NOVA SCOTIA
Department of Education
Testing and Evaluation

NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JANUARY 2002

Comment Box—For Use by Teacher

What accommodations have been made?

By whom?

Position/Title:

Why?

Name:_____

General Instructions

This examination is composed of three sections, with an estimated time allotment as listed below:

Question Type	value	Suggested Time
Selected Response	40	60 minutes
Constructed Response	50	90 minutes
Case Study	10	30 minutes

NOTE: Times are suggestions only

Total time: 3 hours

Calculators are permitted, but are not to be shared.

Selected Response Questions
(Total Value: 40)

In this part of the examination, there are 40 multiple choice questions, each with a value of one point. Read each question carefully and decide which of the choices best answers the question asked. You are provided with a separate response form. Fill in the space that corresponds to your choice. Use HB pencil only.

Fill in the answers to the multiple choice questions in this part of the examination in 1 to 40 of section 1 on side 1 of the response form. At the completion of the examination, place the response form in the examination booklet.

Example

Which unit is an SI unit of distance?
A. feet
B. inches
C. metres
D. cubits

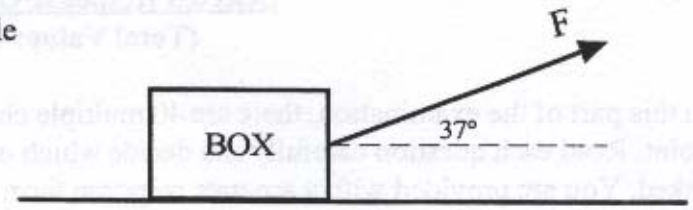
Answer Sheet

A	B	C	D
○	○	●	○

If you wish to change an answer, erase your first mark completely.

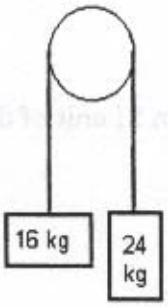
Do not turn the page to start the examination until told to do so by the presiding examiner.

1. The diagram at the right shows a box being pulled along a surface by a force F at an angle of 37° to the horizontal. If the resulting horizontal component in the direction of motion is 60. N, what is the value of F?



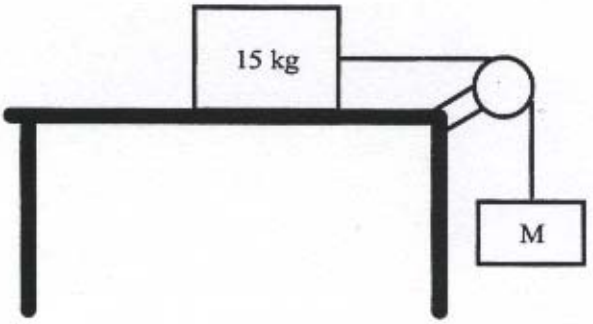
A. 36 N
B. 48 N
C. 75 N
D. 100 N

2. The diagram at the right 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

3. In the system shown at the right, what mass, M, will give the system an acceleration of 2.0 m/s^2, if the system is frictionless?



A. 1.5 kg
B. 2.5 kg
C. 3.1 kg
D. 3.8 kg

4. A large carton is observed to be sliding down a frictionless ramp that makes a 37° angle with the ground. Which of the following statements best describes the force that acts in the direction of motion?

A. The force acting in the direction of motion is 60% of the weight of the carton.
B. The force acting in the direction of motion is 75% of the weight of the carton.
C. The force acting in the direction of motion is 80% of the weight of the carton.
D. The force acting in the direction of motion is 100% of the weight of the carton.

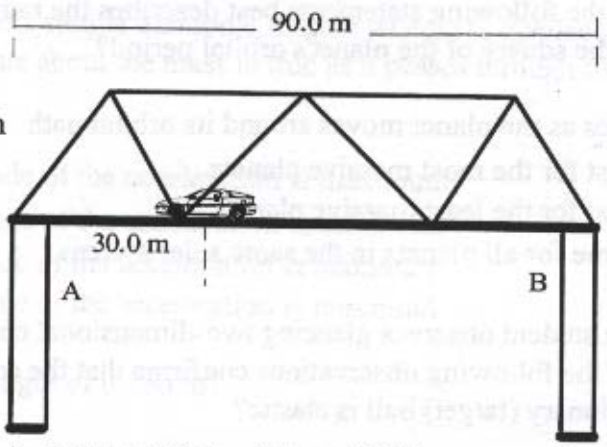
5. An object was subjected to several forces: 50. N pulling east, 40. N pulling south, 85 N pulling west, and 55 N pulling north. What is the magnitude of the resultant force?

A. 15 N
B. 25 N
C. 38 N
D. 42 N

6. A plumber pulls perpendicularly with a force of 50.0 N on the handle of a wrench with an effective length of 40.0 cm. What is the magnitude of the torque produced?

A. 1.25 N•m
B. 20.0 N•m
C. 200 N•m
D. 2000 N•m

7. A car is shown 30.0 m from the end of a 90.0 m long flat bridge. Which of the following statements best describes how the weight of the car is distributed between the two supports?



A. One-third of the weight is supported at A, and two-thirds of the weight is supported at B.
B. Two thirds-of the weight is supported at A, and one-third of the weight is supported at B.
C. One-quarter of the weight is supported at A, and three-quarters of the weight is supported at B.
D. Three-quarters of the weight is supported at A, and one-quarter of the weight is supported at B.

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

A. 23.2° east of north
B. 23.2° west of north
C. 21.5° east of north
D. 21.5° west of north

9. A student runs on a circular track that has a radius of 135 m. If her acceleration is 0.60 m/s^2, what is her speed?

A. 7.0 m/s
B. 9.0 m/s
C. 15 m/s
D. 81 m/s

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

A. It will increase by a factor of 2.
B. It will increase by a factor of 4.
C. It will increase by a factor of 8.
D. It will increase by a factor of 16.

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

12. A physics student observes glancing two-dimensional collisions 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.

13. 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.

14. 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?

A. 11.2 kg• m/s, 26.6° south of east
B. 11.2 kg• m/s, 26.6° south of west
C. 11.2 kg• m/s, 63.4° south of east
D. 11.2 kg• m/s, 63.4° south of west

15. An astronaut releases a 325 g apple in a space shuttle that is orbiting 6.37×10^6 m above the surface of the Earth. What is the acceleration of the apple?

A. 2.45 m/s^2
B. 4.90 m/s^2
C. 9.80 m/s^2
D. 19.6 m/s^2

16. A mass hanging vertically on a spring exibits simple harmonic motion when it is displaced and released. Which of the following statements about the mass is true as it passes through the equilibrium 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 0.750 m?

A. 0.481 s
B. 1.74 s
C. 4.71 s
D. 5.44 s

18. Object X has a mass of 2.00 kg and moves with a velocity of 3.00 m/s, east. Object Y has a mass of 1.75 kg and moves with a velocity of 5.00 m/s, north. The two objects collide and stick together. After the collision, what is the system's direction of motion?

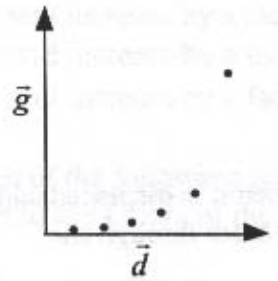
A. east of north
B. west of north
C. east of south
D. west of south

19. A yellow curling stone is travelling east along a sheet of ice. It collides with a stationary red stone of identical mass. The red stone leaves the collision in a direction between east and south. Which of the following statements describes the direction of the yellow stone after the collision?

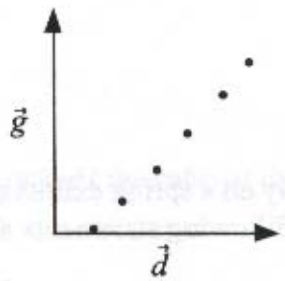
A. It must leave the collision with a direction between east and north.
B. It must leave the collision with a direction between east and south.
C. It must leave the collision with a direction between west and north.
D. It must leave the collision with a direction between west and south.

20. Which diagram represents the gravitational field intensity as the displacement from the centre of the Earth increases?

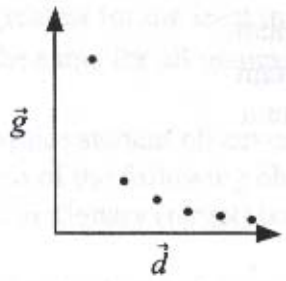
A.



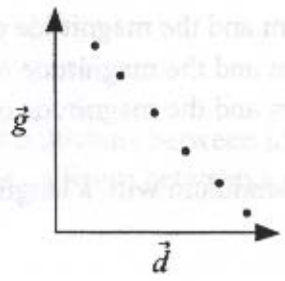
B.



C.



D.



21. The force of gravity on an unidentified planet acts on two objects, X and Y. Object X has one-half the mass of Object Y and is one-half as far from the centre of the planet as Object Y. What is the ratio of the force of gravity on Object X compared to the force of gravity on Object Y?

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

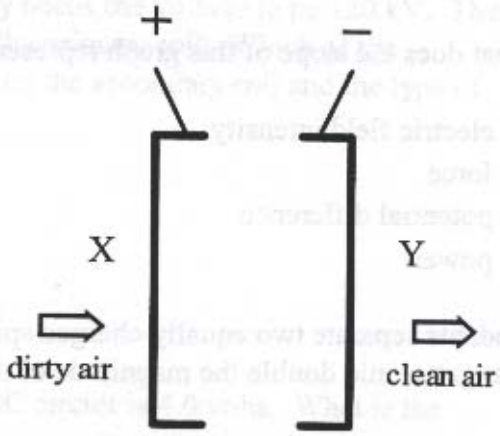
22. An object that has a net excess charge of 5 positive elementary charges is picked up by a student and becomes neutral. What is the best hypothesis to explain this change in charge condition?

A. The object gained five electrons from the student.
B. The object gained five protons from the student.
C. The object lost five electrons to the student.
D. The object lost five protons to the student.

23. If a strip with a **very large** positive charge is moved gradually toward the knob of an electroscope with a **small** negative charge, what will the leaves of the electroscope do?

A. converge and then diverge
B. converge only
C. diverge and then converge
D. diverge only

24. The sketch at the right shows the basic parts of an electrostatic dust precipitator found in industry and some household air cleaners. Air laden with dust particles is fed through the positive grid (X) where friction and electrostatic force remove electrons from the particles and they leave the grid positively charged. The negatively-charged grid (Y) then removes the particles from the air stream.



Electrostatic Precipitator

When the dust particles are between grids X and Y, they are:

A. repelled by grid X and each other, but attracted to grid Y
B. repelled by grid Y and each other, but attracted to grid X
C. repelled by grid X, but are attracted to each other and grid Y
D. repelled by grid Y, but are attracted to each other and grid X

25. Suppose a metal sphere has a net excess charge of +5 elementary charges. What is the net electric charge in coulombs?

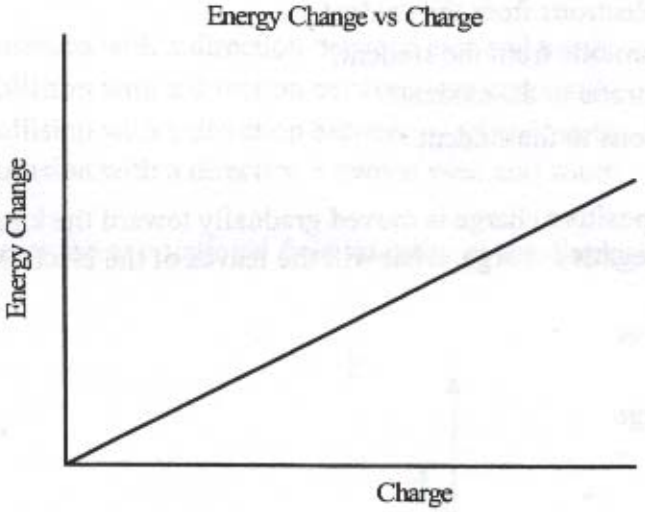
A. 1.6×10^{-19} C

B. 3.2×10^{-19} C

C. 5.0×10^{-19} C

D. 8.0×10^{-19} C

26. A student measured the energy gained by a variety of charged objects moving through an electric field. The data produced the following graph.



What does the slope of this graph represent?

A. electric field intensity
B. force
C. potential difference
D. power

27. Students separate two equally-charged spheres by a distance of 0.02 m. Which of the following changes would double the magnitude of the electric force between the two spheres?

A. decrease the separation to 0.01 m
B. double the magnitude of either charge
C. halve the magnitude of both charges
D. increase the separation to 0.04

28. What is the electric force between an electron and a proton that are separated by 2.0×10^{-9} m?

A. 1.2×10^{-19} N
B. 5.8×10^{-11} N
C. 7.2×10^{-1} N
D. 3.6×10^{8} N

29. A proton is moving in the plane of this page. It is moving towards the top of the page. A magnetic field is directed upwards out of the plane of the page. What will be the direction of the force on the proton?

A. upwards out of the page
B. downwards into the page
C. to your left
D. to your right

30. Which of the following will **decrease** the strength of the magnetic field created in 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

31. 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 on the primary coil. Which of the following statements correctly gives the number of turns on the secondary coil and the type of transformer?

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

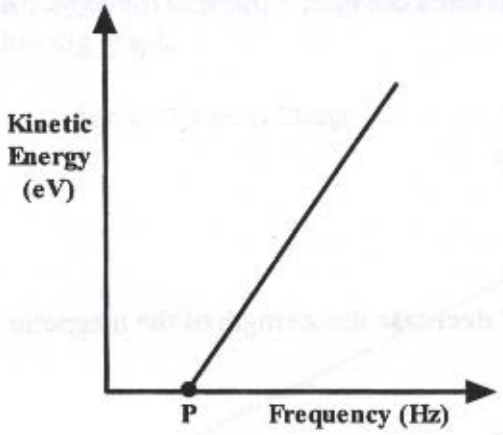
32. The potential difference across a 12.0 ohm resistor in a DC circuit is 4.0 volts. What is the current in the resistor?

A. 0.33 amperes
B. 1.0 ampere
C. 3.0 amperes
D. 48 amperes

33. In a DC circuit, what does a voltmeter measure when it is connected across a resistor?

A. energy lost per ampere of current passing through the resistor
B. energy lost per coulomb of charge passing through the resistor
C. energy gained per ampere of current passing through the resistor
D. energy gained per coulomb of charge passing through the resistor

34. 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

35. The work function of a particular photoemissive 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

36. 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

37. If an electron is emitted from a nucleus during the process of 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.

38. In a fission reaction, the loss of mass was 0.0075 g. 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

39. Which of the following reactions represents nuclear fusion?

A. ${}_1^2H + {}_1^2H \rightarrow {}_2^4He + \text{energy}$
B. ${}_3^6Li + {}_0^1n \rightarrow {}_1^3H + {}_2^4He$
C. ${}_{92}^{239}U \rightarrow {}_{93}^{239}Np + {}_{-1}^{0}e$
D. ${}_{92}^{235}U + {}_0^1n \rightarrow {}_{56}^{144}Ba + {}_{36}^{90}Kr + 2{}_0^1n + \text{energy}$

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. Solutions to numerical problems must include:

- ✓ ***appropriate formulae***
- ✓ ***correct substitution of values***
- ✓ ***final answer clearly indicated***

41. A player kicks a soccer ball toward the goalkeeper at an initial speed of 14.7 m/s and at an angle of 37° from the horizontal. The kicker is 26.0 m from the goalkeeper.

A) How far from the goalkeeper will the ball hit the ground? **value: 5**

B) If the goalkeeper watches the ball until it reaches maximum height, then runs at constant speed to intercept the ball just as it strikes the ground, how fast must the goalkeeper run? **value: 2**

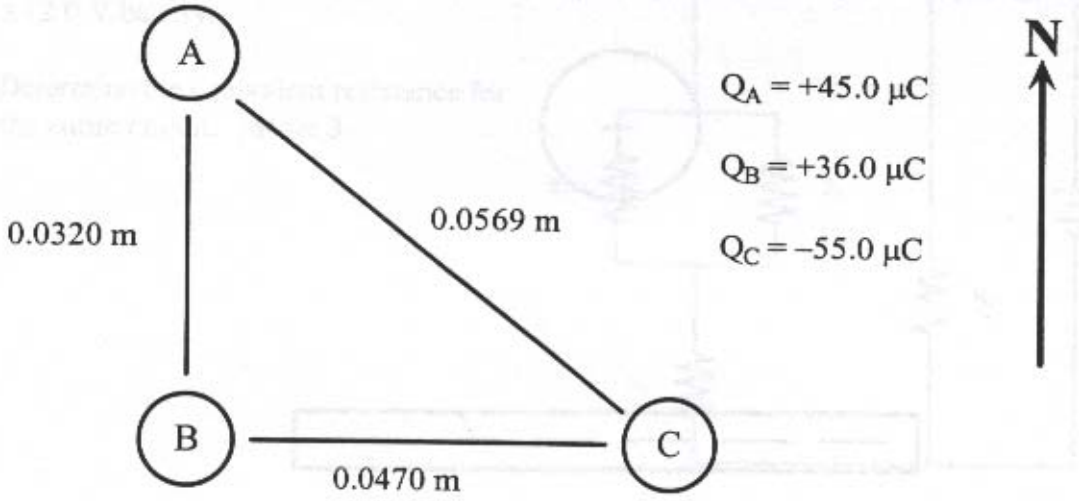
42. A satellite is 5.0×10^6 m above the surface of Jupiter. The radius of Jupiter is 7.18×10^7 m and the mass of Jupiter is 1.90×10^{27} kg.

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

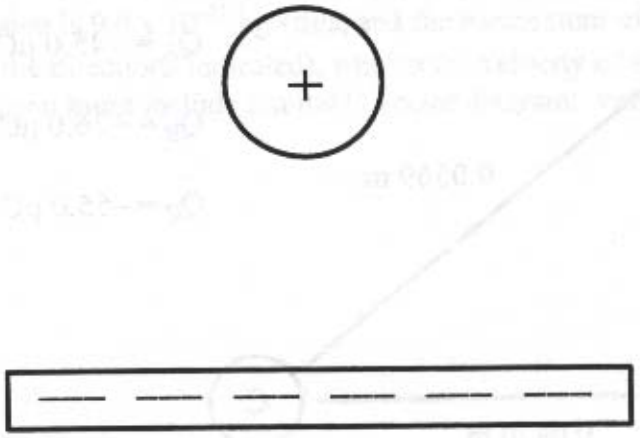
B) Determine the period of the satellite. **value: 2**

43. An atomic nucleus, initially at rest, decays radioactively into three parts that then travel in the same plane. An electron is emitted to the east, and a neutrino to the south, while the remainder of the nucleus, mass 3.6×10^{-25} kg, travels in an unknown direction. If the momentum of the electron after the explosion is 9.0×10^{-21} kg • m/s, and the momentum of the neutrino is 4.8×10^{-21} kg • m/s (in the directions indicated), what is the **velocity** of the remaining piece of the nucleus? Your solution **must** include a suitable vector diagram. **value: 7**

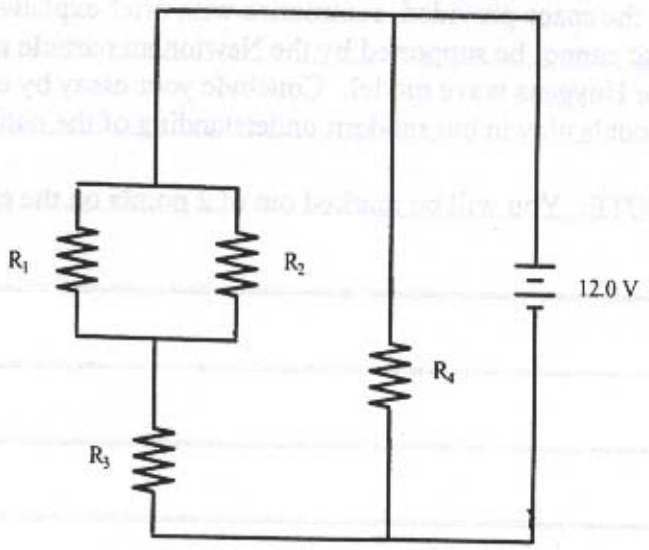
44. Determine the net force on **charged particle C,** at the right in the diagram below. **value: 7**



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



46. The diagram at the right shows four equal 4.00 Ω resistors arranged in a circuit along with a 12.0 V battery.



A. Determine the equivalent resistance for the entire circuit. **value: 3**

B. Determine the current in resistor R_1. **value: 3**

C. Determine the value of a single resistor placed in series with R_4 that would result in R_3 and R_4 having the same current. **value: 2**

47. In the space provided, summarize with brief explanations in essay format those behaviors of light that cannot be supported by the Newtonian particle model, and those that cannot be supported by the Huygens wave model. Conclude your essay by explaining the part that the particle and wave models play in our modern understanding of the nature of light. **value: 8**

NOTE: You will be marked out of 2 points on the clarity and mechanics of your writing.

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

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

C) Complete the following decay equation. $^{58}_{29}Cu \rightarrow ? + \gamma$ **value: 1**

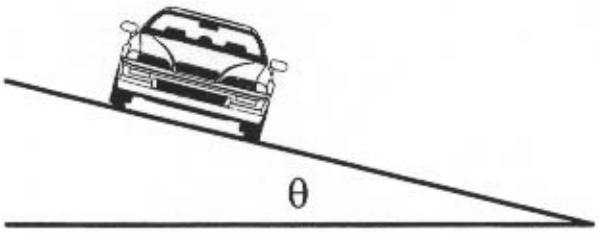
Case Study
(Total Value:10)

This section is an extension of the circular motion concepts you learned in Physics 12. Any additional information you require is given.

49. Engineers designing roadways must make careful calculations involving centripetal force at all curves, but especially at exit ramps from high speed highways. The typical ramp is an approximately circular arc. Some force must be exerted towards the center of the circle to make a vehicle follow the path. On a flat curve, this force is supplied by friction between the tires and the road surface. If the outer edge of the ramp is raised, (a design called "banking"), the frictional force can be reduced or even eliminated.

A) If a van, mass 2500 kg, enters a ramp at a speed of 120 km/h, what is the magnitude of the centripetal force required to make it follow a curve of radius 160 m? **value: 2**

B) To the right of the diagram below, draw a labelled diagram of vectors representing the weight of the vehicle, the normal force, and the vertical and horizontal components of the **normal force.** **value: 2**



49. C) There is a derived expression which can be used to determine the bank angle that would completely eliminate the need for friction to provide the centripetal force. It is:

$$\tan\theta = \frac{v^2}{rg}$$

Using this formula, calculate the bank angle for the van described in part A. **value: 1**

D) The Daytona 500 is a major NASCAR race run on a track that has a radius at the top of the banked track of 316 m and a bank angle of 31.0 °. At what speed, in **km/h**, must the race cars travel so that no friction is needed to provide centripetal force? **value: 2**

E) From the expressions for the components of the **normal force**, show an algebraic derivation of the bank angle formula shown in part C. **value: 3**