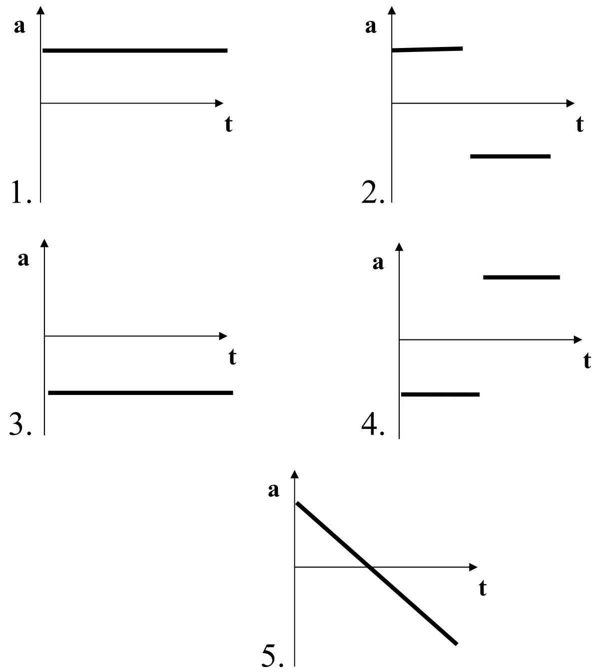


What does a graph of displacement v. time look like?

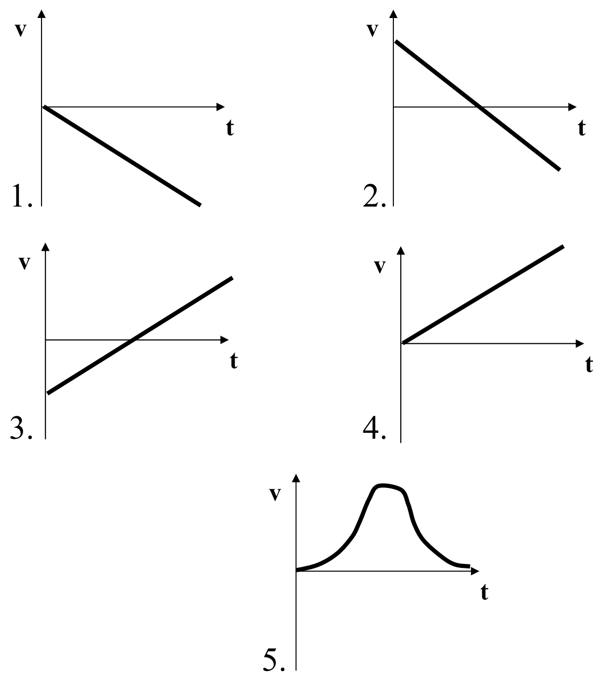


How do we represent the motion of a ball thrown up and falling back to the ground?

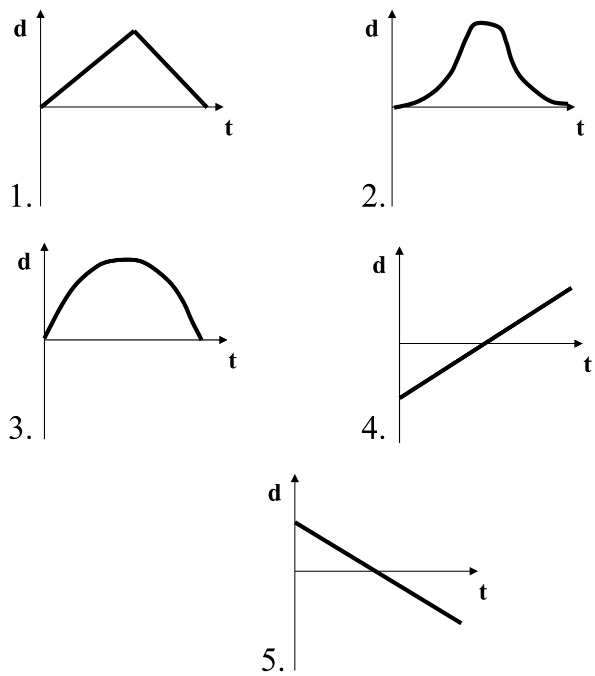
What does a graph of acceleration v. time look like?



What does a graph of velocity v. time look like?



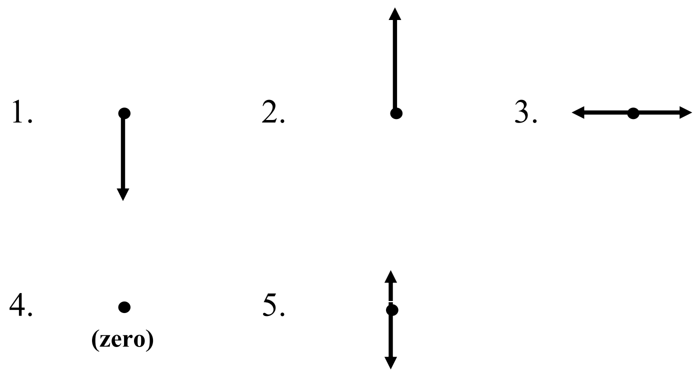
What does a graph of displacement v. time look like?



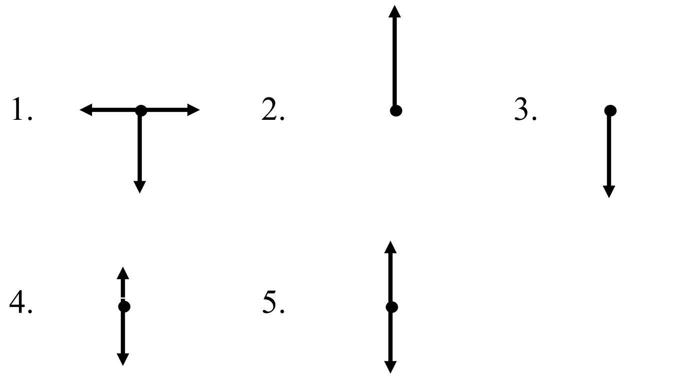
Answers 4,1,1 3,2,3

Consider a person standing upright and motionless on the floor.

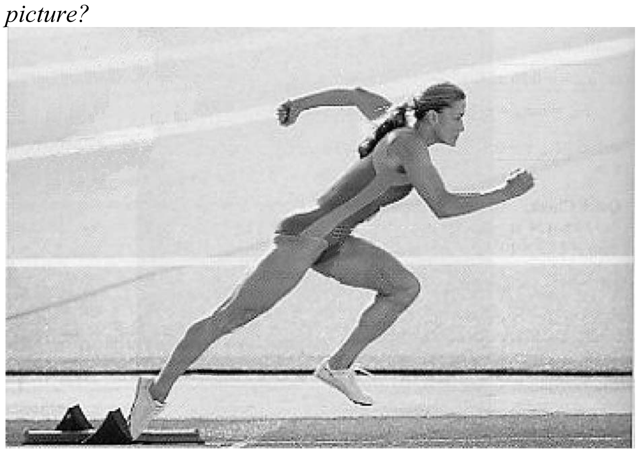
What is the net (i.e. total) force on the person?



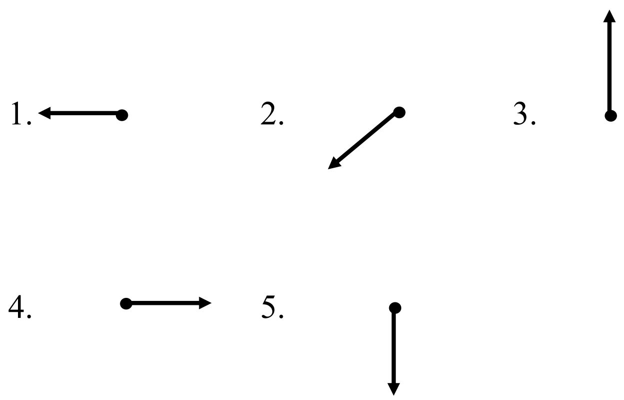
What are the individual forces on the person? (the real forces – not their components)



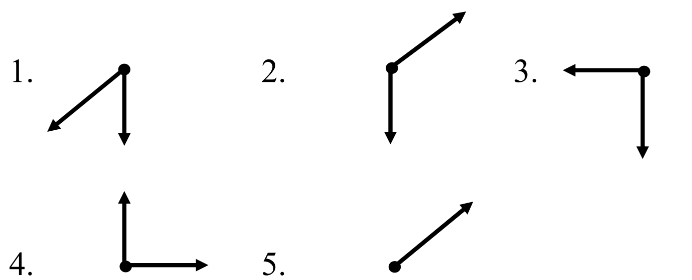
Consider a runner pushing off the starting blocks in a sprint race. What are the forces on her in the position shown in the picture?



What is the net (i.e. total) force on the runner?

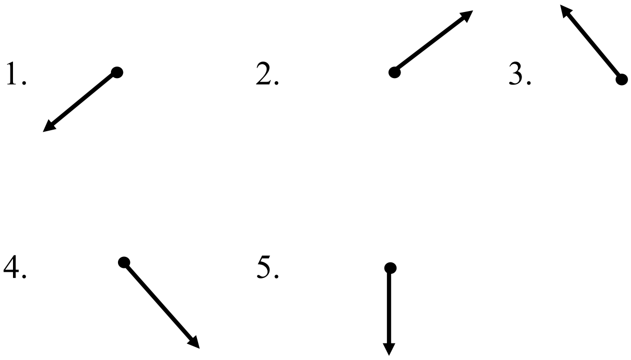


What are the individual forces on the runner? (the real forces – not their components)



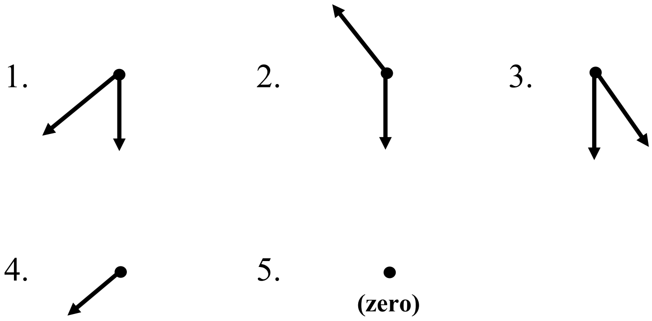
Consider a skier sliding down a slope. What are the forces on her in the position shown in the picture?

What is the net (i.e. total) force on the skier?



EDUH 1017 Sports Mechanics

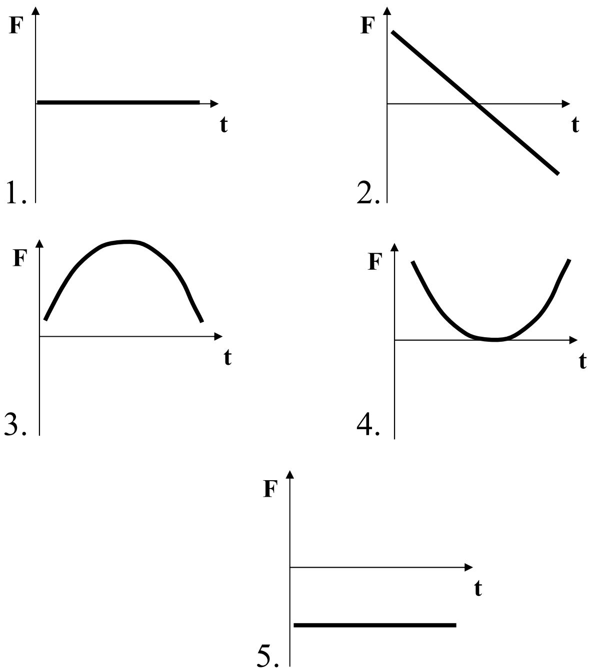
What are the individual forces on the skier?
(the real forces – not their components)



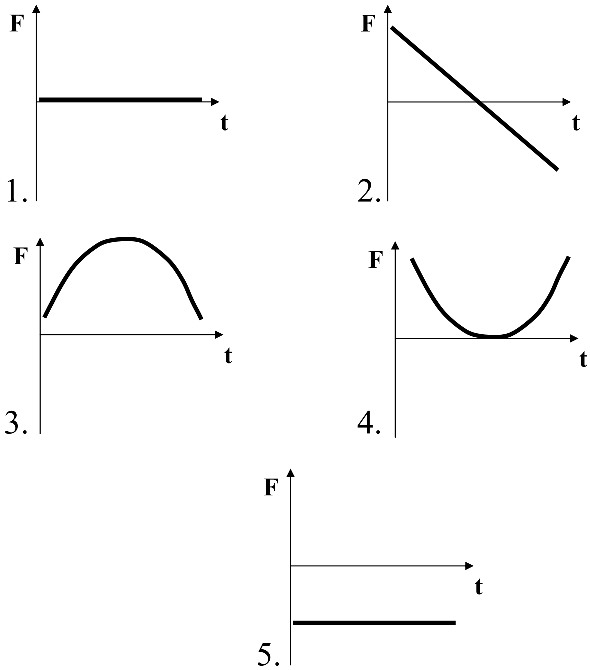
The venue is the SCG. Adam Gilchrist hits a cricket ball into the stands on the full for six.

Consider the motion of ball (after it is hit):

Ignoring air resistance, what does a graph of ***horizontal* force on the ball v. time** look like?

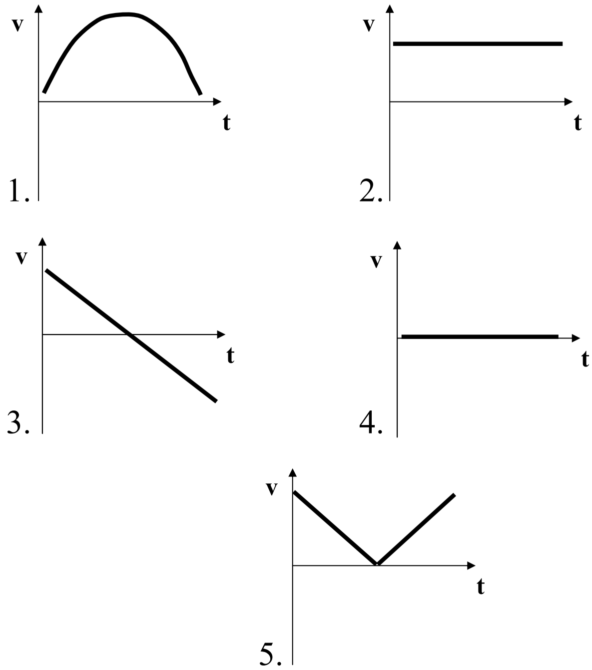


Ignoring air resistance, what does a graph of ***vertical* force on the ball v. time** look like?

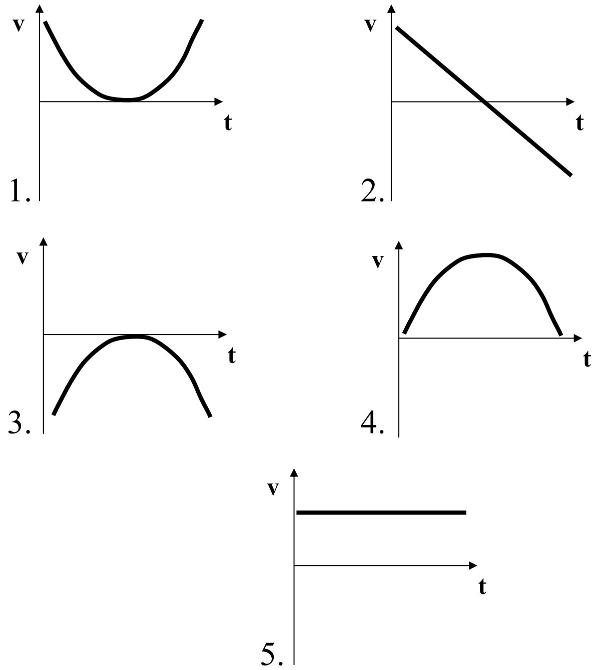


How would you derive accelerations from the forces?

Ignoring air resistance, what does a graph of ***horizontal*** **velocity of the ball v. time** look like?

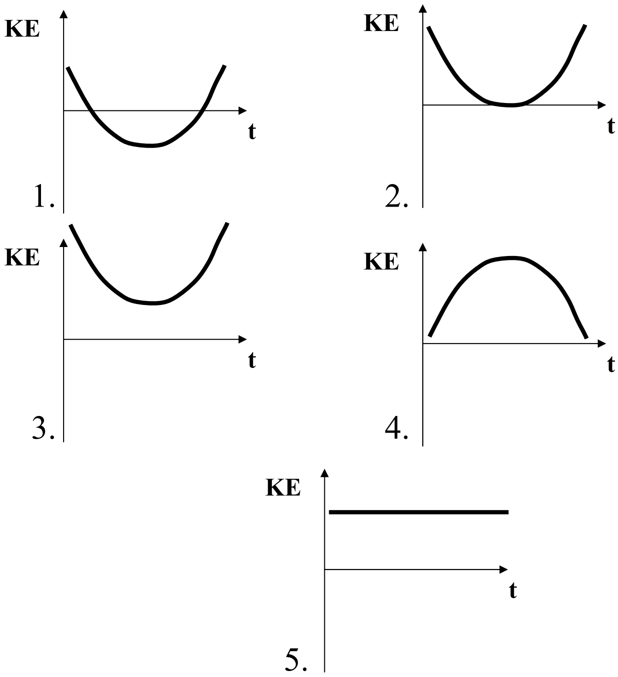


Ignoring air resistance, what does a graph of ***vertical*** **velocity of the ball v. time** look like?

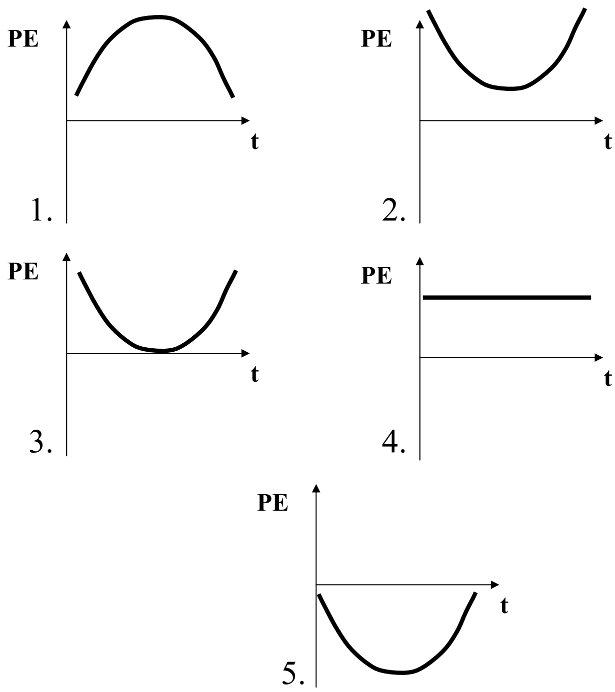


As an exercise for later, what do the graphs of ***horizontal*** and ***vertical*** **displacement v. time** look like?

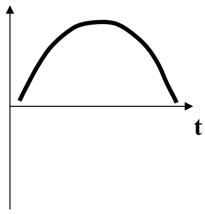
Ignoring air resistance, what does a graph of **Kinetic Energy of the ball v. time** look like?



Ignoring air resistance, what does a graph of **Potential Energy of the ball v. time** look like?



Ignoring air resistance, what does a graph of
Total Mechanical Energy of the ball v. time look like?



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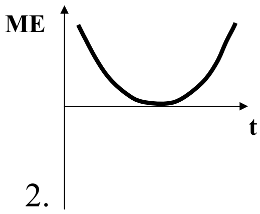

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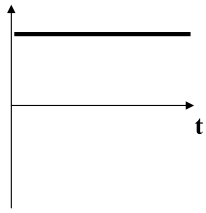

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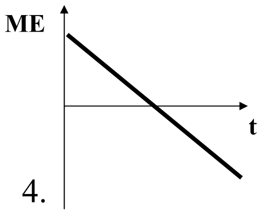

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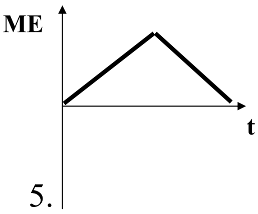

5.