Strategy, Math and Research Methods Question Set

To answer many of the questions that follow, you will need to be familiar with the following equations:

$X = 1/2at^2$; where X = distance traveled, a = acceleration and t = time.

$v = \sqrt{(2gh)}$; where v = initial or final velocity, g = gravity or acceleration and h = height or distance traveled

$F = Gmm/r^2$; where F = force, m = one of two masses, G = a constant and r = distance between the two masses

$F = ma$; where F = force, m = mass and a = acceleration

$PV = nRT$; where P = pressure, V = volume, n = moles of gas, R = a constant and T = temperature

1. Tripling the force on an object accelerating at a constant 12 m/s^2 will increase the acceleration to:

   A. 12 m/s^2
   B. 36 m/s^2
   C. 48 m/s^2
   D. The acceleration will not change.

2. An object is dropped from a fixed height and strikes the ground in a time, t. If drop height is doubled, what is the new time, in terms of t?

   A. 2t
   B. 4t
   C. 1.4t
   D. 16t

3. Object A is dropped from a height *x* and is in the air for five seconds. If Object B is in the air for twenty seconds, which of the following best represents the height from which it was dropped?

   A. 2*x*
   B. 4*x*
   C. 8*x*
   D. 16*x*

4. If the height from which a falling body is dropped doubles, the object's final velocity will:

   A. double.
   B. increase by the square root of two.
   C. decrease by a factor of two.
   D. decrease by the square root of two.

5. The final velocity of a moving particle goes from 10 m/s to 20 m/s from Trial 1 to Trial 2. Which of the following could be a plausible explanation?

   I. The distance traveled by the object increased by a factor of 4.
   II. The acceleration increased by a factor of 4.
   III. The drop height increased by a factor of 2.

   A. I only
   B. II only
   C. I and II
   D. I, II and III

6. The initial velocity of a projectile is tripled. The maximum height of the projectile will increase by a factor of:

   A. 9
   B. 3
   C. 1.7
   D. 16

7. If the pressure of an ideal gas in a closed system is doubled, what would one expect to happen to the volume?

   A. It would stay the same.
   B. It would double.
   C. It would triple.
   D. It would decrease by a factor of 2.

8. Q is inversely proportional to the square of Y. If Y is increased by a factor of three, Q will:

   A. go up by a factor of 3.
   B. go down by a factor of 9.
   C. go down by a factor of 6.
   D. go up by a factor of 9.

9. Two planets are separated by a distance *r*, and move in space such that the force between them due to gravity increases by a factor of sixteen. What is the new distance between the two planets in terms of *r*?

   A. 4*r*
   B. 1/4*r*
   C. 1/16*r*
   D. 16*r*

10. If two stars are attracted by a gravitational force *F*, what will happen to that force if the mass of one star is cut in half and the distance between the stars is doubled?

    A. It will double.
    B. It will decrease by a factor of 8.
    C. It will quadruple.
    D. It will be cut in half.

11. If the volume of an ideal gas in a closed system is decreased by 80 percent, what will happen to the pressure?

    A. It will increase by a factor of 5.
    B. It will increase by 80 percent.
    C. It will increase by a factor of 1/5.
    D. It will increase by a factor of 8/10.

12. If the distance between two objects in space is increased by a factor of 5/3, what will happen to the gravitational force between those objects?

    A. It will increase by 25/9.
    B. It will decrease by a factor of about 3.
    C. It will decrease to 3/5 of its original value.
    D. It will be multiplied by 1.6.

13. Suppose the exact gravitational force between the moon and the Earth is *F*. If the mass of the moon were decreased by 20%, which of the following would give the new value for *F*?

    A. 4/5*F*
    B. 1/5*F*
    C. 0.8/*F*
    D. *F* – 0.2

14. If the volume of an ideal gas is decreased by 40%, the pressure of that same gas will increase by:

    A. 80%.
    B. a factor of 5/3.
    C. 140%.
    D. Pressure will decrease, not increase.

15. In Trial 1, an object is dropped from a height *x* and reaches the ground in a time *t*. In Trial 2, the time required to reach the ground is decreased by 20%, and in Trial 3 it is decreased by 80%. Which of the following gives the drop heights, in terms of *x*, for Trials 1, 2 and 3, respectively?

    A. *x*, 0.8*x* and 0.2*x*
    B. *x*, 0.2*x* and 0.8*x*
    C. 0.2*x*, 0.64*x* and 0.4*x*
    D. *x*, 0.64*x* and 0.04*x*

16. For two planets in space, the distance between the planets must be multiplied by which of the following factors in order for the force between the planets to increase by exactly 125%?

    A. 4/5
    B. √1.25
    C. 2/3
    D. 4/9

17. A researcher designs a study to investigate the question: "What are all of the biomolecules involved in cancer proliferation and metastasis?" This study design may be characterized as an example of:

    A. observational research.
    B. low external validity.
    C. high internal validity.
    D. an untestable hypothesis.

18. A student in the lab added 10 mL of ethanol to a calorimeter. An exothermic reaction released exactly 500 J of heat into the ethanol and the calorimeter. The student used the heat capacity of the calorimeter and the measured change in temperature to determine that 20% of the heat had been absorbed by the calorimeter. If the temperature of the ethanol increased by 20°C, what is the specific heat of ethanol? ($density_{ethanol}$ = 0.789g/mL)

    A. 3.2 J/g°C
    B. 2.5 J/g°C
    C. 4.0 J/g°C
    D. 12.5 J/g°C

19. The orbital period of mercury is 88 days. Mercury orbits at an average distance of 57,909,100 km from the sun. Which of the following gives the average orbital velocity of Mercury in m/s? (Note: assume a circular orbit)

    A. $(1.16 \times 10^{11})(\pi)/(88)(24)(60)(60)$
    B. $(5.8 \times 10^{10})(\pi)(60)/(88)(24)$
    C. $(5.8 \times 10^{7})(\pi)/(88)(24)(60)(60)$
    D. $(1.16 \times 10^{11})(2\pi)/(88)(24)(60)(60)$

20. At one point in their orbits, Earth and Venus are 38 million kilometers apart. At this exact point, how long will it take for a radio signal sent from the Earth to return to the Earth from Venus? (Note: speed of light = 3.0×10^{8} m/s)

    A. Approximately 2 minutes
    B. Approximately 4 minutes
    C. Approximately 12 minutes
    D. Radio signals cannot be used because they will be diffracted by the Earth's atmosphere.

21. Which data set suggests a study with the highest internal validity? (Note: SEM = Standard Error of the Mean)

    A. $p > .05$; Mean = 18 ; SEM= 3.4
    B. $p < .05$; Mean = 15 ; SEM = 11.1
    C. $p < .01$; Mean = 19 ; SEM = 1.2
    D. $p < .01$; Mean = 12 ; SEM = 4.1

Passage 1 (Questions 22-31)

Falling bodies behave in highly predictable ways with respect to their displacement, velocity and acceleration. Air resistance, however, greatly complicates the study of falling bodies. In a vacuum, all falling bodies, regardless of mass, are affected in an identical manner by the forces of gravity. As a result, two balls, one of Mass A and another of Mass B, will both fall at the same velocity *v* and with the same acceleration *a*. If both balls are dropped from the same height, *h*, they will both strike the ground at the same time.

If the effects of air resistance are taken into consideration, balls of different masses will no longer exhibit the same fall times, velocities or accelerations. If the drop height is sufficiently large, all balls will eventually reach *terminal velocity*, a point at which the upward forces on the ball due to drag are exactly equal to the downward forces on the ball due to gravity. The terminal velocity of any object with a mass *m* is given by the following equation:

$$V = \sqrt{\frac{2mg}{pAC}}$$

Equation 1

Where *V* is the terminal velocity, *g* is the strength of the gravitation field, *p* is the density of the fluid, *A* is the surface area of the object colliding with air molecules, and *C* is a coefficient describing the aerodynamic properties of the object.

22. For a ball at terminal velocity, if the force of air resistance is increased by 20%, to maintain terminal velocity, the force due to gravity must:

    A. increase by 20%.
    B. decrease by 20%.
    C. remain the same, so that upward forces equal downward forces.
    D. increase by the square root of 5/4.

23. Which scenario best describes the terminal velocity of an object falling from a very high altitude?

    A. Terminal velocity remains constant at all times.
    B. The increasing density of the air increases the terminal velocity of the object.
    C. The decreasing density of the air decreases the terminal velocity of the object.
    D. The increasing density of the air decreases the terminal velocity of the object.

24. If Object A has a mass of 10 kg and Object B has a mass of 90 kg, which of the following gives the relationship between the terminal velocities of Objects A and B?

    A. A = 3B
    B. 1/9A = B
    C. 9A = B
    D. 3A = B

25. An experiment on falling bodies involved two trials, Trial A and Trial B. Between Trial A and Trial B, the terminal velocity of two objects of identical mass quadruples. Which of the following is(are) possible explanations for the increase in the terminal velocity between Trials A and B?

    I. The mass of the object used in Trial B is 16 times that of the object used in Trial A.
    II. Trial A was conducted on the earth, and Trial B was conducted on a planet with a gravitational field 16 times stronger.
    III. Although their masses were identical, the surface area of the object used for Trial B was 16 times larger.

    A. I only
    B. II only
    C. I and II
    D. II and III

26. The terminal velocity, *v*, of object *x* in air is known. Researchers drop this same object through a gas with three times the density of air. If, at the same time, they also increase the surface area of object *x* by a factor of three, the terminal velocity in terms of *v* will be:

A. 3*v*
B. 1/9*v*
C. 1/3*v*
D. *v*

27. A falling object is traveling at a terminal velocity of 100 m/s when it enters a cloud bank. If the cloud bank is 225% as dense as air, the ball's new velocity in the cloud will be:

A. slightly more than 50 m/s.
B. slightly less than 50 m/s.
C. approximately 66 m/s.
D. approximately 33 m/s.

28. A student drops three balls of increasing mass and discovers that by altering the humidity of the air he can cause each subsequent ball to travel at the same terminal velocity despite minor differences in mass. If each ball is 33% more massive than the previous one, the student must: (Note: Assume humidity is directly proportional to air density)

A. increase the humidity by 66% before dropping each ball.
B. increase the humidity by 33% before dropping each ball.
C. decrease the humidity by the square root of 1/3 prior to dropping each ball.
D. increase the humidity by the square root of 1/3 prior to dropping each ball.

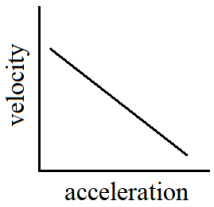
29. Jupiter, the most massive planet in the solar system, has a gravitational field nearly three times as strong as that of earth. If the terminal velocity of a falling object on earth is 150 m/s, what will be the terminal velocity of this same object falling near Jupiter? (Note: assume all other factors remain constant)

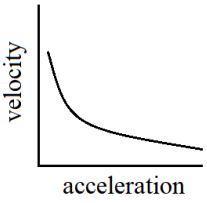
A. 50 m/s
B. 450 m/s
C. 925 m/s
D. 255 m/s

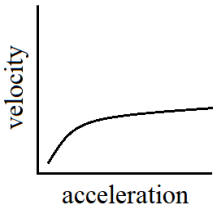
30. Rain drops usually reach terminal velocity before striking the ground. Their fluid nature allows them to contort in response to air resistance and attain shapes with decreasing surface area. If a rain drop's surface area decreases linearly as it approaches the ground, how will this affect its terminal velocity?

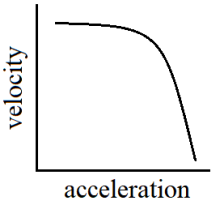
A. It will increase linearly.
B. It will increase non-linearly.
C. It will decrease linearly.
D. It will decrease non-linearly.

31. Which of the following graphs best illustrates the relationship between terminal velocity, *V*, and surface area, *A*, for a falling object experiencing air resistance?

A.


B.


C.


D.


Passage 2 (Questions 32-38)

The H1N1 influenza virus, commonly referred to as the "swine flu," is a sub-strain of the common Influenza A viruses that infect human, avian and porcine hosts. In April of 2009, the first human H1NI case was confirmed in the United States. Two months later, the Centers for Disease Control (CDC) estimated that there had already been over one million cases of H1N1 in the United States. That same month the World Health Organization declared that a worldwide pandemic was underway.

Epidemiologists have traced the genetic history of the H1N1 virus to avian populations in Africa. Migration, followed by transmission across host species (a rare occurrence made possible in most cases only by mutation) resulted in the current prevalence among swine populations worldwide. Current U.S. isolates from swine and turkey stocks are triple *reassortants*, combining human, swine and avian lineages.

Symptoms of H1N1 infection include chills, fever, sore throat, muscle pain, severe headache, coughing, and general lethargy. Because these symptoms are not specific to swine flu over other influenza strains, a differential diagnosis of *probable* swine flu requires a high likelihood from the patient's history that he or she was exposed to the swine flu. For example, during the 2009 outbreak, CDC advised physicians to "consider swine influenza infection in the differential diagnosis of patients with acute febrile respiratory illness who have either been in contact with persons with confirmed swine flu, or who were in one of the five U.S. states that have reported swine flu cases, or in Mexico during the 7 days preceding their illness onset." A diagnosis of *confirmed* swine flu requires laboratory testing of a respiratory sample.

Figure 1 tracks the progress of physician-verified H1N1 infections in a rural community in the United States during the 2009 outbreak. Figure 2 tracks the prevalence of laboratory-confirmed H1N1cases in three densely populated states in northern Mexico.

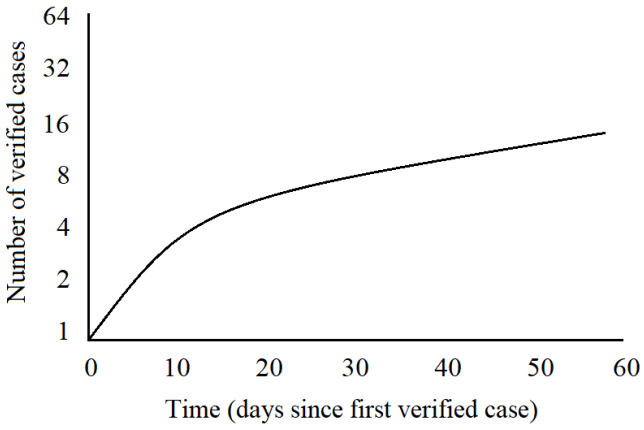


Figure 1 Physician-verified H1N1 infections in one U.S. community.

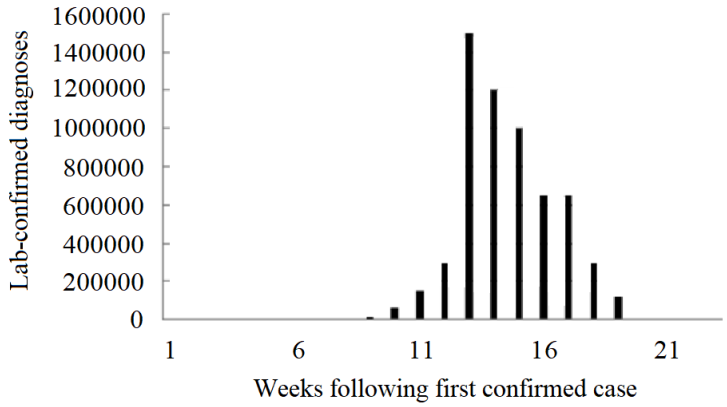


Figure 2 Laboratory-confirmed H1N1 infections in three states in northern Mexico.

32. In tracking the swine flu outbreak, the epidemiologists who created Figure 1 most likely chose the scale used in this graph because:

A) it demonstrated the transition from the exponential growth of H1N1 cases during the first 15 days to linear growth thereafter.

B) it demonstrated the transition from linear growth of H1N1 cases during the first 15 days to exponential growth thereafter.

C) one of the variables to be graphed was changing exponentially and the other was changing linearly.

D) after 60 days no additional cases of H1N1were reported.

33. Which of the following provides the best explanation for the observation that a far greater number of H1N1 cases were reported in the data for Mexico (Figure 2) than were reported in the data for the United States (Figure 1)?

A) Persons in the United States had already developed H1N1 antibodies prior to the outbreak.
B) Persons of Mexican lineage had a genetic predisposition to infection by H1N1.
C) The data for Mexican cases were laboratory-verified, whereas those for the United States were physician-verified.
D) The sample size used in the United States study was much smaller

34. According to CDC recommendations, physicians attempting to make a differential diagnosis of probable HIN1 influenza during the 2009 outbreak would have looked for which symptoms?

I. Respiratory illness
II. Likely exposure to the swine flu
III. Fever

A) I only
B) I and II
C) I and III
D) I, II and III

35. Assuming the first confirmed cases of H1N1 occurred within the same week in both northern Mexico and the rural U.S. community, how did the prevalence of H1N1 in both locations compare six weeks later?

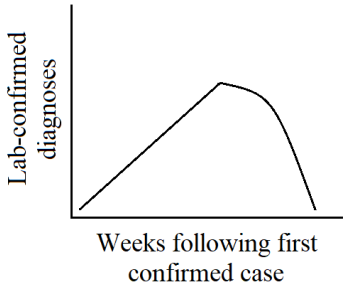
A) Approximately 8 cases had been confirmed in the U.S. community, but no cases were yet confirmed in Mexico.
B) Approximately 8 cases had been confirmed in the U.S. community; many cases were likely to have been confirmed in Mexico, but this assertion cannot be confirmed by Figure 2.
C) Less than 2 cases had been confirmed in the U.S. community, but no cases were yet confirmed in Mexico.
D) Less than 2 cases had been confirmed in the U.S. community and many thousands of cases had been confirmed in Mexico.

36. According to passage information, a *triple reassortant* is most likely a:

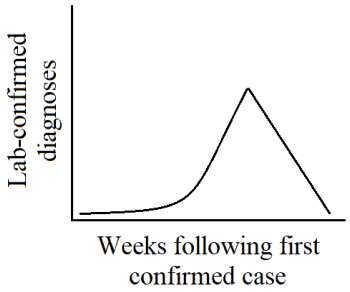
A) pig which has developed antibodies to avian, porcine, and human viral antigens.
B) virus containing DNA from viruses known to infect pigs, birds, and humans.
C) virus containing a mixture of avian, porcine, and human DNA.
D) virus capable of utilizing pigs, birds, and humans as its host, but not other mammals.

37. If the data from Figure 2 were plotted on a semi-log graph, it would appear most like which of the following?

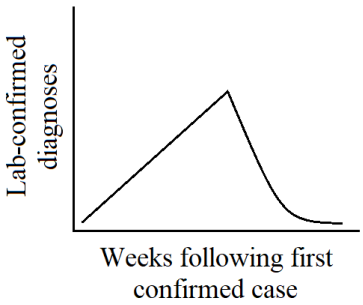
A)



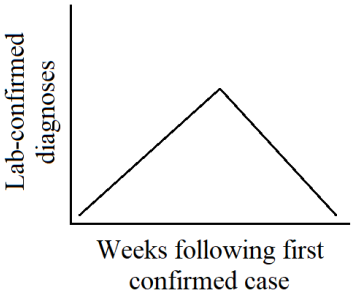
B)



C)



D)



38. Epidemiologists at the CDC used other data to confirm that the prevalence of H1N1 cases in northern Mexico was many times greater than that in the United States. Suppose additional research were to show that only 40% of physician-verified H1N1 cases were later confirmed in the laboratory. What effect does this new information have on the CDC's conclusion about the prevalence of H1N1 in Mexico during 2009, and on their recommendations discussed in the passage?

A) It has no relevance to their conclusions about H1N1 in Mexico, but their recommendations would be drawn into question.

B) The data in Figure 2 confirm their conclusions about H1N1 in Mexico, but the new information would have no effect on their recommendations.

C) It would weaken their conclusions about H1N1 in Mexico, but would strengthen the validity of their recommendations.

D) It would have no effect on either their conclusions about H1N1 in Mexico, or on their recommendations.