NOVA SCOTIA EXAMINATIONS

PHYSICS 12

JUNE 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, each with an estimated time allotment shown.

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

Total Time: 3 Hours

Calculators are permitted but are not to be shared.

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
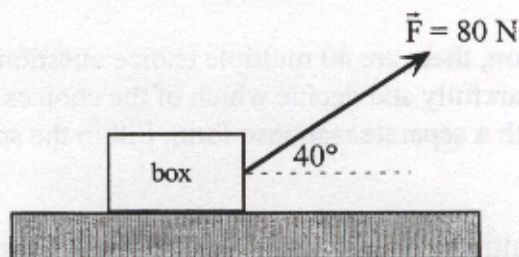B. inches
C. metres
D. cubits

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.
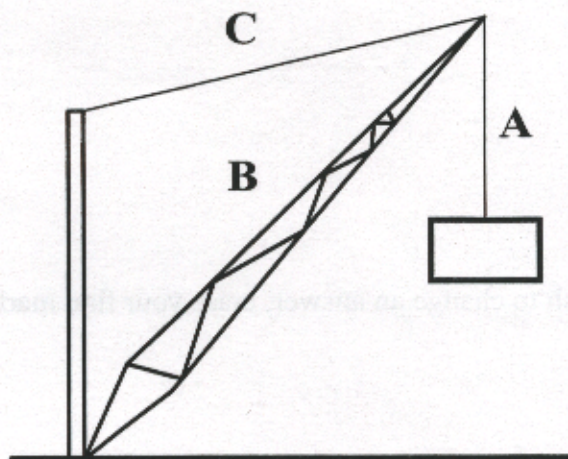
1. A force of 80 N is applied to a box by pulling on a rope at an angle of 40° with a horizontal table as shown in the following diagram.

$$\vec{F} = 80 \text{ N}$$

box   40°

What is the horizontal component of the force?

A. 30 N
B. 50 N
C. 60 N
D. 70 N

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

C

A

B

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

3. Three forces act simultaneously on a mass. One force is 60.0 N, East. The second is 75.0 N, South. The third is 30.0 N, North. What is the magnitude of the vector sum of the forces?

A. 75.0 N
B. 105 N
C. 130. N
D. 175 N

4. Which of the following statements is always true when describing a collision between any two objects on a frictionless horizontal surface?

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

5. You observe a collision between two objects that stick together and move together after impact. Which of the following statements is true?

   A. Momentum is conserved, but not kinetic energy.
   B. Kinetic energy is conserved but not momentum.
   C. Both momentum and kinetic energy are conserved.
   D. Neither momentum nor kinetic energy is conserved.

6. A bowler releases a ball of mass (m) that undergoes a collision at an angle of about 45° with a bowling pin, which has a mass (m/3). Which of the following statements best describes the displacements after impact?

   A. The displacement of the pin will be larger than the displacement of the ball.
   B. The displacement of the ball will be larger than the displacement of the pin.
   C. The arithmetic sum of the two displacements will be the same as if the ball had not hit anything.
   D. The vector sum of the two displacements will be the same as if the ball had not hit anything.

7. Which of the following **does not** affect the total time in air of a projectile?

   A. the acceleration due to gravity
   B. the initial height
   C. the initial horizontal velocity
   D. the initial vertical velocity

8. You hit a ball and it breaks a window at the highest point in its flight. If the original velocity was v_o at an angle Q above the horizontal, which of the following is the velocity as it strikes the window?

   A. zero
   B. $v_o \sin Q$
   C. $v_o \cos Q$
   D. $2v_o$

9. Which of the following must be zero for a projectile to be at its maximum height?

    A. the horizontal position
    B. the horizontal velocity
    C. the vertical position
    D. the vertical velocity

10. An object on a string is twirled around with uniform circular motion in a horizontal plane. In what direction is the centripetal force acting?

    A. along the curving path of the circular motion
    B. toward the center of rotation
    C. along a tangent to the curve of the motion
    D. away from the center of rotation

11. 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.

12. A satellite of mass (m) is orbiting the Earth at a distance (r). It experiences a centripetal force (F_c). Which of the following expressions can be used to calculate its speed?

    A. $\sqrt{\dfrac{F_c r}{m}}$

    B. $\dfrac{F_c r}{m}$

    C. $\dfrac{F_c m}{r}$

    D. $F_c mr$
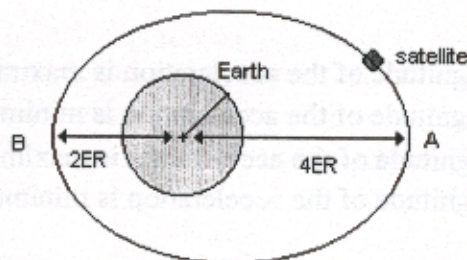
Base your answers to questions 13 and 14 on the diagram above, which represents a satellite in an elliptical orbit about the Earth. The most distant point in the orbit, A, is four Earth Radii (ER) from the center of the Earth. The nearest point, B, is two Earth radii from the center of the Earth.

13. Which of the following choices best describes the speed of the satellite as it moves from point A to point B in its orbit?

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

14. At point A, how does the magnitude of the force of the Earth on the satellite (F_E) compare to the magnitude of the force of the satellite on the Earth (F_s)?

A. the forces cannot be determined
B. F_E is greater than F_s
C. F_E is less than F_s
D. F_E is equal to F_s

15. Which of the following conditions is required for a satellite to be in geosynchronous orbit around the Earth?

A. The period of revolution of the satellite must be the same as the rotational period of the Earth.
B. The altitude of the satellite must be the same as the radius of the Earth.
C. The orbital speed of the satellite around the Earth must be the same as the orbital speed of the Earth around the Sun.
D. The daily distance travelled by the satellite must be equal to the circumference of the Earth.

16. A mass hanging vertically on a spring exhibits 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. A mass attached to a vertically suspended spring oscillates with a certain period. If you quadruple the mass on the end of the spring, what happens to the period?

    A. it doubles
    B. it halves
    C. it quadruples
    D. it quarters

Questions 18 and 19 relate to a situation in which a 29.0 kg child is sitting on a playground swing seat that is supported by two chains.

18. If each chain is 2.0 m long, what is the period of the swing motion?

    A. 1.7 s
    B. 2.8 s
    C. 11 s
    D. 24 s

19. What length would each chain have to be for the period to be 1.0 s?

    A. 12 cm
    B. 25 cm
    C. 160 cm
    D. 200 cm

20. A magnetic compass is held directly above a straight conductor that is lying across this page. If electrons flow from left to right in the conductor, towards which edge of the page does the north-seeking pole of the compass point?

    A. top
    B. left
    C. right
    D. bottom

21. At a certain separation, the electric force between two point charges is given by F. If the distance between the point charges is tripled, what is the resulting electric force?

A. $\frac{1}{9}$ F

B. $\frac{1}{3}$ F

C. 3 F

D. 9 F

22. An electric current measures the amount of

A. force that moves past a point in a certain time
B. charge that moves past a point in a certain time
C. energy that moves past a point in a certain time
D. electricity that moves past a point in a certain time

23. The current through an electrical device is 0.450 A when connected across a potential difference of 110 V. What is the power of this device?

A. 4.09×10^{-3} W

B. 2.23×10^{1} W

C. 4.95×10^{1} W

D. 2.44×10^{2} W

24. If each of the resistors in the diagrams has a resistance of 6.0 Ω, which combination has the greatest resistance?

A.

B.

C.

D.
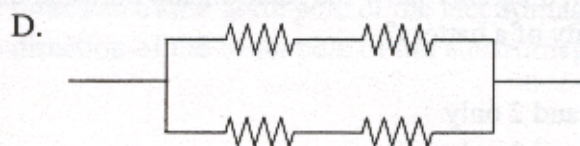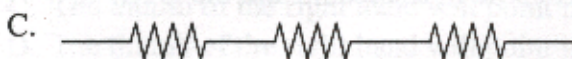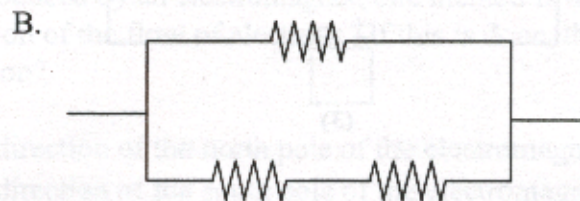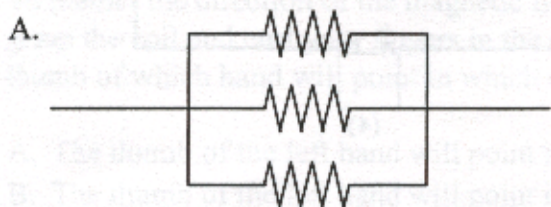
25. During an experiment with an electromagnet, a student disconnected the wires leading from the electromagnet to the battery. When she reconnected these wires, the student reversed the terminal connections. What will happen to the electromagnet?

    A. Its magnetic properties will be lost.

    B. Its magnetic polarity will be reversed.

    C. Its magnetic strength will be decreased.

    D. Its magnetic behaviour will not be changed.

26. A step-down transformer has 100 turns on its primary coil and 25 turns on its secondary coil. When the transformer operates, a 3.50 A current and a 117 V potential difference are measured in the primary. What is the potential difference in the secondary coil?

    A. 29.3 V

    B. 33.4 V

    C. 117 V

    D. 468 V

27. Each diagram shows the connection of a solenoid to a battery.
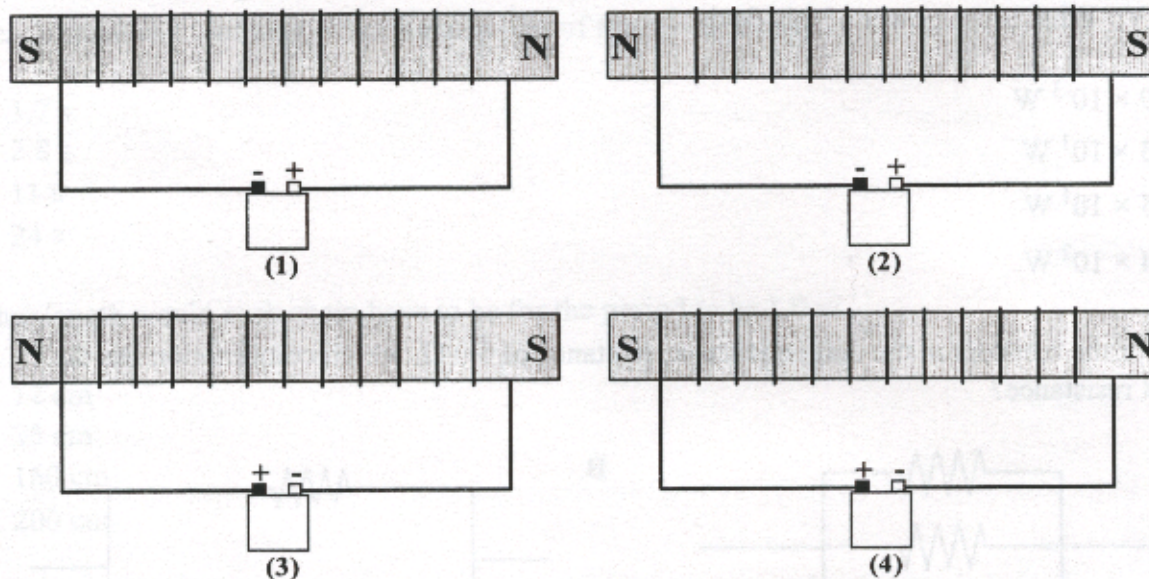
Which diagrams show the relationship between the north pole of a solenoid and the given polarity of a battery?

    A. 1 and 2 only

    B. 1 and 3 only

    C. 2 and 3 only

    D. 3 and 4 only

28. A permanent magnet is thrust into a coil of wire. Which of the alternatives best completes the following statement: *One property of electromagnetic induction shows that an induced*

    A. current varies inversely with the number of coil windings.
    B. potential difference varies directly with the number of coil windings.
    C. current varies directly with the square of the number of coil windings.
    D. potential difference varies inversely with the number of coil windings.

29. Which of the following best describes the energy conversion that takes place in a generator?

    A. chemical energy to electrical energy
    B. electrical energy to chemical energy
    C. electrical energy to mechanical energy
    D. mechanical energy to electrical energy

30. 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

31. In the hand rule for motors, which of the following is represented by your palm or second finger?

    A. direction of current flow
    B. direction of force
    C. direction of electric field
    D. direction of magnetic field

32. To predict the direction of the magnetic field produced by an electromagnet, one method is to grasp the coil and curl your fingers in the direction of the flow of electrons. If this is done, the thumb of which hand will point in which direction?

    A. The thumb of the left hand will point in the direction of the north pole of the electromagnet.
    B. The thumb of the left hand will point in the direction of the south pole of the electromagnet.
    C. The thumb of the right hand will point in the direction of the north pole of the electromagnet.
    D. The thumb of the right hand will point in the direction of the south pole of the electromagnet.

33. Which model of the nature of light successfully explains the photoelectric effect?

    A. both the wave model and the particle model
    B. neither the wave model nor the particle model
    C. particle model but not wave model
    D. wave model but not particle model

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

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

35. The graph below represents the relationship between mass and its energy equivalent.

Mass (kg)
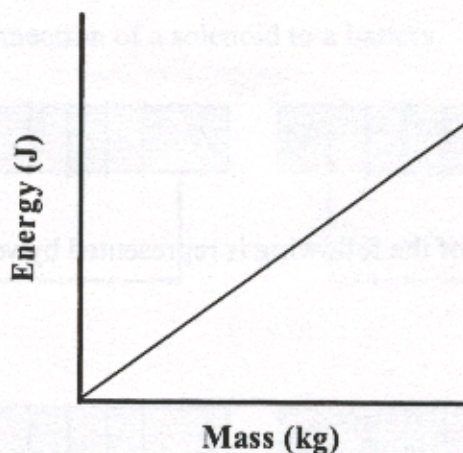
What is represented by the slope of the graph?

    A. gravitational field strength
    B. momentum
    C. Planck's constant
    D. the speed of light squared

36. In a hydrogen emission spectrum, which of these electron transitions will give the longest wavelength of electromagnetic radiation?

    A. $n = 2$ to $n = 1$
    B. $n = 3$ to $n = 2$
    C. $n = 4$ to $n = 3$

37. Bohr's model of the atom includes which of the following concepts?

    A. Only certain numbers of spectra lines are emitted from nuclei.
    B. Only certain levels of bonding quanta are available for elements.
    C. Only certain values of energy are possible for orbiting electrons.
    D. Only certain quantities of relativistic mass are available for atoms.

38. Light emitted from excited atoms has frequencies that are related to the atom's

    A. nuclear size
    B. orbital volume
    C. energy level differences
    D. electron speed of circulation

39. What does X represent in the following nuclear equation? $^{14}_{6}C \rightarrow {}^{14}_{7}N + X$

    A. an electron
    B. a neutron
    C. a positron
    D. a proton

40. Which of the following decay products has the greatest penetrating power?

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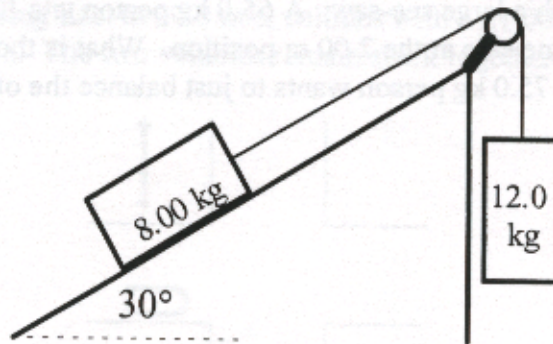   D. neutron

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.

coefficient of friction is 0.200

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 as part of your solution.
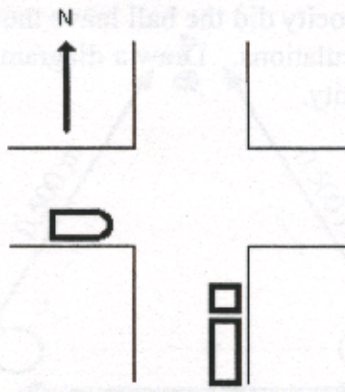
value: 6

42. Three friends experiment with a large see-saw. A 65.0 kg person sits 1.00 m from the pivot. A 42.5 kg person sits on the same side at the 2.00 m position. What is the minimum length of the other side of the see-saw if a 75.0 kg person wants to just balance the other two?   **value: 3**

43. A 2100 kg minivan, travelling East at 30.0 m/s, collides with a 21 000 kg tractor trailer, travelling North at 10.0 m/s. The two vehicles remain stuck together after impact.

A) Calculate the momentum of each vehicle prior to the collision. Construct a momentum diagram in approximate scale showing the two original momenta and the final momentum.

value: 3

B) Determine the velocity of the combined mass immediately after impact. **value: 4**

44. A golfer is practising his/her swing at a distance of 150. m from a house. On the way back to the ground, 5.00 seconds after being hit, the ball goes through a second storey window that is 6.00 m from the ground. With what initial velocity did the ball leave the face of the golf club? Ignore the effects of air resistance in your calculations.   Draw a diagram that shows the horizontal and vertical components of the initial velocity.   **value: 6**

45. The diagram below shows two equal positive 42.0 μ C charges at the base of an equilateral triangle separated by a distance of 0.500 m.
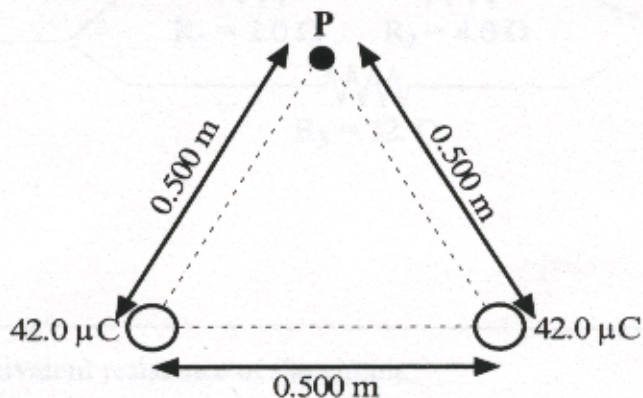
A) Draw a vector diagram, to approximate scale, showing the electric field strength due to each charge at point P, and the resultant electric field strength at point P.   **value: 2**

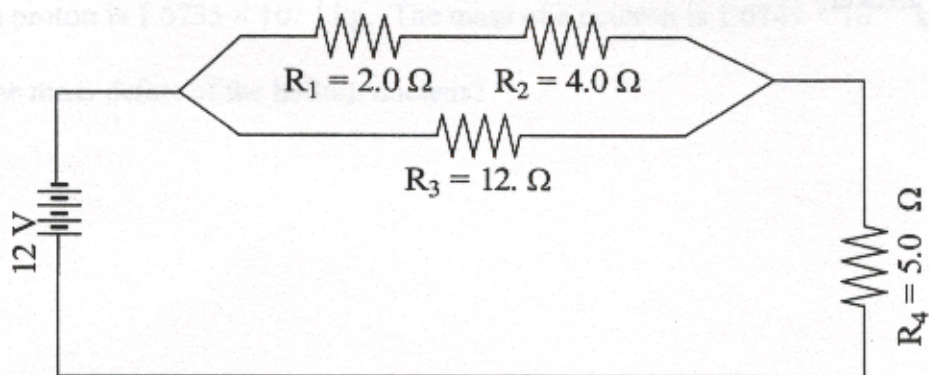B) Determine the electric field strength at point P.   **value: 4**

46. Determine the electric force between two charged spheres placed 5.0 cm apart if one sphere has a charge of 4.0×10^{-6} C and the other sphere has a charge of 6.0×10^{-6} C . **value: 2**

47. Refer to the following circuit diagram in all parts of this question.

R₁ = 2.0 Ω   R₂ = 4.0 Ω

R₃ = 12. Ω

12 V

R₄ = 5.0 Ω

A) Determine the equivalent resistance of the circuit.   **value: 3**

B) Determine the total current in the circuit.   **value: 2**
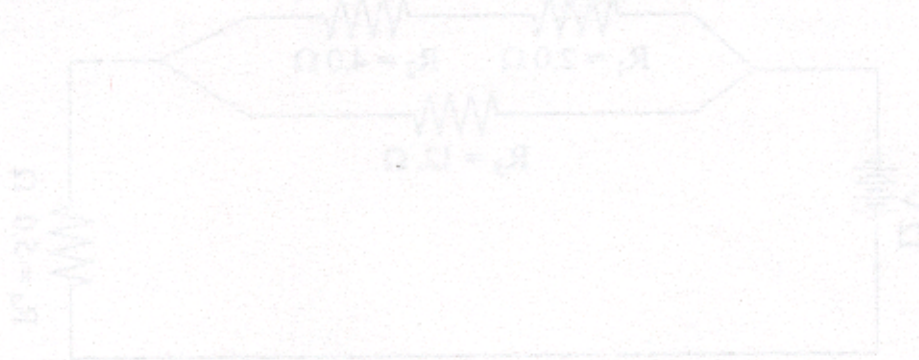
C) Determine the current through R_2.   **value: 3**

48. Does the Compton effect demonstrate that light has properties of a particle or a wave? Explain your answer.   **value: 2**

49. Michael is cleaning his room. He kicks his Physics notebook (mass 0.32 kg) under the bed, giving it a speed of 13 m/s. According to DeBroglie, this notebook should exhibit wave properties. Why are these properties not observable in this case? Use appropriate calculations to support your answer.   **value: 2**

50. The mass of a helium nucleus ($^4_2$He) is 6.6443×10^{-27} kg.
The mass of a proton is 1.6735×10^{-27} kg. The mass of a neutron is 1.6749×10^{-27} kg.

A) What is the mass defect of the helium nucleus?   **value: 2**

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

C) What is the binding energy per nucleon in the Helium nucleus?   **value: 1**

51. What are two serious concerns relating to nuclear power stations?   In two or three sentences for each, elaborate on the nature of the concern and the degree of risk.   **value: 4**
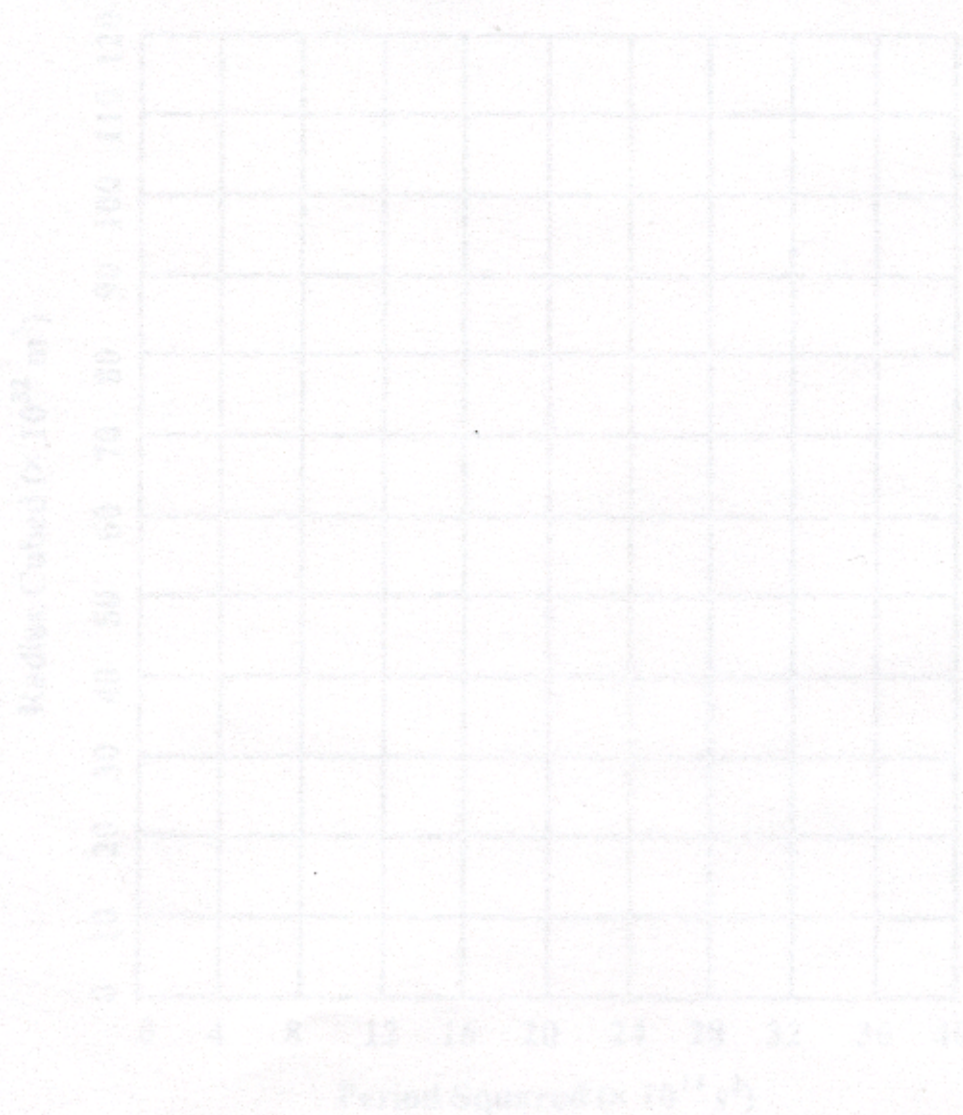
Case Study
(Total Value:10)

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

52.

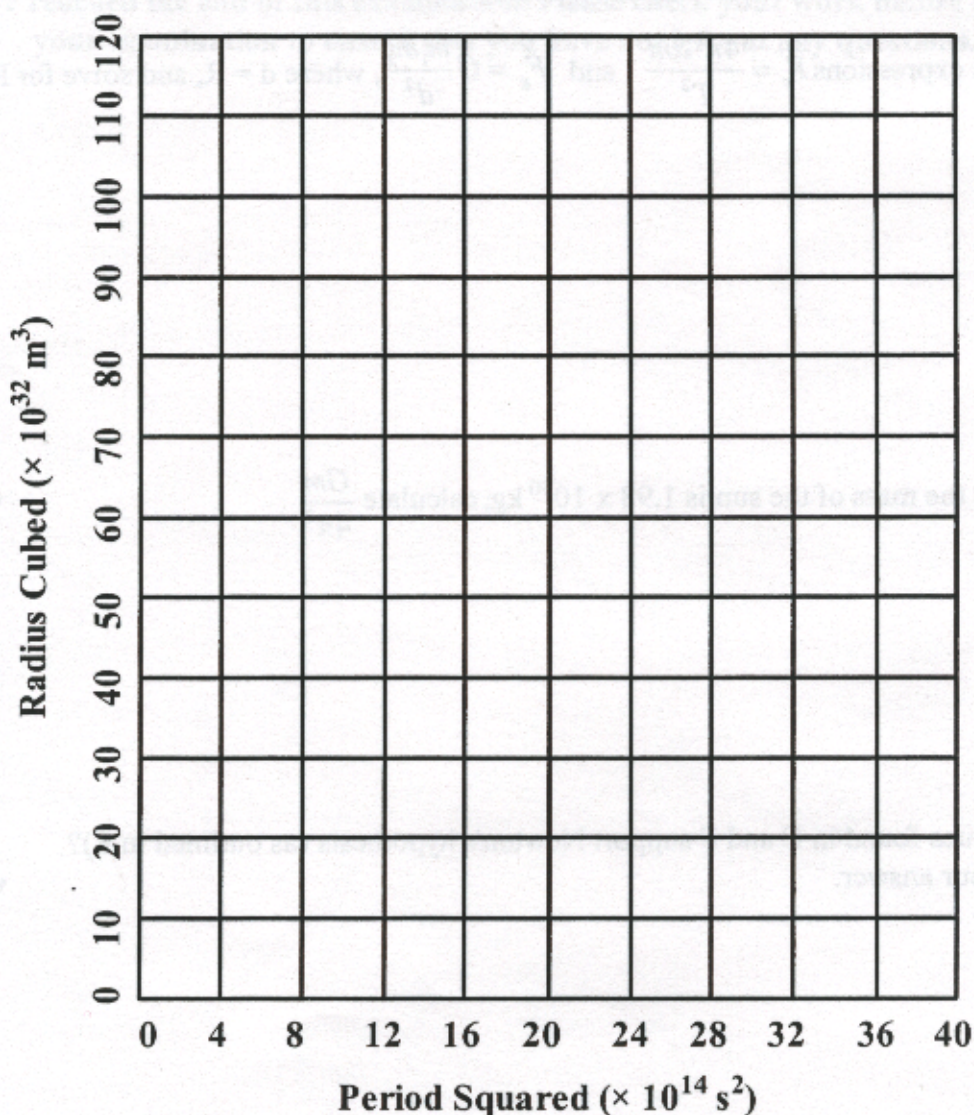| Planet	R (m)	T (s)	R^3 (m^3)	T^2 (s^2)
Mercury	5.79×10^{10}	7.60×10^6		
Venus	1.08×10^{11}	1.94×10^7		
Earth	1.49×10^{11}	3.16×10^7		
Mars	2.28×10^{11}	5.94×10^7		

A) Calculate R^3 and T^2 for each of the planets in the table above and put the values in the table.

value: 1

B) Plot a graph of R^3 vs T^2 on the grid below and show a line of best fit.

value: 2

Radius Cubed vs Period Squared

Radius Cubed (× 10^{32} m^3)

Period Squared (× 10^{14} s^2)

52. C) Calculate the slope of the best fit line and indicate the points used on the graph.   **value: 2**

D) What does the slope represent?   **value: 1**

E) Newton hypothesized that the centripetal force on a planet was provided by the gravitational force of attraction between the sun and a planet.

Equate the expressions $F_c = \dfrac{4\pi^2 Rm}{T^2}$ and $F_g = G\dfrac{m_1 m_2}{d^2}$, where $d = R$, and solve for R^3.

value: 1

F) Given that the mass of the sun is 1.98×10^{30} kg, calculate $\dfrac{Gm}{4\pi^2}$.   **value: 1**

G) Do the values found in C and F support Newton's hypothesis (as outlined in E)? Explain your answer.   **value: 2**