NOVA SCOTIA
Department of Education
Evaluation Services

1416094

NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JUNE 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?

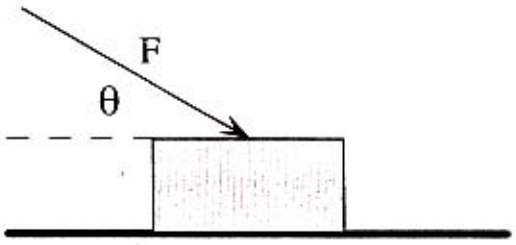
A. cubits
B. feet
C. inches
D. metres

Answer Sheet

A	B	C	D
○	○	○	●

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

1. The diagram below represents a constant force acting on a box that is located on a frictionless surface. As the angle θ between the force and the horizontal increases, the acceleration of the box will:



A. decrease proportionally with the cosine of the angle
B. decrease proportionally with the sine of the angle
C. increase
D. remain the same

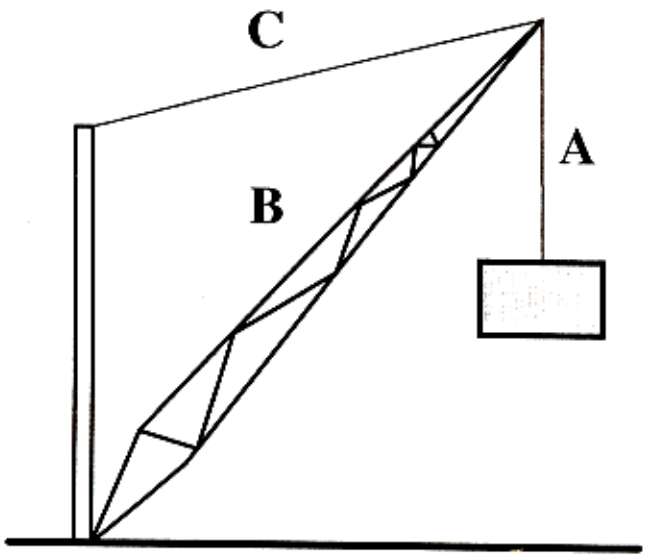
2. The driver of a motor boat points it directly toward the opposite bank of a 52 m wide river. The speed of the boat is 4.0 m/s and the river flows at 3.2 m/s. When the boat reaches the opposite riverbank, what is the magnitude of the displacement?

A. 42 m
B. 52 m
C. 67 m
D. 94 m

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?

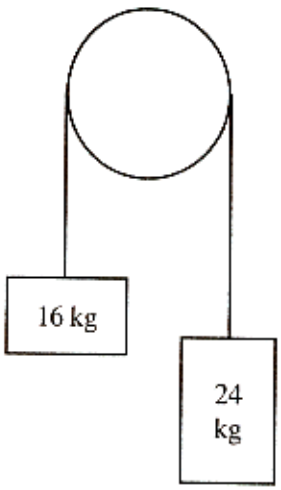
A. [N21.5°E]
B. [N21.5°W]
C. [N23.2°E]
D. [N23.2°W]

4. The diagram shows a typical boom crane used to unload ships. When the mass is being held stationary, which force will be the largest?



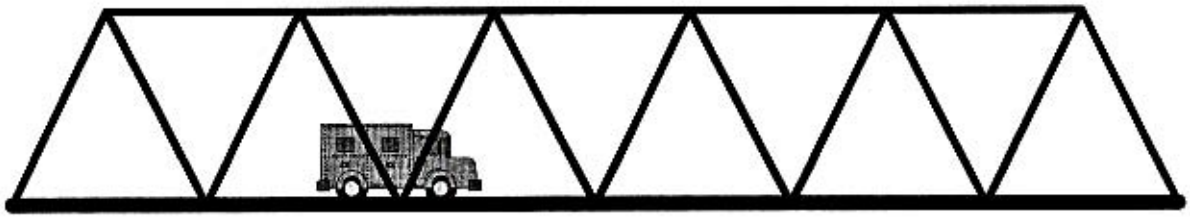
A. the tension in cable A
B. the tension in cable C
C. the thrust (or compression) in boom B
D. the weight of the object being lifted

5. The diagram below shows a rope that passes over a fixed frictionless pulley. Two masses are attached, as shown, and held in place. Which of the following is the magnitude of the acceleration that will result if the masses are released?



A. 2.0 m/s^2
B. 6.0 m/s^2
C. 10. m/s^2
D. 15 m/s^2

6. A truck is shown one third of the way across a bridge. How is the weight of the truck distributed between supports A and B?



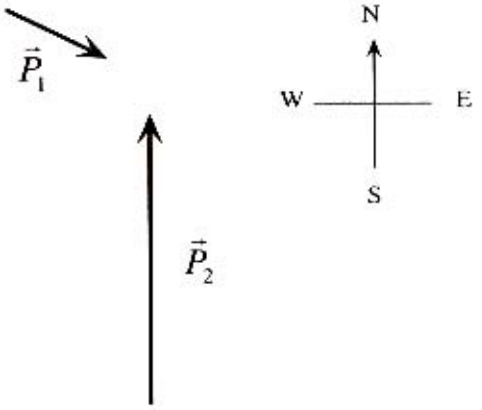
A B

A. The weight of the truck is equally shared between A and B.
B. The weight of the truck is distributed one third at A and two thirds at B.
C. The weight of the truck is distributed two thirds at A and one third at B.
D. The weight of the truck is distributed one ninth at B and eight ninths at A.

7. A curling stone travelling 10. m/s undergoes a two-dimensional elastic collision with an identical stationary stone. The target stone has a speed of 8.0 m/s after impact. What speed should the incident stone have after impact?

A. 2.0 m/s
B. 4.0 m/s
C. 6.0 m/s
D. 8.0 m/s

8. The diagram represents, in approximate scale, the momentum vectors of two objects before an inelastic collision. After the collision, what is the approximate direction of the motion of the combined masses?



A. East of North
B. West of North
C. East of South
D. West of South

9. A 4.00 kg mass moving at 10.0 m/s south collides with a stationary 8.00 kg mass. The 4.00 kg mass comes to a stop and the 8.00 kg mass breaks into two equal pieces. One piece moves at 7.08 m/s southeast. What is the velocity of the other piece?

   A. 2.92 m/s, southeast
   B. 2.92 m/s, southwest
   C. 7.08 m/s, southeast
   D. 7.08 m/s, southwest

10. The following statements relate to a collision between any two objects on a frictionless horizontal surface. Which one of the statements is **always true**?

   A. The kinetic energy of each object before and after the collision is the same.
   B. The momentum of each object before and after the collision is the same.
   C. The total kinetic energy of the two objects before and after the collision is the same.
   D. The total momentum of the two objects before and after the collision is the same.

11. The initial momentum of one object is 10.0 kg•m/s, west, and the initial momentum of a second object is 5.00 kg•m/s, south. What is the total momentum if they collide?

   A. 11.2 kg•m/s, [E26.6°S]
   B. 11.2 kg•m/s, [W26.6°S]
   C. 11.2 kg•m/s, [E63.4°S]
   D. 11.2 kg•m/s, [W63.4°S]

12. A student wants to see how the maximum height of a projectile is related to the launch angle. She does trials at 60° and 30° launch angles from the horizontal. Predict the ratio of the maximum heights for these two angles. $h_{60} : h_{30}$

   A. 0.577: 1
   B. 1.73:1
   C. 2:1
   D. 3:1

13. A projectile is fired at 50.0 m/s horizontally from the top of a high building. At what time will the vertical component of the instantaneous velocity be the same magnitude as the horizontal component of the instantaneous velocity?

   A. 4.47 s
   B. 5.10 s
   C. 7.07 s
   D. 10.2 s

14. For a given launch velocity, which of the following launch angles will give a projectile the same range?

    A. 15° and 30°
    B. 15° and 45°
    C. 15° and 60°
    D. 15° and 75°

15. When the displacement of an object moving in simple harmonic motion is greatest, the magnitude of the acceleration is at which of the following values?

    A. maximum
    B. minimum
    C. half the maximum
    D. halfway between the maximum and minimum

16. A 0.100 kg mass is suspended from a spring that has a force constant of 0.667 N/m. If the mass is pulled down and released, what will be the frequency of oscillation?

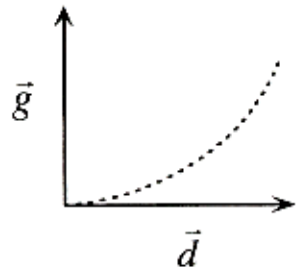
    A. 0.0616 Hz
    B. 0.411 Hz
    C. 0.942 Hz
    D. 2.43 Hz

17. If the mass and the length of a certain pendulum are both doubled, what effect will this change have on the period of the pendulum?

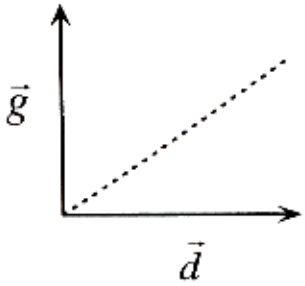
    A. 1.4 times the original
    B. 2.0 times the original
    C. 4.0 times the original
    D. remains the same

18. 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?

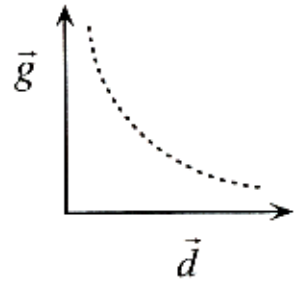
A.



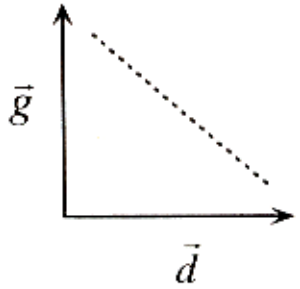
B.



C.



D.

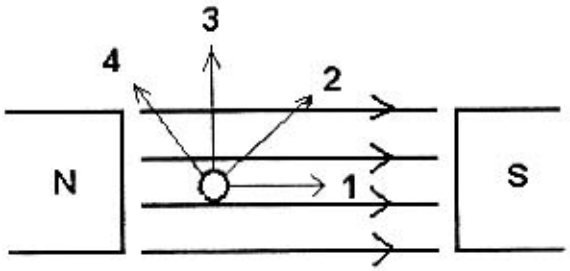


19. This diagram shows an electron in a magnetic field.

Under which of the following conditions will there be no magnetic force?

A. when the electron moves into the page
B. when the electron moves out of the page
C. when the electron moves to the right side of the page
D. when the electron moves toward the top of the page

20. The diagram below shows the cross section of a wire that is perpendicular to the page and is situated in a uniform magnetic field that is directed to the right. In which of the indicated directions should the wire be moved to induce maximum current?



A. 1
B. 2
C. 3
D. 4

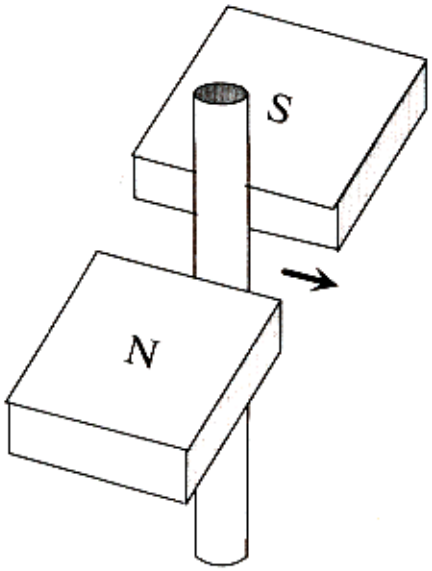
21. What are the magnitude and direction of the electric field at a distance of 1.20 m from a point charge of -0.0200 μC ?

A. 25.0 N/C toward the charge
B. 25.0 N/C away from the charge
C. 125 N/C toward the charge
D. 125 N/C away from the charge

22. One T (Tesla) is equivalent to:

A. 1 (N•m)/A
B. 1 (N•A)/m
C. 1 N•m•A
D. 1 N/(A•m)

23. The diagram below shows a wire moving from left to right through a permanent magnetic field. Which of the following statements best describes the resulting current?



A. Electrons will flow from bottom to top in the wire.
B. Electrons will flow from top to bottom in the wire.
C. Protons will flow from bottom to top in the wire.
D. Protons will flow from top to bottom in the wire.

24. Which statement best represents a definition of Lenz's law?

A. A conductor in a magnetic field experiences a force perpendicular to itself and the field.
B. The magnetic field of an induced current opposes the change in magnetic field causing it.
C. A current can be induced only when the magnetic field surrounding a conductor is changing.
D. The potential difference across a conductor is directly proportional to the current through it.

25. An ideal transformer (100% efficient) has 20 turns of wire in the primary coil and 40 turns of wire in the secondary coil. If 25 watts of power is supplied to the primary coil, what power is developed in the secondary coil?

A. 5.00 watts
B. 12.5 watts
C. 25.0 watts
D. 50.0 watts

26. In a certain transformer, the primary coil has 5.00×10^2 turns and the secondary coil has 1.50×10^3 turns. If the voltage applied to the primary coil is 5.33 volts, what is the voltage in the secondary circuit?

A. 1.78 V
B. 3.00 V
C. 3.33 V
D. 16.0 V

27. A circular loop of wire lies flat on a horizontal table. A bar magnet is held above its center with its North pole pointing down, and released. As it approaches the loop, the falling magnet induces (when viewed from above)

A. a clockwise flow of electrons in the coil
B. a counterclockwise flow of electrons in the coil
C. a flow of electrons whose direction cannot be determined from the information provided
D. no flow of electrons in the coil

28. Which principle best explains how a generator works?

A. conduction
B. induction
C. resonance
D. transfer of charge

29. What type of commutator is found in a simple AC generator?

A. "O"-ring commutator
B. slip ring commutator
C. split ring commutator
D. three ring commutator

30. Which of the following will NOT increase the amount of electrical energy produced by a generator?

A. increasing the number of windings on the armature
B. increasing the speed of rotation
C. increasing temperature in the windings
D. winding the armature on a soft iron core

31. A direct current source is used to operate an electric motor. Which of the following statements best explains what happens at each half rotation of the split ring commutator?

A. The current increases in the armature.
B. The direction of the current in the armature reverses.
C. The polarity of the magnetic field reverses.
D. The strength of the field magnet increases.

32. The current in the armature of an electric motor switches direction with every half rotation. Which part of the motor produces this effect?

A. armature
B. commutator
C. iron core
D. magnets

33. In 1923, Louis-Victor deBroglie suggested which of the following?

A. An object's momentum and position cannot be determined at the same time.
B. Any mass can be totally converted into energy.
C. Luminous objects radiate visible light only at specific discrete frequencies.
D. Material particles have wave properties.

34. What is the term used to refer to the minimum energy required for a photoelectron to escape from a metal plate in a photocell?

A. incident frequency
B. Planck's constant
C. threshold frequency
D. work function

35. Threshold frequency is to work function as hertz is to which of the following?

A. coulomb
B. joule
C. newton
D. watt

36. Electrons are emitted from a photoelectric surface only when the incident light is higher than a value called the threshold frequency. Above this frequency, what happens to the current of electrons when the intensity of incident light increases?

A. cannot be determined
B. decreases
C. increases
D. remains the same

37. When electromagnetic radiation with a wavelength of 350 nm falls on a metal, the maximum kinetic energy of the ejected electrons is 1.20 eV. What is the the work function of the metal?

A. 1.3 eV
B. 2.4 eV
C. 5.4 eV
D. 5.7 eV

38. 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

39. Which of the following is the minimum material needed to stop beta particles?

A. air alone
B. paper
C. plastic sheet
D. lead block

40. 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

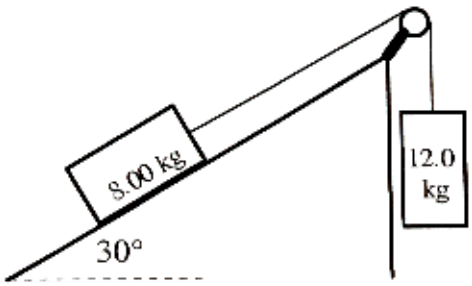
Constructed Response Questions

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
reasonable attention paid to significant figures



coefficient of friction is 0.200

41.

The system shown above is held at rest. If it is released, what will be the magnitude of the acceleration of the system? Draw a clear free-body diagram for each mass as part of your solution. **value: 7**

42. A soccer ball is kicked into the air at a speed of 20.0 m/s and an angle of 37.0° from the horizontal and lands on the same level ground.

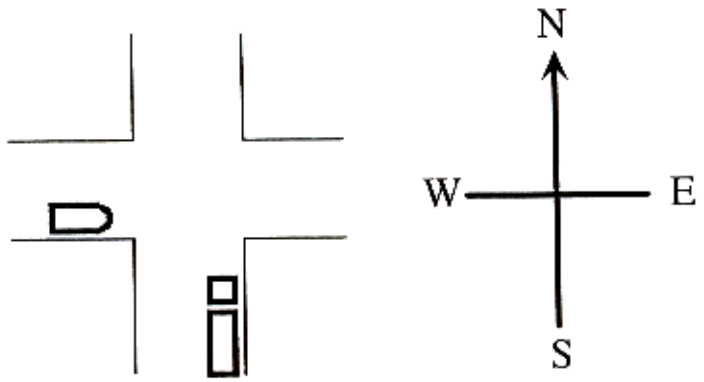
A) What is the total time the soccer ball is in the air? **value: 2**

B) What is the range? **value: 2**

C) What is the maximum height reached by the soccer ball? **value: 2**

D) What are the components of the velocity as it hits the ground? **value: 1**

43. A 2140 kg minivan, traveling East at 20.0 m/s, collides with a 4280 kg truck, traveling North at 30.0 m/s. The two vehicles remain stuck together after impact.

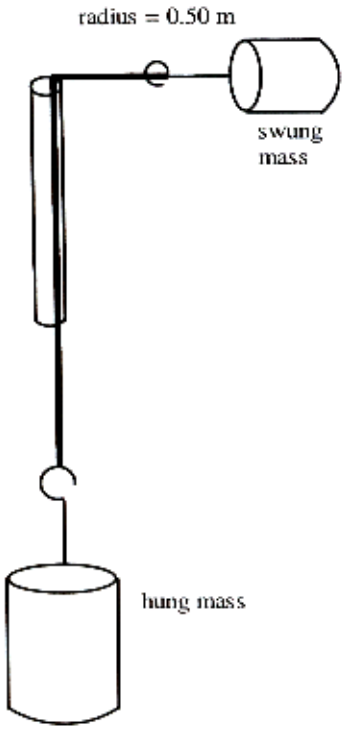


A) In the space provided, construct and label an appropriate scaled momentum vector addition diagram. **value: 2**

43.

B) Determine the velocity of the combined mass immediately after impact. **value: 3**

44. Two students were conducting centripetal force trials in an experiment in which a mass is rotated in a circular path on a string above the head. The string is passed through a vertical glass tube to a mass hanger which is loaded so that the vertical pull on the mass hanger just provides the centripetal force needed to prevent the swung mass from flying off in a straight line. The swung mass was kept in a circle of 0.50 m radius. They decided to determine the frequency of each trial. The following table summarizes average trial data.



Hung Mass (kg)	**f (Hz)**	**v (m/s)**	**v^2 (m^2/s^2)**
0.200	1.00	3.14	9.86
0.500	1.55	4.87	23.7
0.750	1.85	5.81	33.8
1.00	2.25	____	____
1.25	2.50	7.85	61.6
1.65	2.85	8.95	80.1

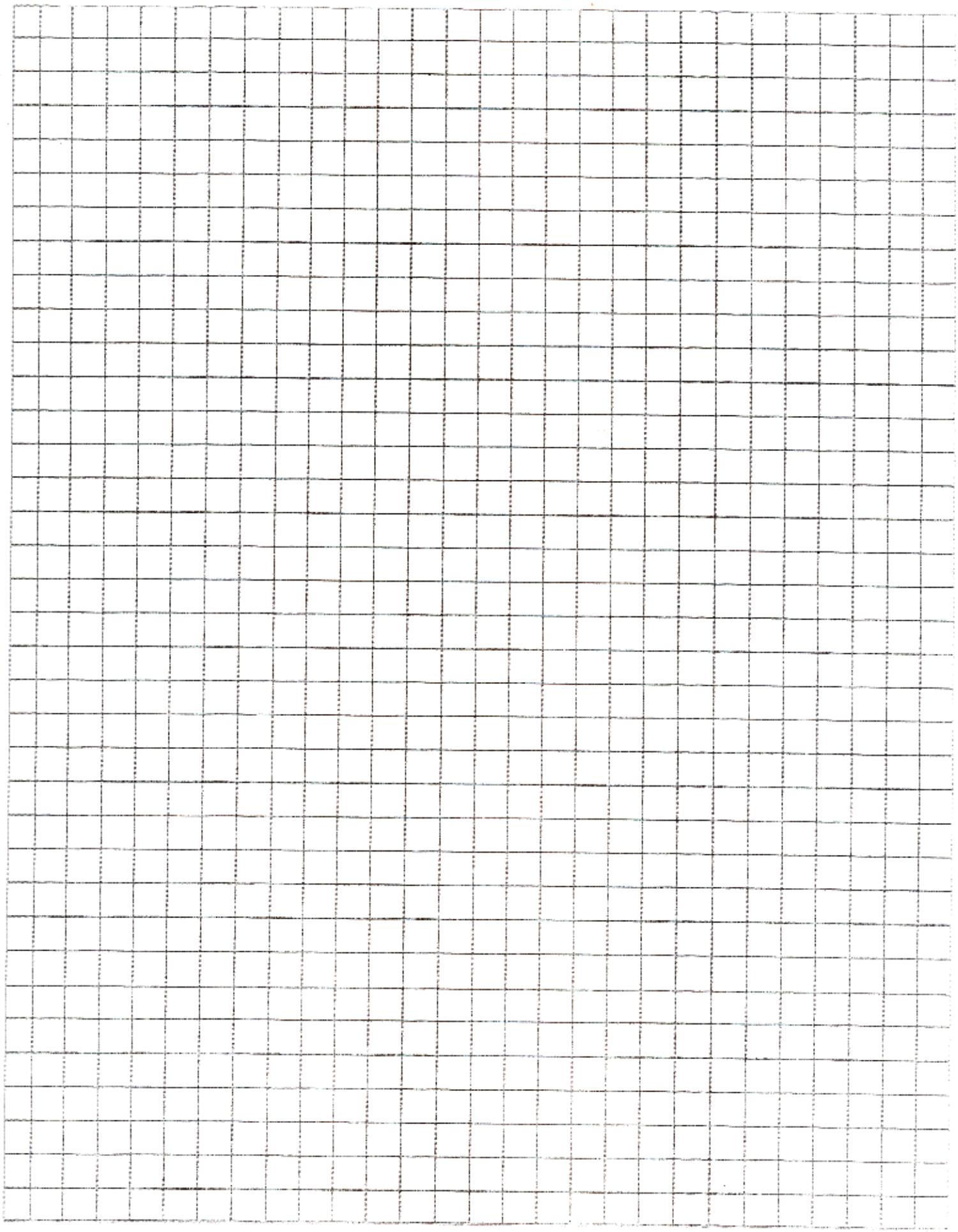
A) Calculate the values for the velocity, v, and velocity squared, v^2, when the hung mass was 1.00 kg. **value: 1**

B) Plot a graph of F_c vs v^2 on the grid on the next page and show the line of best fit. **value: 3**

C) Determine the slope of the line of best fit for this graph. **value: 2**

D) Using your answer from C, determine the mass being **swung**. **value: 1**

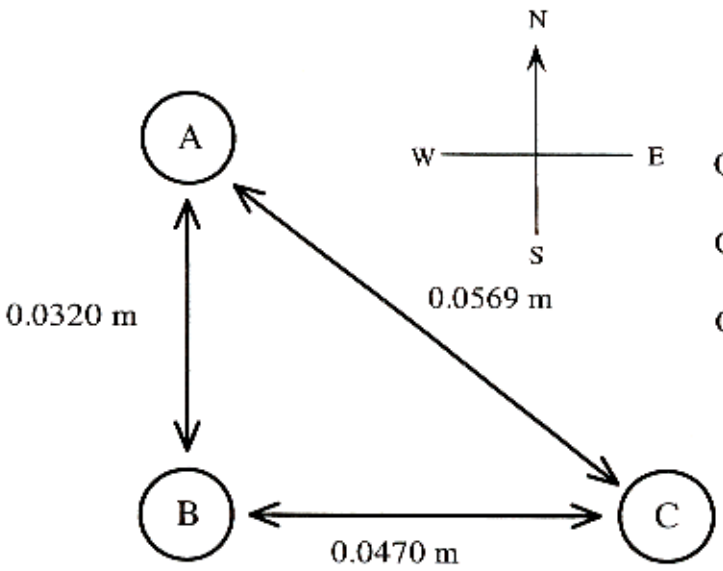
44.



45. A) On a certain rollercoaster, the cars travel on the inside of a vertical loop that starts at ground level and reaches a maximum height of 30.0 m. What minimum speed must the cars have at the highest point in order to successfully complete the loop? **value: 2**

B) Draw and label a free body diagram for a person at the top position who is traveling faster than the minimum speed. **value: 1**

46.

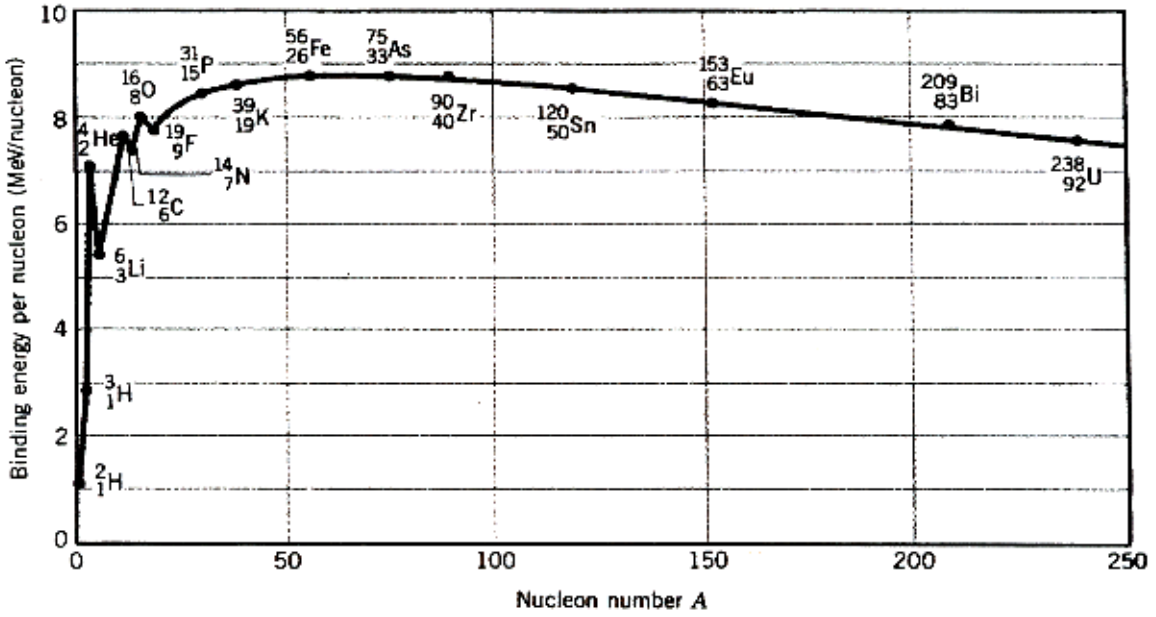


Determine the net force on sphere B. **value: 5**
Include a labelled force vector addition diagram in your solution.

47. A) An electron in a hydrogen atom drops from the third energy level to the second energy level. Calculate the energy emitted in both electron volts and joules. **value: 3**

B) The visible spectrum falls between 450 nm and 750 nm. Show that the energy emitted in part (A) falls in the visible spectrum. **value: 2**

48. Following is a graph of binding energy per nucleon vs nucleon number.



A) Which element has the highest binding energy per nucleon? **value: 1**

B) Fusion reactions release more energy per unit mass than fission reactions. How does the graph support this statement? **value: 2**

48. C) What is the mass defect in atomic mass units of a helium nucleus of mass 4.001506 μ ?

value: 2

D) What is the binding energy of the helium nucleus? **value: 1**

49. A) Write an alpha decay equation for $^{238}_{92}\mathrm{U}$. **value: 2**

B) Write a beta decay equation for $^{14}_{6}\mathrm{C}$. **value: 2**

C) Complete the following decay equation. $\_\_\_\_ \rightarrow {}^{58}_{29}\mathrm{Cu} + \gamma$ **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.

50. Tycho Brahe (1546–1601) was the last and perhaps greatest astronomer to work without a telescope. Brahe built a device called a quadrant, which allowed him to measure the angular position of a star to an accuracy of 1/1000 of a degree. Over a period of more than twenty years, Brahe collected amazingly accurate data on the movements and positions of planets, stars, and comets. These observations called into serious question the existing theory of the geocentric (Earth-centered) universe.

Shortly before his death, Brahe chose a brilliant young mathematician named Johann Kepler (1571–1630) to become his assistant. Kepler attempted to use Brahe's data to support the accepted theory that planets moved around the Earth in perfect circles. In spite of his best efforts, the empirical evidence led him to a different conclusion: that the planets moved in elliptical orbits around the Sun.

Although Kepler was able to show how the planets' orbital periods and radii were related, no theory existed to explain why. Edmund Halley (1656–1742) had been performing calculations that showed that the gravitational force between the planets and the sun decreased with the square of their distance from the sun. He was not able to see how the data could be used to support the elliptical orbits suggested by Kepler. Halley asked Isaac Newton (1642–1727), a contemporary, how the inverse square relationship would relate to the elliptical shape of the orbits. To his surprise, Newton claimed to have already made these calculations years earlier. Halley asked Newton to repeat the calculations and within three months Halley had his answer. The inverse square calculations supported elliptical orbits.

Three years later, Newton published *Principia,* his work on the mathematical principles of natural philosophy, which included both his laws of gravity and motion. Newton was able to develop a relationship that showed how Kepler's constant was related to the mass of the body about which the satellites orbit.

Henry Cavendish (1731–1810) followed up Newton's work. His experiments with a torsion pendulum produce extremely accurate results given the technology of the day. With his torsion pendulum, Cavendish was able to determine the value of what we now call the Universal Gravitational constant. His calculated value was within approximately 1% of the currently accepted value.

50.

Planet	Mass ($\times 10^{24} kg$)	Satellite	Orbital Radius ($\times 10^{6} m$)	Period ($\times 10^{6} s$)	Kepler's Constant ($m^3 s^{-2}$)
Earth	5.98	Moon	384.4	2.36	_____
Mars	0.637	Phobos	9.38	0.0276	1.08×10^{12}
		Deimos	23.46	0.109	1.09×10^{12}
Jupiter	_____	Thebe	221.9	0.0583	3.21×10^{15}
		Io	421.6	0.153	3.20×10^{15}
		Europa	670.9	0.307	3.20×10^{15}
		Elara	11737	22.4	3.20×10^{15}
Saturn	567	Janis	151.47	0.0600	9.65×10^{14}
		Mimas	185.54	0.0814	9.64×10^{14}
		Calypso	294.67	0.163	9.63×10^{14}
Uranus	88.0	Miranda	129.4	0.122	1.46×10^{14}
		Ariel	191.0	0.218	1.47×10^{14}
		Oberon	583.5	1.16	1.48×10^{14}
Neptune	103	Triton	355.3	0.508	1.74×10^{14}
		Nereid	5510	31.1	1.73×10^{14}
Pluto	0.600	Charon	19.7	0.552	_____

A) Calculate Kepler's constant for the Earth, and also for Pluto. **value: 2**

50.

B) What evidence in the article shows the importance for scientific progress of teamwork, communication, and the questioning of accepted ideas? **value: 3**

C) Brahe's observations, Kepler's analysis, and Newton's law of gravity led to a theory that explains the movements of the planets. By equating $F_g = F_c$, show that Kepler's constant, k, is equal to $\frac{Gm_{planet}}{4\pi^2}$. **value: 3**

50. D) Calculate the mass of Jupiter. **value: 2**