NOVA SCOTIA
Department of Education
Testing and Evaluation

1414701

NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JANUARY 2005

Comment Box—For Use by Teacher

What adaptations have been made?

By whom?

Position/Title:

Why?

Name:_____

GENERAL INSTRUCTIONS

This examination has three sections. Suggested completion times are indicated below. Total time available is three hours. Calculators are permitted, but are not to be shared. Students are responsible for clearing all memory in their calculator before the exam begins. Calculators may be checked by the invigilator at any time during the exam.

QUESTION TYPE	VALUE	SUGGESTED TIME (minutes)
selected response	40	60
constructed response	50	90
case study	10	30

Selected Response Questions

Total Value: 40

In this part of the examination, there are 40 multiple choice questions, each with a value of 1 point. Read each question carefully and decide which one of the choices **best** answers the question. You are provided with a separate response form. Please ensure that your booklet number is properly identified on the form. Use spaces 1 to 40 in part 1 on side 1 to record your answers. Fill in the space that represents your choice using a soft HB pencil only. To change an answer, it must be erased completely. When you have finished the exam, please make sure the response sheet is inside your examination booklet.

EXAMPLE

Which of the following is an SI unit of distance?

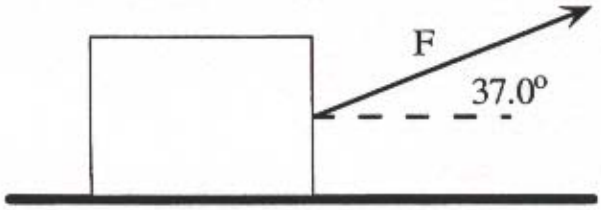
A. cubits
B. feet
C. inches
D. metres

Answer Sheet

A	B	C	D
○	○	○	●

Do not turn the page until you are told to start.

1. The diagram below shows a box being pulled along a horizontal surface by a force F at an angle of 37.0° to the horizontal. If the resulting vertical component is 60.0 N, what is the value of F?



A. 36.1 N
B. 47.9 N
C. 75.1 N
D. 99.7 N

2. A plumber pulls perpendicularly with a force of 80.0 N on the handle of a wrench with an effective length of 50.0 cm. What is the magnitude of the torque produced?

A. 1.60×10^0 Nm
B. 4.00×10^1 Nm
C. 1.60×10^2 Nm
D. 4.00×10^3 Nm

3. An aircraft is flying north at a speed of 165 km/h relative to the air. The wind is blowing from the west at 65.0 km/h. Which of the following is the best description of the plane's flight direction relative to the ground?

A. [N21.5°E]
B. [N21.5°W]
C. [N23.2°E]
D. [N23.2°W]

4. A physics student observes a glancing two-dimensional collision between identical billiard balls. Which of the following observations confirms that the collision between a moving (incident) ball and a stationary (target) ball is elastic?

A. The incident ball bounces back.
B. The target ball has a much higher velocity after impact.
C. The two balls have identical speeds after impact.
D. The two balls travel along paths separated by a 90° angle after impact.

5. In an inelastic collision, what quantity is conserved?

A. kinetic energy
B. momentum
C. potential energy
D. velocity

6. A yellow curling stone is traveling east along a sheet of ice. It undergoes a glancing collision with a stationary red curling stone of identical mass. After the collision, the red stone is moving in a direction south of east. Which of the following statements best describes the direction of the yellow stone after the collision?

   A. It must leave the collision in a direction between east and north.
   B. It must leave the collision in a direction between east and south.
   C. It must leave the collision in a direction between west and north.
   D. It must leave the collision in a direction between west and south.

7. A baseball is thrown by a centre fielder towards home plate. The ball is caught by the catcher at the same height at which it was released. At what point does the magnitude of the vertical component of the ball's velocity have its minimum value?

   A. at the top of its trajectory
   B. just after leaving the fielder's hand
   C. just before arriving at the catcher's mitt
   D. The vertical component is constant.

8. Which of the following launch angles will give a projectile maximum range?

   A. 30.0^{o}
   B. 45.0^{o}
   C. 60.0^{o}
   D. 90.0^{o}

9. A circus performer is launched with a velocity of 12.0 m/s from a cannon that makes a 60.0^{o} angle to the horizontal. Ignoring the height of the cannon, what is the maximum height that the performer attains?

   A. 0.530 m
   B. 1.84 m
   C. 5.51 m
   D. 7.35 m

10. A student runs on a circular track at 9.00 m/s. If her acceleration is $0.600\ m/s^2$, what was the radius of the track?

    A. 15.0 m
    B. 25.0 m
    C. 48.0 m
    D. 135 m

11. A ball is whirled in a circle of radius r and speed v. If the speed is cut in half and the radius is cut in half, what will happen to the centripetal force?

    A. It will be 1/4 the original value.
    B. It will be 1/2 the original value.
    C. It will be unchanged.
    D. It will be twice the original value.

12. Consider a point on a bicycle tire that is momentarily in contact with the ground as the bicycle moves to the right on a horizontal surface with a constant speed. What is the direction of the acceleration of this point as it touches the ground?

    A. down toward the ground
    B. left
    C. right
    D. upward

13. As a car travels around a horizontal circular track at a constant speed, it must undergo a change in which of the following quantities?

    A. mass
    B. speed
    C. velocity
    D. weight

14. A ferris wheel has a radius of 12.4 m and a tangential speed of 1.35 m/s. If a 60.0 kg person is riding it, what is the magnitude of the apparent weight at the bottom of the path?

    A. 0.00 N
    B. 580 N
    C. 589 N
    D. 597 N

15. An Olympic athlete is throwing the hammer (a chain with a mass on one end and a handle on the other). The 7.27 kg hammer is moving at 21.4 m/s just before release. If the chain and athlete's arms cause the hammer to move in a horizontal circular path with a radius of 2.35 m, what is the magnitude of the tension on the chain?

    A. 66.2 N
    B. 195 N
    C. 366 N
    D. 1420 N

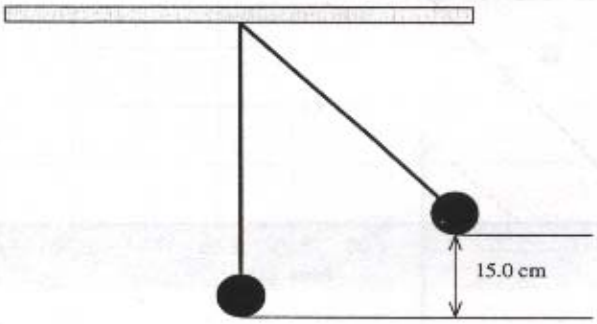
16. A mass hanging vertically on a spring exhibits simple harmonic motion when displaced and released. Which of the following statements is true at the highest position?

A. The speed is maximum and the magnitude of the acceleration is maximum.
B. The speed is maximum and the magnitude of the acceleration is minimum.
C. The speed is minimum and the magnitude of the acceleration is maximum.
D. The speed is minimum and the magnitude of the acceleration is minimum.

17. What is the period of a pendulum with a length of 1.25 m?

A. 0.446 s
B. 0.801 s
C. 1.12 s
D. 2.24 s

18. The diagram shows a swinging pendulum bob. If the bob is pulled to the side so that it is 15.0 cm higher and released, what will its speed be at the bottom of the swing?

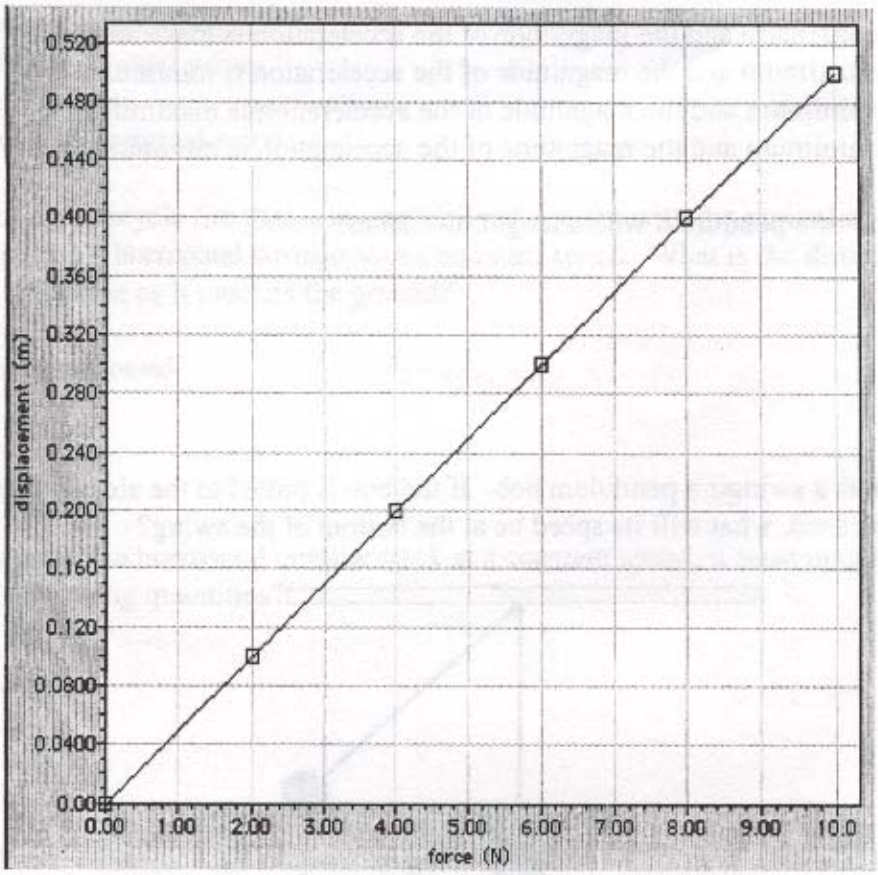


A. 1.21 m/s
B. 1.72 m/s
C. 2.94 m/s
D. 17.2 m/s

19. Students place a spring that has a spring constant of 22.0 N/m in a horizontal position on a highly polished surface. They fasten one end rigidly in position and attach a 17.0 g mass to the free end. If the spring is compressed 25.0 cm and released, what speed will the mass have when it passes through the equilibrium position?

A. 8.99 m/s
B. 18.0 m/s
C. 80.9 m/s
D. 324 m/s

20. Students exerted forces on a spring and measured the resulting stretch of the spring. They created the following graph.



According to this graph, what is the spring constant (k)?

A. 0.0500 N/m
B. 0.200 N/m
C. 4.00 N/m
D. 20.0 N/m

21. Which of the following statements best describes the ratio of the cube of the orbital radius of a planet to the square of the planet's orbital period?

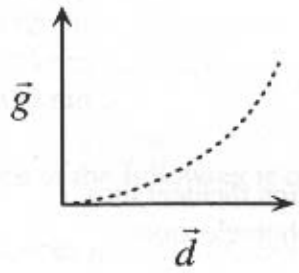
A. It changes as the planet moves around in its orbital path.
B. It is greatest for the most massive planets.
C. It is greatest for the least massive planets.
D. It is the same for all planets in the same solar system.

22. An astronaut releases an apple in a space shuttle that is orbiting 6.37×10^6 m above the surface of the Earth. Relative to the space shuttle, the apple will:

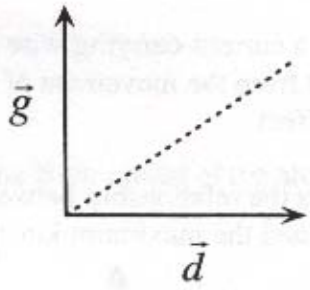
A. accelerate toward earth
B. move forward at a constant velocity
C. accelerate toward the back of the shuttle
D. remain stationary

23. As an object moves away from the surface of the Earth, which sketch below best represents the gravitational field intensity as the displacement from the centre of the Earth increases?

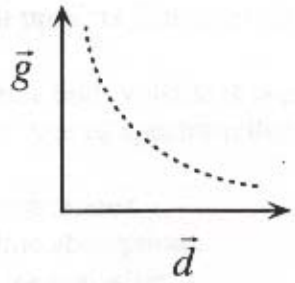
A.



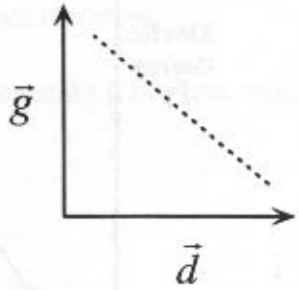
B.



C.



D.



24. An electron is moving in the plane of this page. It is moving toward the bottom of the page. A magnetic field is directed upward out of the plane of this page. What will be the direction of the force on the electron?

A. upward out of the page
B. downward into the page
C. to the left of the page
D. to the right of the page

25. Which of the following will decrease the strength of a magnetic field created by a solenoid that has fifty turns?

A. add a ferromagnetic core
B. increase the current flow
C. increase the diameter of the coil
D. increase the number of coils

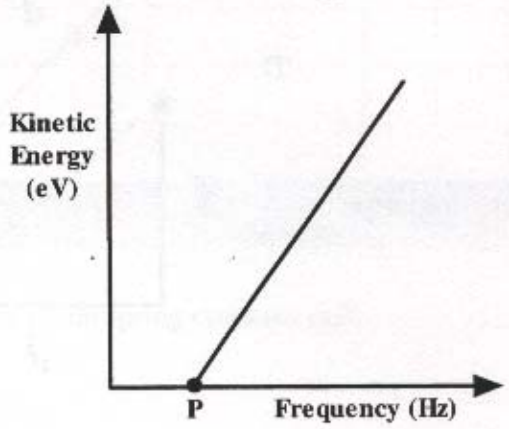
26. A long-distance power line operates at 600 kV. A factory needs the voltage to be 120 kV. The transformer used to change the voltage has 500 turns in the primary coil. Which of the following alternatives correctly gives the number of turns in the secondary coil and the type of transformer?

A. 100 turns, step down
B. 100 turns, step up
C. 2500 turns, step down
D. 2500 turns, step up

27. The operation of an electric motor depends on which of the following effects?

A. the Doppler effect
B. the force acting on a current-carrying wire in a magnetic field
C. the induced current from the movement of a wire in a magnetic field
D. the photoelectric effect

28. The graph below shows the relationship between the frequency of radiation incident on a photosensitive surface and the maximum kinetic energy of the emitted photoelectrons.



What does point P represent?

A. fundamental frequency
B. photoelectron frequency
C. photon escape frequency
D. threshold frequency

29. The work function of a particular photo-emissive material is 4.0 eV. If photons with 16 eV of energy are incident on the material, what would be the maximum kinetic energy of the ejected photoelectrons?

A. 0.25 eV
B. 4.0 eV
C. 12 eV
D. 20. eV

30. Calculate the wavelength of a photon with 3.2×10^{-19} J of energy.

A. 210 nm
B. 420 nm
C. 530 nm
D. 620 nm

31. The Balmer series for hydrogen is comprised of transitions from higher levels to n = 2 level. If the first line in this series has a wavelength of 653 nm, what wavelength corresponds to the transition from n = 5 to n = 2?

A. 390 nm
B. 432 nm
C. 503 nm
D. 630 nm

32. Which of the following is considered a weakness of the Bohr model of the atom?

A. It does not describe any atom other than hydrogen.
B. It does not take into account electron mass.
C. It predicts that electrons will spiral away from the nucleus.
D. It predicts that outer electrons are heavier than inner electrons.

33. When a high voltage is applied to a low pressure gas causing it to glow, which of the following is the type of spectrum that will be produced?

A. continuous
B. line absorption
C. line emission
D. monochromatic

34. Of the following types of electromagnetic radiation, which is the most penetrating?

A. infrared
B. gamma
C. ultraviolet
D. visible light

35. Which type of decay does not result in a change of either mass number or atomic number?

A. alpha
B. beta
C. gamma
D. neutron

36. If a nucleus undergoes the process of alpha decay followed by beta decay, what will happen to the atomic number of the atom?

A. It will decrease by one unit.
B. It will decrease by two units.
C. It will increase by one unit.
D. It will increase by two units.

37. In a nuclear fission reaction, the loss of mass is 0.0075 kg. How much energy would have been released in this event?

A. 2.25×10^{3} J
B. 2.25×10^{6} J
C. 6.75×10^{11}J
D. 6.75×10^{14}J

38. In a nuclear fission reactor the fuel is surrounded by a moderator. What is the purpose of the moderator?

A. absorb neutrons
B. release neutrons
C. slow down neutrons
D. speed up neutrons

39. The modern CANDU reactor uses heavy water as:

A. coolant and fuel
B. coolant and moderator
C. control rods and coolant
D. fuel and moderator

40. Which of the following reactions best represents nuclear fusion?

A. ${}^{2}_{1}\mathrm{H}+{}^{2}_{1}\mathrm{H}\rightarrow{}^{4}_{2}\mathrm{He}$
B. ${}^{6}_{3}\mathrm{Li}+{}^{1}_{0}\mathrm{n}\rightarrow{}^{3}_{1}\mathrm{H}+{}^{4}_{2}\mathrm{He}$
C. ${}^{235}_{92}\mathrm{U}+{}^{1}_{0}\mathrm{n}\rightarrow{}^{144}_{56}\mathrm{Ba}+{}^{90}_{36}\mathrm{Kr}+2\,{}^{1}_{0}\mathrm{n}+\mathrm{energy}$
D. ${}^{239}_{92}\mathrm{U}\rightarrow{}^{239}_{93}\mathrm{Np}+{}^{0}_{-1}\mathrm{e}$

Constructed Response Questions

Total Value: 50

Read each question carefully and write your response in the space provided. Be as neat and organized as possible in order to get maximum marks for method.

Solutions to numerical problems must include:

appropriate formulae
correct substitution of values
final answer clearly indicated

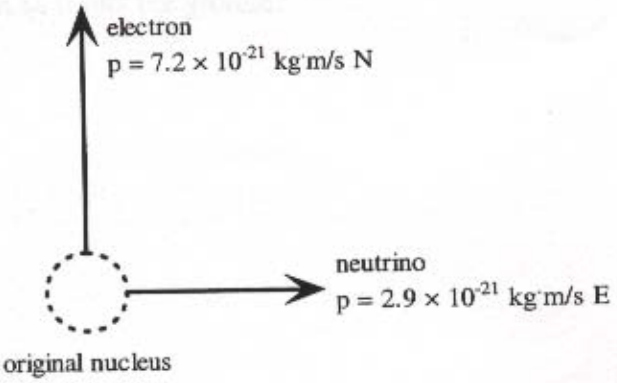
41. On a sunny afternoon, you are outside playing with your dog. You throw a tennis ball at an angle of 60.0° above the horizontal at an initial speed of 10.0 m/s and from an initial height of 2.00 m. If the dog was standing beside you when you threw the ball, how far would the dog have to run to catch the ball **just** as it hits the ground? **value: 7**

42. A space station is orbiting 250. km above the Earth's surface.

A) Determine the orbital speed of the space station. **value: 4**

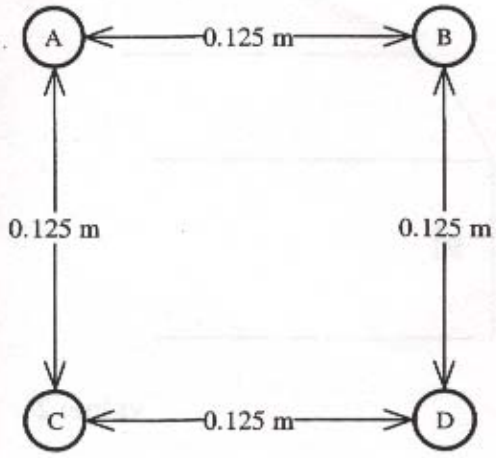
B) How many minutes does it take for each orbit? **value: 2**

43. An atomic nucleus, initially at rest, decays radioactively into three pieces that then travel in the same plane. Two of the pieces are shown below:

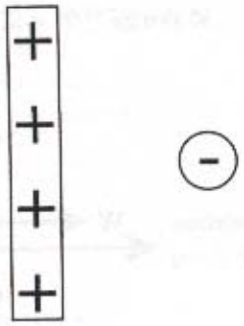


The remainder of the nucleus travels in an unknown direction. If the remainder of the nucleus has a mass of 2.8×10^{-25} kg, what is its velocity? Your solution **must** include a suitable momentum vector diagram. **value: 7**

44. Four +45.0 μC charges are arranged in a square as shown below. Determine the net force on charged particle C. Include in your answer a force vector diagram. **value: 7**



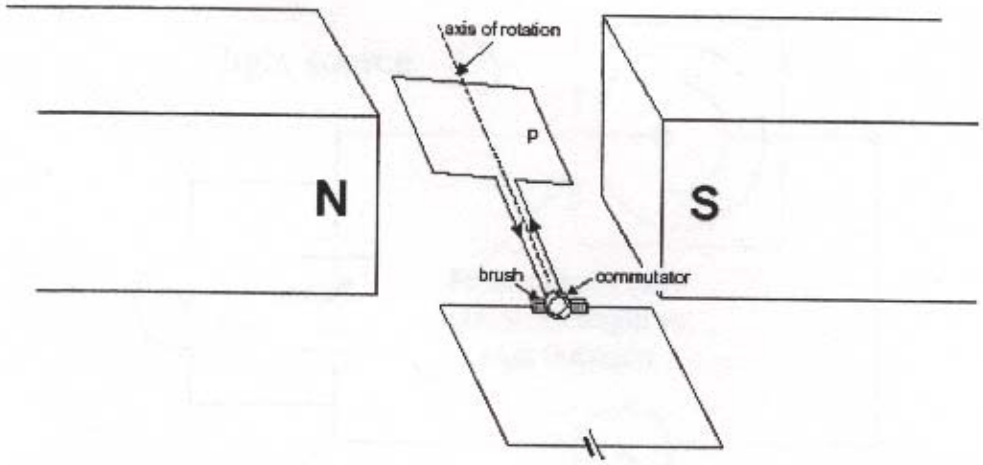
45. A) On the diagram below, draw in appropriate lines that show the electric field between the negatively-charged sphere and the positively-charged plate. **value: 2**



B) Why can "g" have units of N/kg or m/s^2? Explain. **value: 2**

C) Find the gravitational field strength, "g", acting on a satellite orbiting Earth with an orbital radius of 42 000 km. **value: 2**

46. The circuit of a simple DC electric motor is shown in the figure below. It consists of a current-carrying coil as the armature. The coil is square with sides of 0.05 m. The coil is in a uniform magnetic field of strength 0.005 T. A conventional current of 3.0 A flows through the coil in the direction shown in the diagram by the arrows.



A) When the coil is in the position shown in the diagram, indicate the direction of the force on side P of the wire. **value: 1**

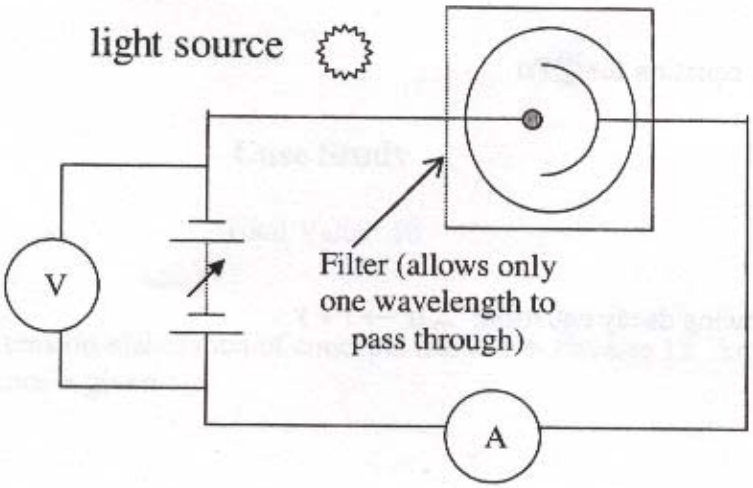
B) What happens to the direction of the force on side P when the direction of the current is reversed? **value: 1**

C) Give 2 different ways that the armature could be made to spin faster. **value: 2**

47. A) When you walk through a doorway, you represent a particle having momentum and, therefore, having a wavelength. Why is it improbable that you will be "diffracted" as you pass through the doorway? **value: 2**

B) Some science fiction writers use a large sail to enable a space vehicle to move through space. They argue that sunlight will exert pressure on the sail, causing it to move away from the sun. Explain which Quantum Theory experiment supports this claim and how. **value: 2**

47. C) According to the wave theory of light, increasing the light intensity shone on a photo-emissive surface should increase the kinetic energy of emitted electrons. Experiments with the apparatus seen below showed that when the light intensity was increased, the ammeter reading increased, however the maximum kinetic energy of the emitted electrons did not change.



Describe how Einstein explained this result. **value: 4**

48. A) Write an alpha decay equation for $^{223}_{88}\mathrm{Ra}$. **value: 2**

B) Write a beta decay equation for $^{218}_{84}\mathrm{Po}$. **value: 2**

C) Complete the following decay equation: $^{192}_{77}\mathrm{Ir} \rightarrow ? + \gamma$ **value: 1**

Case Study

Total Value: 10

This section is an extension/elaboration of concepts learned in Physics 12. Any additional information you require is given.

49.

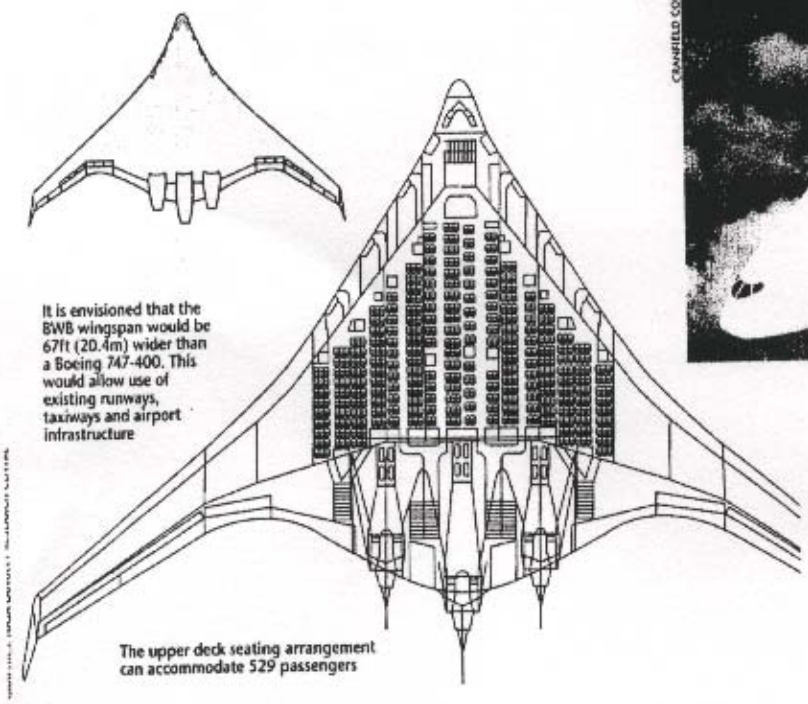
The Future of Long Distance Air Travel

Suppose you are about to fly to Paris. You will have to fly on a plane like the Boeing 747, a design that has been around for decades. Seating is cramped for the approximately four hundred people on board and the flight will take seven hours. A few years ago, you could have jumped on a supersonic Concorde with about one hundred people and been in Paris in three hours. Unfortunately Concordes were expensive to operate, notoriously noisy and dirty, and required speeds at take-off and landing that put extreme loads on the tires.

By 2025, air travel will be considerably different. Current estimates are that the demand for air travel will at least double. One solution would be to increase the number of flights, but that would require more runways and more fuel. An alternative would be to build bigger planes that carry more passengers. The bigger planes would require less fuel per passenger and minimal changes to existing airport facilities.

Most of the aircraft designed since the 1950's have been refinements of the common tubular fuselage type. In 2006, the Airbus company will deliver the first of its A-380 models, which is also based on the tubular fuselage design. The main difference is that the new Airbus will have two decks running the full length of the fuselage. It will have a capacity of five hundred and fifty passengers. Existing engine technology needs little modification to meet this new demand. Flying from existing terminals with minor modifications, passengers will be able to eat in restaurant-style seating, work in office-style cubicles, or stretch out for a relaxing sleep. There will even be recreational facilities for children and an exercise room.

BWB - the one wing wonder of the future



49.

Another possibility to accommodate a larger seating capacity involves a blended-wing body design shown on the previous page. The design is based on the "flying wing" planes built in the 1940's by both German and American manufacturers. These "flying wing" planes were exceptionally stable during flight. They were also safer designs because the landing gear was not near the fuel tanks. This design has the engines, wing, and body integrated into a single lifting surface with the engines at the rear of the plane. There is no visible tail-rudder. It is similar in concept to the U. S. military's B-2 bomber, a stealth aircraft.

The blended wing design can be configured for up to eight hundred passengers. Proponents say that it would burn 27% less fuel than the four-engined Airbus and therefore reduce emissions. Due to the design of the plane, the load will be more evenly distributed. This will enhance the structural integrity of the plane. There are, however, design problems to overcome, relating to cabin pressure, propulsion, and high speed aerodynamics.

For any new design involving larger payloads, engineers have to consider the variables that govern lift. Variables that affect lift include: the density, viscosity, and compressibility of air; the velocity of the aircraft; the surface over which the air flows; the shape of the lifting surface; and the orientation within the airflow. This is a very complex relationship.

One way to deal with complex relationships is to represent many variables by a single variable. For example in the equation for lift, **L**, many factors are combined into a single variable called the lift coefficient, designated **Cl**.

$$L = Cl \times r \times \frac{v^2}{2} \times A$$

In the equation given above, the density is designated by the letter **r** and the letter **A** represents the wing area. The combination of terms $r \times \frac{v^2}{2}$ is called the **dynamic pressure**.

A) State three reasons why supersonic aircraft like the Concorde have not become more common. **value: 1**

49. B) How is a blended wing body aircraft visually different from the typical current airliner? **value: 1**

C) Suppose the designers want to try a blended wing body model with a shorter wingspan that effectively cuts the wing area to 3/4 its original size. Assuming all other factors remain unchanged, what effect will this have on the required velocity at takeoff? **value: 2**

D) One of the lift variables has a greater impact than the others. What is this factor and why is its impact larger? **value: 2**

49. E) In a perfect world, problems are solved with appropriate attention to the needs of society, the environment, and economic reality. In about 150-200 words, indicate which of the two new aircraft you think best meets all criteria and explain your reasoning. **value: 3 for content, 1 for presentation.**