Government of Saskatchewan
Ministry of Education

DRAFT

Grade 12 Prototype Examination

Physics

Course Code 8257

Barcode Number

Month Day
Date of Birth

September 2015
Revised July 2016

Physics

Time: Two and One-Half Hours

Calculators may be used. Only silent hand-held calculators designed for mathematical computations such as logarithmic, trigonometric, and graphing functions are permissible. Computers, calculators with QWERTY keyboards, calculators capable of symbolic manipulation, and electronic writing pads are not allowed. Calculators that have built-in notes (definitions or explanations in alpha notation) that cannot be cleared are not permitted. All calculators must be cleared of programs.

Do not spend too much time on any question. Read the questions carefully.

The examination consists of 45 multiple-choice and 5 numeric response questions of equal value which will be machine scored. Record your answers on the Student Examination Form which is provided. Each multiple choice question has four suggested answers, one of which is better than the others. Select the **best** answer and record it on the Student Examination Form as shown in the example below:

Student Examination Form:

Multiple Choice

Which subject is this examination being written in?

A. Foundations of Mathematics
B. Physics
C. Pre-Calculus
D. Workplace and Apprenticeship Mathematics

1.	(A)	●	(C)	(D)

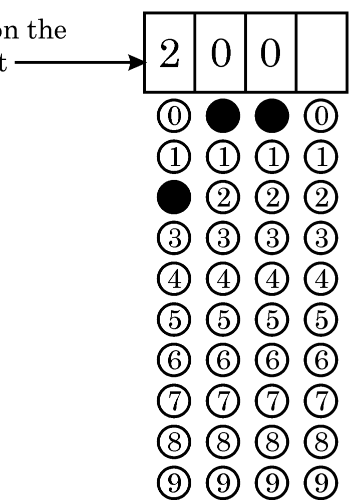
Numeric Response

Calculation Questions and Solutions

What is the distance travelled by a car moving at 10 m/s for 20 seconds?
Round your answer to the nearest meter.

(Record your answer in the numeric response section on the answer sheet.)

Record 200 on the answer sheet



Use an ordinary HB pencil to mark your answers on the Student Examination Form. If you change your mind about an answer, be sure to erase the first mark completely. There should be only one answer marked for each question. Be sure there are no stray pencil marks on your answer sheet. If you need space for rough work, use the space in the examination booklet beside each question.

Do not fold either the Student Examination Form or the examination booklet. Check that all information at the bottom of the Student Examination Form is correct and complete. Make any necessary changes, and fill in any missing information. Be sure to complete the Month and Day of Your Birth section.

Physics 30 (8257) Reference Material

These insert pages may be torn out of the exam booklet in order to answer exam questions. They must be replaced in the exam booklet upon completion of the examination.

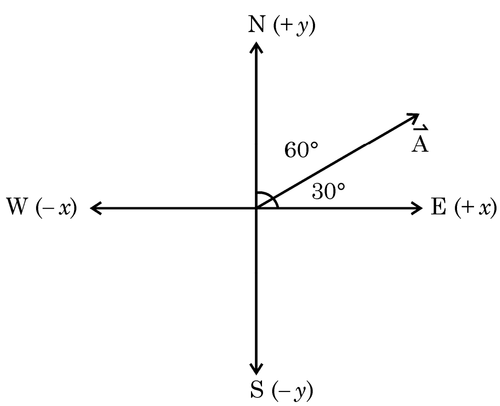
These metric (SI) units and symbol may be used throughout this test.

Unit	Symbol	Quantity	Unit	Symbol	Quantity
coulomb	C	electric charge	newton	N	force
hertz	Hz	frequency	second	s	time
joule	J	work, energy	watt	W	power
kilogram	kg	mass	electron volt	eV	energy
metre	m	length			

Quantities that may be needed for calculations

Name	Symbol	Value
acceleration due to gravity at Earth's surface (approx..)	g	$9.81\ \text{m/s}^2$
Coulomb's constant	k	$8.99\times10^{9}\ \text{N}\cdot\text{m}^2/\text{C}^2$
electron volt	eV	$1\ \text{eV} = 1.60\times10^{-19}\ \text{J}$
elementary charge	e	$1.60\times10^{-19}\ \text{C}$
gravitational constant	G	$6.67\times10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2$
Planck's constant	h	$6.63\times10^{-34}\ \text{J}\cdot\text{s}$ $4.14\times10^{-15}\ \text{eV}\cdot\text{s}$
speed of light (in a vacuum)	c	$3.00\times10^{8}\ \text{m/s}$

Conventions used for expressing direction in Vector Quantities



Example:

The direction of vector $\vec{A}$ can be expressed as:

[E 30° N] or [N 60° E]

Conventions used for significant figures.

A bar over a zero digit indicates the level of significance. For example, $5\bar{0}0\ \text{m}$ has two significant figures and $50\bar{0}\ \text{m}$ has three significant figures.

In scientific notation, the mantissa indicates the number of significant figures. For example, $2.34\times10^{12}\ \text{J}$ has three significant figures.

Physics Formulas

Modern Physics

$E = mc^2$

$E = hf$

$E = \frac{hc}{\lambda}$

Forces and Motion

$c^2 = a^2 + b^2$

$c^2 = a^2 + b^2 - 2ab\cos C$

$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$\overline{\Delta d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$

$\Delta\vec{d} = \frac{1}{2}(\vec{v}_i + \vec{v}_f)t$

$v_f^2 = v_i^2 + 2a\Delta d$

$\vec{v}_f = \vec{v}_i + \vec{a}t$

$\vec{v} = \frac{\Delta\vec{d}}{\Delta t}$

$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$

$\vec{F} = m\vec{a}$

$\vec{F}_g = m\vec{g}$

$v = \frac{2\pi r}{T}$

$a = \frac{4\pi^2 r}{T^2}$

$a = \frac{v^2}{r}$

$v = \sqrt{gr}$

$F = \frac{4\pi^2 mr}{T^2}$

$F = \frac{mv^2}{r}$

Conservation Laws

$E_k = \frac{1}{2}mv^2$

$E_p = mgh$

$E_T = E_k + E_p$

$W = \Delta E$

$W = F \cdot d$

$W = F \cdot d\cos\theta$

$E_p = \frac{Gm_1m_2}{r}$

$E_p = \frac{kq_1q_2}{r}$

$\bar{\rho} = m\vec{v}$

$\vec{F}\Delta t = m\Delta\vec{v}$

$m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1{}' + m_2\vec{v}_2{}'$

$m_1\vec{v}_1 + m_2\vec{v}_2 = (m_1 + m_2)\vec{v}'$

$\%\ \text{efficiency} = \frac{E_{out}}{E_{in}} \times 100$

Fields

$F = \frac{Gm_1m_2}{r^2}$

$g = \frac{Gm}{r^2}$

$F = \frac{kq_1q_2}{r^2}$

$\varepsilon = \frac{kq}{r^2}$

Periodic Table of Elements

11	**Atomic Number**
Na	**Atomic Symbol**
Sodium	Element name
22.99	Average Atomic mass
( )	Indicates mass of the most stable isotope

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** Hydrogen 1.01																		**2** **He** Helium 4.00
3 **Li** Lithium 6.94	**4** **Be** Beryllium 9.01												**5** **B** Boron 10.81	**6** **C** Carbon 12.01	**7** **N** Nitrogen 14.01	**8** **O** Oxygen 16.00	**9** **F** Fluorine 19.00	**10** **Ne** Neon 20.18
11 **Na** Sodium 22.99	**12** **Mg** Magnesium 24.31												**13** **Al** Aluminum 26.98	**14** **Si** Silicon 28.09	**15** **P** Phosphorus 30.97	**16** **S** Sulfur 32.07	**17** **Cl** Chlorine 35.45	**18** **Ar** Argon 39.95
19 **K** Potassium 39.10	**20** **Ca** Calcium 40.08		**21** **Sc** Scandium 44.96	**22** **Ti** Titanium 47.87	**23** **V** Vanadium 50.94	**24** **Cr** Chromium 52.00	**25** **Mn** Manganese 54.94	**26** **Fe** Iron 55.85	**27** **Co** Cobalt 58.93	**28** **Ni** Nickel 58.69	**29** **Cu** Copper 63.55	**30** **Zn** Zinc 65.41	**31** **Ga** Gallium 69.72	**32** **Ge** Germanium 72.64	**33** **As** Arsenic 74.92	**34** **Se** Selenium 78.96	**35** **Br** Bromine 79.90	**36** **Kr** Krypton 83.80
37 **Rb** Rubidium 85.47	**38** **Sr** Strontium 87.62		**39** **Y** Yttrium 88.91	**40** **Zr** Zirconium 91.22	**41** **Nb** Niobium 92.91	**42** **Mo** Molybdenum 95.94	**43** **Tc** Technetium (98)	**44** **Ru** Ruthenium 101.07	**45** **Rh** Rhodium 102.91	**46** **Pd** Palladium 106.42	**47** **Ag** Silver 107.87	**48** **Cd** Cadmium 112.41	**49** **In** Indium 114.82	**50** **Sn** Tin 118.71	**51** **Sb** Antimony 121.76	**52** **Te** Tellurium 127.60	**53** **I** Iodine 126.90	**54** **Xe** Xenon 131.29
55 **Cs** Cesium 132.91	**56** **Ba** Barium 137.33	**57-70** *****	**71** **Lu** Lutetium 174.97	**72** **Hf** Hafnium 178.49	**73** **Ta** Tantalum 180.95	**74** **W** Tungsten 183.84	**75** **Re** Rhenium 186.21	**76** **Os** Osmium 190.23	**77** **Ir** Iridium 192.22	**78** **Pt** Platinum 195.08	**79** **Au** Gold 196.97	**80** **Hg** Mercury 200.59	**81** **Tl** Thallium 204.38	**82** **Pb** Lead 207.20	**83** **Bi** Bismuth 208.98	**84** **Po** Polonium (208.98)	**85** **At** Astatine (209.99)	**86** **Rn** Radon (222.02)
87 **Fr** Francium (223.02)	**88** **Ra** Radium (226.03)	**89-102** ******	**103** **Lr** Lawrencium (262.11)	**104** **Rf** Rutherfordium (265.12)	**105** **Db** Dubnium (268.13)	**106** **Sg** Seaborgium (271.13)	**107** **Bh** Bohrium (270)	**108** **Hs** Hassium (277.15)	**109** **Mt** Meitnerium (276.15)	**110** **Ds** Darmstadtium (281.16)	**111** **Rg** Roentgenium (280.16)	**112** **Cn** Copernicium (285.17)	**113** **Nh** Nihonium (284.18)	**114** **Fl** Flerovium (289.19)	**115** **Mc** Moscovium (288.19)	**116** **Lv** Livermorium (293)	**117** **Ts** Tennessine (294)	**118** **Og** Oganesson (294)

*§ Lanthanoid Series

57 **La** Lanthanum 138.91	**58** **Ce** Cerium 140.12	**59** **Pr** Praseodymium 140.91	**60** **Nd** Neodymium 144.24	**61** **Pm** Promethium (145)	**62** **Sm** Samarium 150.36	**63** **Eu** Europium 151.96	**64** **Gd** Gadolinium 157.25	**65** **Tb** Terbium 158.93	**66** **Dy** Dysprosium 162.50	**67** **Ho** Holmium 164.93	**68** **Er** Erbium 167.26	**69** **Tm** Thulium 168.93	**70** **Yb** Ytterbium 173.04

**¥ Actinoid Series

89 **Ac** Actinium (227.03)	**90** **Th** Thorium 232.04	**91** **Pa** Protactinium 231.04	**92** **U** Uranium 238.03	**93** **Np** Neptunium (237.05)	**94** **Pu** Plutonium (244.06)	**95** **Am** Americium (243.06)	**96** **Cm** Curium (247.07)	**97** **Bk** Berkelium (247.07)	**98** **Cf** Californium (251.08)	**99** **Es** Einsteinium (252.08)	**100** **Fm** Fermium (257.10)	**101** **Md** Mendelevium (258.10)	**102** **No** Nobelium (259.10)

GRADE 12 DEPARTMENTAL EXAMINATION

PHYSICS 30, PROTOTYPE EXAM

VALUE
100
(50 × 2)

Answer the following 50 questions on the computer sheet entitled "Student Examination Form."

1. What is the ratio of energy in ultraviolet light with a wavelength of 300 nm compared to orange light with a wavelength of 600 nm?

   A. 2:1
   B. 3:1
   C. 4:1
   D. 6:1

2. Emma has a 20 year-old twin named Jane. Emma plans to take a hypothetical space journey to a distant planet having a mass 3 times greater than Earth. Travelling at the speed of light, Emma's trip to the planet and back to Earth takes 15 years. Upon her return, Emma discovers that Jane is 65 years old. Compared to Jane, Emma's time has passed

   A. more slowly because of her travelling speed.
   B. more quickly because of her travelling speed.
   C. more slowly because of the distant planet's decreased gravity.
   D. more quickly because of the distant planet's increased gravity.

3. Which of the following best describes the photoelectric effect?

A. Low frequency light hitting a metal causing protons to be emitted.
B. Low frequency light hitting a metal causes electrons to be emitted.
C. High frequency light hitting a metal causing protons to be emitted.
D. High frequency light hitting a metal causes electrons to be emitted.

4. Orange light of wavelength 600 nm shines onto a piece of metal. What is the energy of the light in electron volts?

A. 2.07×10^{0} eV

B. 7.44×10^{-13} eV

C. 3.32×10^{-19} eV

D. 5.30×10^{-38} eV

NR1. Fluorine-18 has a half-life of 1.8 hours. If a 2000 g sample of the isotope decays for 5.4 hours, how many grams of fluorine will remain? Round your answer to the nearest whole number.

(Record your answer in the numeric response section on the answer sheet.)

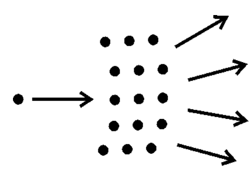
5. Which type of radiation consists of high speed electrons?

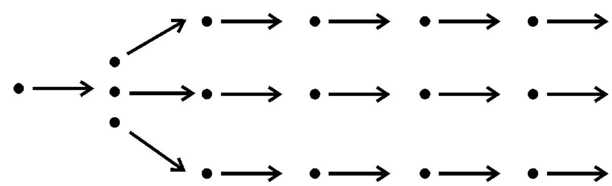
A. beta
B. x-ray
C. alpha
D. gamma

6. Which of the following are short-term health effects of a 60 rem radiation dose received in a short period of time?

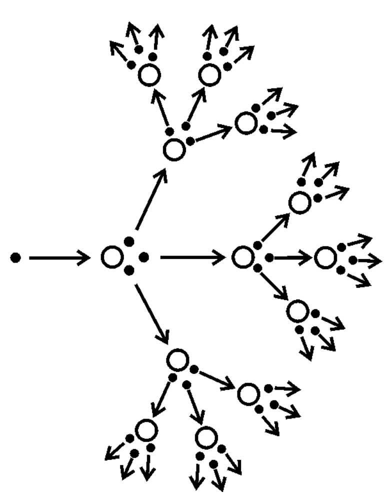
   A. cancer, hair loss, nausea
   B. sterility, skin redness, nausea
   C. genetic defects, cancer, reduced white blood cell count
   D. hair loss, skin redness, reduced white blood cell count

7. Which of the following diagrams best illustrates the release of neutrons in a nuclear fission chain reaction?

   A. 

   B. 

   C. 

   D. 

8. What is the mass defect in a nuclear fission reaction that releases 3.09×10^{-11} J of energy?

A. 2.78×10^{-6} kg
B. 1.03×10^{-19} kg
C. 2.91×10^{-27} kg
D. 3.43×10^{-28} kg

9. What process creates the energy released by the sun?

A. fusion
B. fission
C. combustion
D. radioactive decay

10. Consider the following three situations involving moving objects.

1: A merry-go-round rotating at a constant speed.
2: A truck moving uniformly backwards as it drags a stuck vehicle from a hole.
3: A ball moving toward a wall at 7 m/s, bouncing off, and then moving away at 7 m/s.

Which situation(s) illustrate changes in velocity?

A. 1 only
B. 1 and 3
C. 2 and 3
D. 1, 2, and 3

11. A car accelerates from rest at 5.00 m/s^2 [E] until it reaches a maximum speed of 20.0 m/s [E]. The car then continues travelling eastward with uniform motion. How long will it take the car to travel 100 m [E]?

A. 4.0 s
B. 5.0 s
C. 7.0 s
D. 10 s

12. A pilot flies to a city with an airspeed of 500 km/h against a head wind of 250 km/h. The pilot immediately returns to the starting point flying with the same airspeed but now with a 250 km/h tailwind. On the second day, the pilot flies the same trip with the same airspeed but there is no wind.

How will the time needed to complete the trips compare?

A. The total trip will take the same time on each day
B. The total trip time on the second day is less than the first day.
C. The total trip time on the first day is less than the second day.
D. The trip times cannot be compared without knowing the distance travelled.

13. A fishing boat has a velocity of 12 km/h [N] while crossing a lake with a current of 5.0 km/h [W].

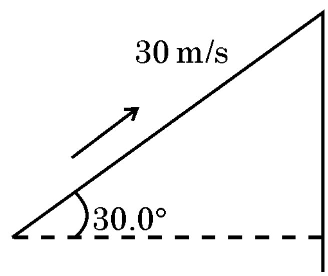
What is the displacement of the fishing boat in the first 36 minutes?

A. 13 km [N23° W]
B. 13 km [N23° E]
C. 7.8 km [N23° W]
D. 7.8 km [N23° E]

NR2. In 2012, Felix Baumgartner set a world record for freefall when he stepped out of a hot air balloon from a height of 39.0 km above the ground. Ignoring air resistance and assuming a constant gravitational field strength during the freefall, how long did it take him to freefall 1.0 km? Round your answer to the nearest second.

(Record your answer in the numeric response section on the answer sheet.)

14. A skier launches from a ramp with a velocity of 30.0 m/s at an angle of 30.0° above horizontal as shown in the diagram below.



What is the skier's vertical displacement above the ramp after flying through the air for 2 seconds?

A. 10.4 m [up]
B. 20.0 m [up]
C. 32.4 m [up]
D. 49.6 m [up]

15. A 12.0 m diameter Ferris wheel completes 20 revolutions in 5.0 minutes. What is the magnitude of the centripetal acceleration on the outer edge of the Ferris wheel?

A. 1.1 m/s^2
B. 2.1 m/s^2
C. 15 m/s^2
D. 16 m/s^2

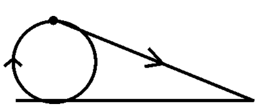
16. A person stands motionless at the equator where the Earth's diameter is 1.27×10^7 m and its period of rotation is 1 day. What is the person's rotational speed relative to the Earth's centre?

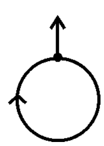
A. 0 m/s
B. 148 m/s
C. 465 m/s
D. 931 m/s

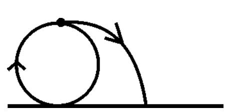
17. A certain satellite revolves around the Earth in a geosynchronous orbit. What is the period of the satellite?

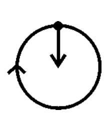
A. one day
B. one year
C. one hour
D. one month

18. A 100 g mass tied to the end of a string is twirled in a vertical circle. If the string breaks when the mass is at the highest point of its motion, which diagram shows the path the mass will follow?

A. 

B. 

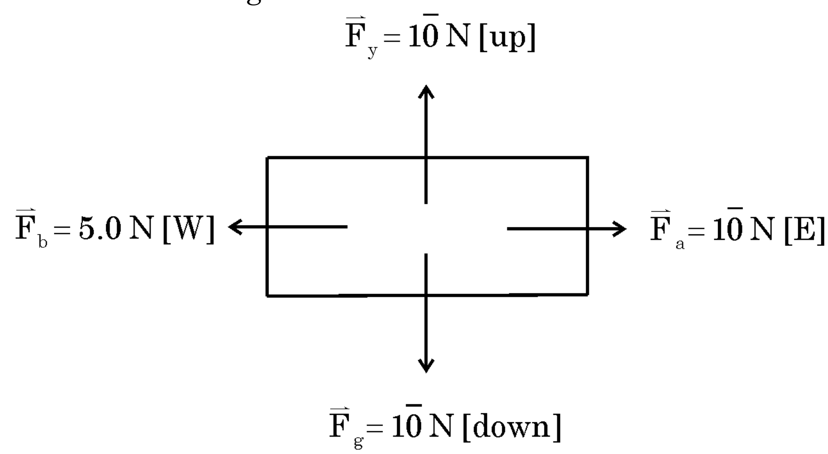
C. 

D. 

19. A force of 20 N [E] is acting on a 5.0 kg object causing it to move at a constant velocity of 4.0 m/s [E]. What is the force of friction acting on the object?

A. 0 N [W]
B. 20 N [W]
C. less than 20 N [W]
D. more than 20 N [W]

20. Four forces are acting on a wooden block as shown in the diagram below:



What conclusion can be made about the motion of the block? The block will

A. remain at rest.
B. accelerate [down].
C. accelerate towards the east.
D. accelerate towards the west.

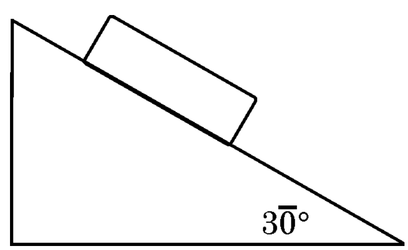
21. An unbalanced force accelerates an object at $6.0\ \text{m/s}^2$ [E]. What would be the acceleration if the object's mass is doubled and the applied force tripled?

A. $1.0\ \text{m/s}^2$ [E]
B. $4.0\ \text{m/s}^2$ [E]
C. $9.0\ \text{m/s}^2$ [E]
D. $36\ \text{m/s}^2$ [E]

22 A 3.0 kg object is acted upon by forces of $2\bar{0}$ N [S], $3\bar{0}$ N [N], and 25 N [S] simultaneously. What is the object's acceleration?

A. $5.0\ \text{m/s}^2$ [N]
B. $5.0\ \text{m/s}^2$ [S]
C. $25\ \text{m/s}^2$ [N]
D. $25\ \text{m/s}^2$ [S]

23. A box weighing 98 N is placed on a frictionless ramp which makes an angle of $3\bar{0}°$ with horizontal.

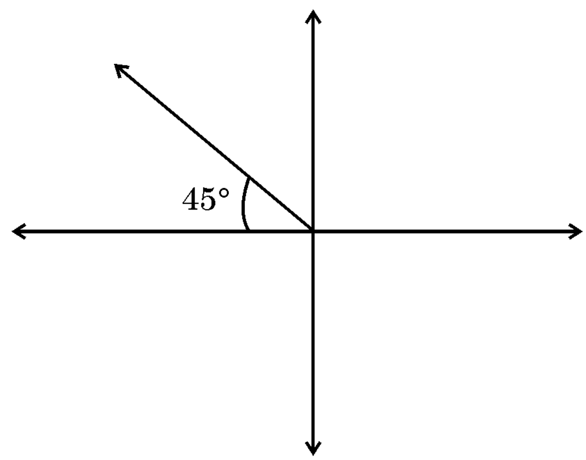


What is the magnitude of the force, $\overline{\text{F}}$, acting down the ramp?

A. 0 N
B. 49 N
C. 85 N
D. 98 N

NR3. Two forces, $\vec{F}_1$ and $\vec{F}_2$, are acting on a fixed point as shown in the diagram.

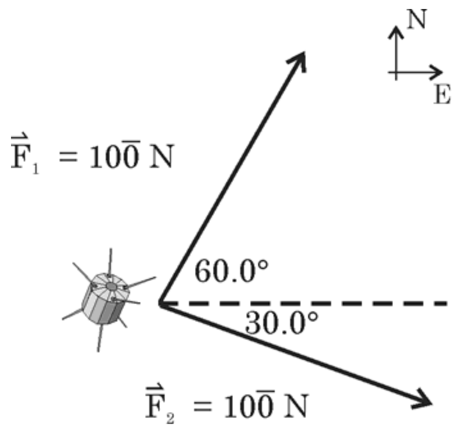
$\vec{F}_1 = 3\bar{0}$ N [E], $\vec{F}_2 = 42.4$ N [N45° W]



What is the magnitude of the resultant force rounded to the nearest newton?

(Record your answer in the numeric response section on the answer sheet.)

24. A small 10.0 kg communications satellite stranded in space is at rest relative to a space station. The satellite is subjected to the forces shown in the diagram to bring it into the space station cargo bay for repairs.



If the two forces act on the satellite for 10.0 s, what is the magnitude of the displacement during this time?

A. 1.41×10^{2} m

B. 3.53×10^{2} m

C. 7.05×10^{2} m

D. 1.00×10^{3} m

25. Which of the following best describes the forces acting on an object that has reached terminal velocity?

A. The force of gravity reaches its maximum value.
B. The force of gravity is equal to the force created by air resistance.
C. The force created by air resistance is greater than the force of gravity.
D. The force of gravity is greater than the force created by air resistance.

26. What is the increase in the gravitational potential energy of a 5.44 kg backpack carried up a 3.66 m tall flight of stairs?

A. 0 J
B. 19.9 J
C. 195 J
D. 290 J

27. Freestyle swimming, a regular overhand swimming motion, has several events in the summer Olympics including 50 m, 200 m, 400 m, and 1500 m. Of these four events, which one requires the largest power output?

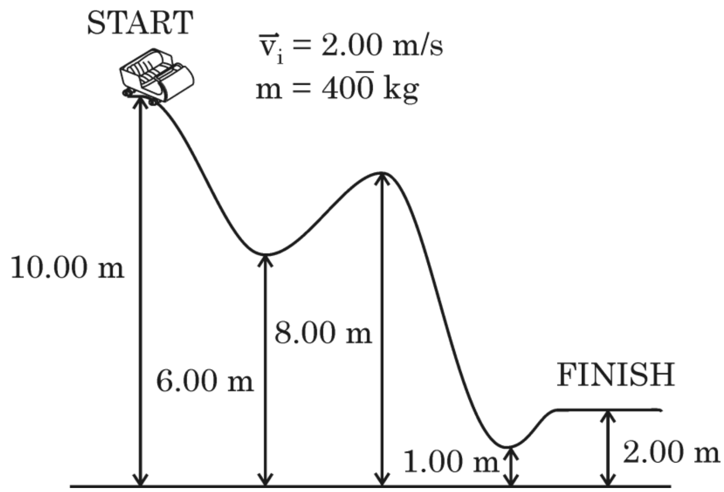
A. 50 m
B. 200 m
C. 400 m
D. 1500 m

28. A cyclist pedals his bike up a hill during a road race and applies the brakes to slow down as he is coasting down the other side.

What is the energy input into the system?

A. heat energy from friction
B. chemical energy within the cyclist
C. kinetic energy of the bike and cyclist
D. gravitational energy of the bike and cyclist

29. A $40\overline{0}$ kg roller coaster car begins its descent on a frictionless track with an initial speed of 2.00 m/s as shown in the diagram below:



What is the car's speed when it reaches the finish?

A. 2.00 m/s
B. 12.7 m/s
C. 13.4 m/s
D. 14.0 m/s

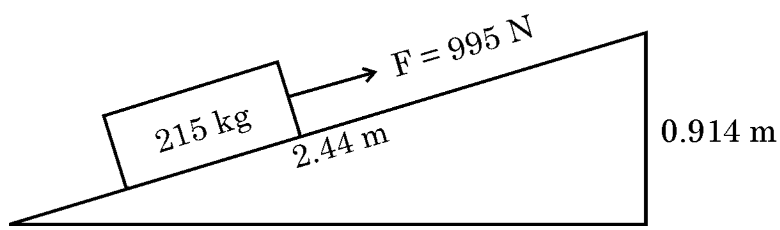
30. A 35.2 g arrow has 117 J of kinetic energy as it is shot at a target. If the arrow loses 45.0% of its energy before hitting the target, how fast is the arrow travelling upon impact?

A. 36.8 m/s
B. 52.9 m/s
C. 54.7 m/s
D. 60.5 m/s

31. A forklift exerts an average force of 29 900 N to raise a 1590 kg container of bricks to a height of 2.75 m. How much energy was converted to friction when the forklift raised the bricks?

A. 19 700 J
B. 39 400 J
C. 42 900 J
D. 82 200 J

32. Rob is taking his snowmobile for repairs and wants to load it into the back of his pickup truck whose box is 0.914 m above the ground. His friend Pete suggests it would be easier to use his 2.44 m long ramp to pull the 215 kg snowmobile up into the box rather than lifting it vertically.



If using the ramp requires an average pulling force of 995 N parallel to the ramp, what is the ramp's efficiency?

A. 20.7%
B. 79.3%
C. 126%
D. 212%

33. What characteristic must an object have if it has a positive momentum?

A. moving
B. changing speed
C. located on Earth
D. moving in an upward direction

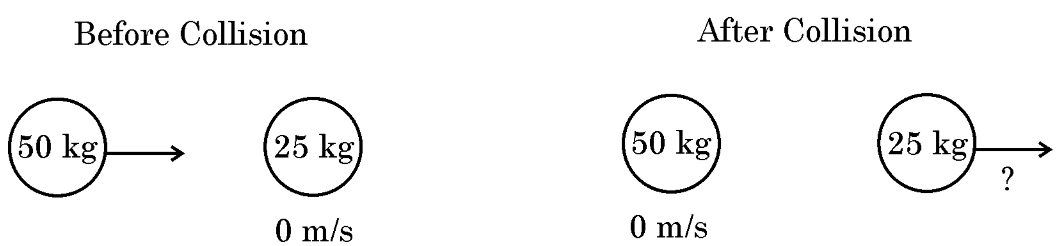
34. A baseball pitcher throws a 0.145 kg baseball towards a batter at 40.0 m/s. If the baseball reaches the batter in 1.80 s, what is its momentum?

A. 3.22 kg · m/s
B. 5.80 kg · m/s
C. 10.4 kg · m/s
D. 12.4 kg · m/s

35. A large truck with a mass of 15 000 kg collides head-on with a compact car with a mass of 800 kg. Which of the following best describes the change in momentum during the collision?

A. The truck experiences the greater change in momentum.
B. The compact car experiences the greater change in momentum.
C. The magnitude of the truck's loss in momentum is the same as the magnitude of the car's gain in momentum.
D. The magnitude of the car's loss in momentum is the same as the magnitude of the truck's gain in momentum.

NR4. A 50 kg object travelling at 6.0 m/s collides in an inelastic collision with a 25 kg object at rest. The object with the greater mass is at rest after the collision.



What is the magnitude of the velocity of the 25 kg object after the collision? Round your answer to the nearest m/s.

(Record your answer in the numeric response section on the answer sheet.)

36. A car's front end is designed to fold up and crumple during a collision. Why does this design decrease the force applied to the passengers?

A. The mass of the vehicle (m) decreases.
B. The duration of the collision (Δt) increases.
C. The stopping distance (Δd) of the vehicle decreases.
D. The change in velocity of the collision (Δv) decreases.

37. What is the gravitational field strength on the surface of the planet Mercury that has a mass of 3.301×10^{23} kg and an average diameter of 4.8794×10^{6} m?

A. 3.70 N/kg
B. 0.925 N/kg
C. 9.02×10^{6} N/kg
D. 4.51×10^{6} N/kg

Use the following information to answer questions 38 and 39.

Two identical 0.0185 kg glass marbles are suspended by separate insulated threads. Each marble has an identical uniform positive electrostatic charge of 2.00×10^{-8} C. Their centers of mass are separated by a distance of 0.0500 m.

38. What is the force of gravity between the marbles?

A. 4.94×10^{-10} N
B. 2.47×10^{-11} N
C. 9.13×10^{-12} N
D. 4.57×10^{-13} N

39. How does the electrostatic force between the marbles compare to the gravitational force?

   A. There is a repulsive gravitational force between the marbles.
   B. There is an attractive electrostatic force between the marbles.
   C. The electrostatic and gravitational forces cancel each other out.
   D. The magnitude of the electrostatic force is larger than the magnitude of the gravitational force.

---

40. Which of the following statements about dark matter is **FALSE**?

   A. Dark matter neither emits nor absorbs light or any other electromagnetic radiation.
   B. The Milky Way galaxy is estimated to have roughly 10 times more dark matter than regular matter.
   C. Dark matter is a hypothetical kind of matter that can only be detected with a scanning electron microscope.
   D. Dark matter existence and properties are inferred from its gravitational effects on visible matter, radiation, and the large scale structure of the universe.

41. Canadian astronaut Chris Hadfield conducted dozens of micro gravity experiments while aboard the International Space Station orbiting Earth. When he was orbiting Earth, which one of the following statements was true?

   A. He was experiencing zero gravity.
   B. He was in a state of constant free fall.
   C. He had slightly less mass than he had on Earth.
   D. He was experiencing zero gravitational field strength.

42. Which of the following has the largest gravitational field strength?

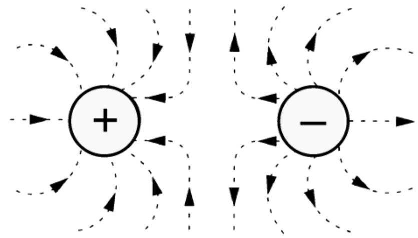
A. the Earth
B. a black hole
C. planet Jupiter
D. the Earth's moon

43. Which of the following statements about the Earth's magnetic field is FALSE?

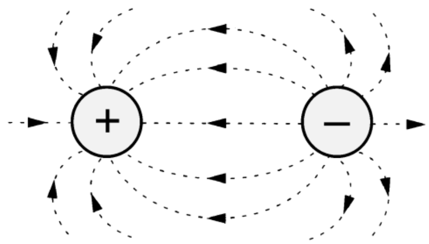
A. The Earth's magnetic poles and geographic poles are in the same location.
B. The Earth's magnetic field deflects most of the cosmic radiation coming to Earth back into space.
C. The Earth's magnetic field deflects some of the incoming charged particles towards the magnetic north pole causing the northern lights.
D. The Earth's magnetic field is caused by a solid iron core at the center of the planet that is spinning at a different rate than the surface of the Earth.

44. Which of the following diagrams correctly shows the electrical field lines surrounding two oppositely charged particles?

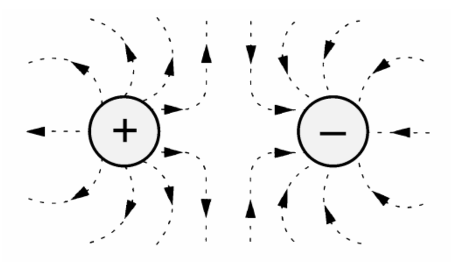
A.



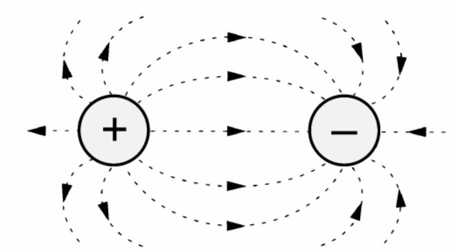
B.



C.



D.

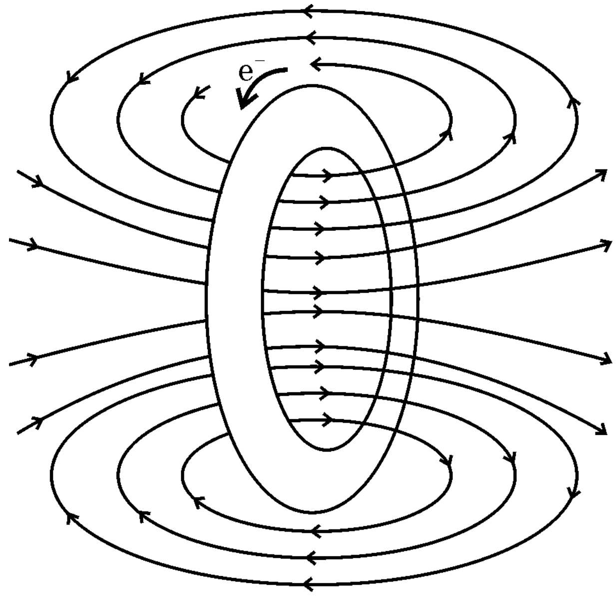


NR5. Two identical 1.8×10^{8} C charges experience a repulsive force of 1.82×10^{25} N. What distance is separating the two charges? Round to the nearest metre.

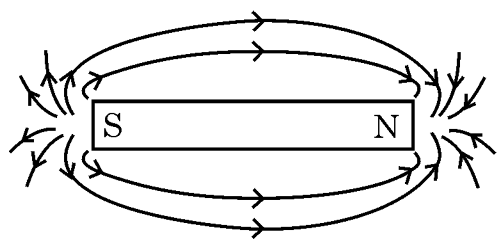
(Record your answer in the numeric response section on the answer sheet.)

45. Which of the following diagrams regarding magnetic fields is correct?

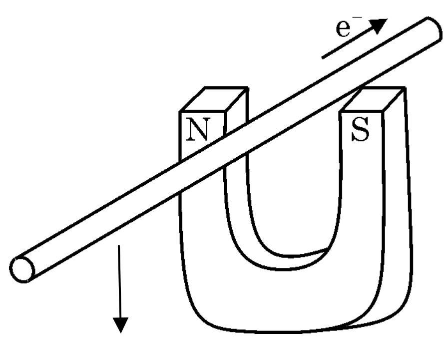
A.



B.

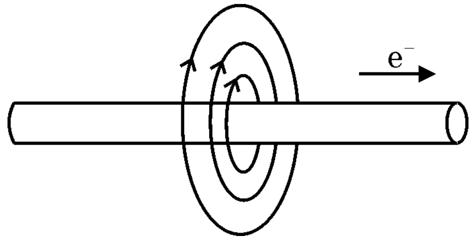


C.



Note: The wire is moving down.

D.



Government of Saskatchewan

Student Examination Form

Month and Day of Your Birth		Day	
JAN ○			
FEB ○			
MAR ○		0	0
APR ○		1	1
MAY ○		2	2
JUN ○		3	3
JUL ○			4
AUG ○			5
SEP ○			6
OCT ○			7
NOV ○			8
DEC ○			9

Physics Prototype 2016

MULTIPLE CHOICE

1	●	B	C	D	11	A	B	●	D	21	A	B	●	D	31	A	●	C	D	41	A	●	C	D
2	●	B	C	D	12	A	●	C	D	22	A	●	C	D	32	A	●	C	D	42	A	●	C	D
3	A	B	C	●	13	A	B	●	D	23	A	●	C	D	33	●	B	C	D	43	●	B	C	D
4	●	B	C	D	14	●	B	C	D	24	A	B	●	D	34	A	●	C	D	44	A	B	C	●
5	●	B	C	D	15	●	B	C	D	25	A	●	C	D	35	A	B	●	D	45	A	B	C	●
6	A	B	C	●	16	A	B	●	D	26	A	B	●	D	36	A	●	C	D	46	A	B	C	D
7	A	B	C	●	17	●	B	C	D	27	●	B	C	D	37	●	B	C	D	47	A	B	C	D
8	A	B	C	●	18	A	B	●	D	28	A	●	C	D	38	A	B	●	D	48	A	B	C	D
9	●	B	C	D	19	A	●	C	D	29	A	●	C	D	39	A	B	C	●	49	A	B	C	D
10	A	●	C	D	20	A	B	●	D	30	A	B	C	●	40	A	B	●	D	50	A	B	C	D

NUMERIC RESPONSE

NR 1				NR 2				NR 3				NR 4				NR 5			
2	5	0		1	4			3	0			1	2			4			
0	0	●	0	0	0	0	0	0	●	0	0	0	0	0	0	0	0	0	0
1	1	1	1	●	1	1	1	1	1	1	1	●	1	1	1	1	1	1	1
●	2	2	2	2	2	2	2	2	2	2	2	2	●	2	2	2	2	2	2
3	3	3	3	3	3	3	3	●	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	●	4	4	4	4	4	4	4	4	4	4	●	4	4	4
5	●	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

GRADE 12 DEPARTMENTAL EXAMINATION
Physics 30, PROTOTYPE EXAM
Answer Key

1. A.

$$E_1 : E_2$$
$$\frac{hc}{\lambda_1} : \frac{hc}{\lambda_2}$$
$$\frac{1}{300\,\text{nm}} : \frac{1}{600\,\text{nm}}$$
$$\frac{1}{3} : \frac{1}{6}$$
$$6\left(\frac{1}{3}\right) : 6\left(\frac{1}{6}\right)$$
$$2 : 1$$

2. A.

Time slows down for Emma as she travels at the speed of light. Time stays the same on Earth.

3. D.

High frequency light has enough energy to cause electrons to be given off of a piece of metal.

4. A.

$$E = \frac{hc}{\lambda}$$
$$= \frac{(6.63\times10^{-34}\,\text{J}\cdot\text{s})(3.00\times10^{8}\,\text{m/s})}{600\times10^{-9}\ \text{m}}$$
$$= 3.315\times10^{-19}\ \text{J}$$

Covert to electron volts:

$$3.315\times10^{-19}\,\text{J}\times\frac{1\ \text{eV}}{1.60\times10^{-19}\ \text{J}}$$
$$= 2.07\ \text{eV}$$

NR1. 250

t (h)	mass (g)
0	2 000
1.8 h	1 000
3.6 h	500
5.4 h	250

5. A.

Beta particles are electrons.

6. D.

Cancer, sterility, and genetic defects are all long term effects.

7. D.

One molecule is split and releases three neutrons that contact other molecules to split them and continue the cycle.

8. D.

$$E = mc^2$$

$$m = \frac{E}{c^2}$$

$$= \frac{3.09 \times 10^{-11}\ \text{J}}{(3.00 \times 10^{8}\ \text{m/s})^2}$$

$$= 3.43 \times 10^{-28}\ \text{kg}$$

9. A.

The energy from the sun comes from the fusion reaction of two hydrogen atoms creating a helium atom.

10. B.

Circular motion and a ball bouncing off a wall both involve a change in direction so velocity is changing.

11. C.

Time to reach max speed:

$$v_f = v_i + at$$
$$20.0 = 0 + 5.00\,t$$
$$t = 4.00\text{ s}$$

Distance traveled to reach max speed:

$$d = \frac{1}{2}at^2$$
$$= \frac{1}{2}(5.0\text{m/s}^2\text{ [E]})(4.0\text{ s})^2$$
$$= 40\text{ m}$$

Distance left to travel:

$$100 - 40.0 = 60\text{ m}$$

Time to travel remaining distance:

$$v = \frac{d}{t}$$
$$20.0 = \frac{60}{t}$$
$$t = 3.0\text{ s}$$

Total time $= 4.00 + 3.0 = 7.0\text{ s}$

12. B.

For a 2 000 km trip:

With wind $\dfrac{2000\text{ km}}{(500 - 250\text{ km/h})} + \dfrac{2000\text{ km}}{(500 + 250\text{ km/h})}$

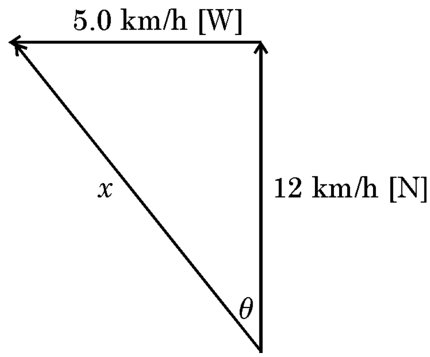
$= 10.7\text{ hrs}$

No wind $\dfrac{2000\text{ km} \times 2}{500\text{ km/h}}$

$= 8.0\text{ hrs}$

Less time with no wind.

13. C.



$$x^2 = 5.0^2 + 12^2$$
$$x = \sqrt{169}$$
$$x = 13\ \text{km/h}$$

$$\tan\theta = \frac{5.0}{12}$$
$$\theta = 23°$$
[N23° W]

$$\begin{aligned} d &= vt \\ &= (13\ \text{km/h})(0.6\ \text{h}) \\ &= 7.8\ \text{km} \end{aligned}$$

7.8 km [N23° W]

NR2. 14

$$d = v_i t + \frac{1}{2} a t^2$$
$$1000\ \text{m} = (0\text{m/s})t + \frac{1}{2}(9.8\ \text{m/s}^2)t^2$$
$$1000\ \text{m} = (4.9\text{m/s}^2)t^2$$
$$t = 14.3\ \text{s}$$
$$t = 14\ \text{s}$$

14. A.

$$v_y = v \sin 30$$
$$= (30 \text{ m/s})(0.5)$$
$$= 15.0 \text{ m/s [up]}$$

$$d = v_y t$$
$$= (15.0 \text{ m/s})(20. \text{ s})$$
$$= 30 \text{ m [up]}$$

$$d = \frac{1}{2}at^2$$
$$= \frac{1}{2}(9.8)(2)^2$$
$$= 19.6 \text{ m [down]}$$
$$30 \text{ m [up]} + 19.6 \text{ m [down]} = 10.4 \text{ m [up]}$$

15. A.

T = seconds/cycle
$$= \frac{(5.0 \text{ min})(60 \text{ s/min})}{20 \text{ rev}}$$
$$= \frac{300 \text{ s}}{20 \text{ rev}}$$
$$= 15 \text{ s/rev}$$

$$a = \frac{4\pi^2 R}{T^2}$$
$$= \frac{4(3.14)^2(6.0 \text{ m})}{(15 \text{ s/rev})^2}$$
$$= 1.1 \text{ m/s}^2$$

16. C.

$$r = \frac{D}{2}$$
$$= \frac{1.28 \times 10^7 \text{ m}}{2}$$
$$= 6.4 \times 10^6 \text{ m}$$

$$T = 1 \text{ day} \times \frac{24 \text{ hrs}}{\text{day}} \times \frac{3600 \text{ s}}{\text{hr}}$$
$$= 86\,400 \text{ s}$$

$$v = \frac{2\pi R}{T}$$
$$= \frac{2(3.14)(6.40 \times 10^6 \text{ m})}{86\,400 \text{ s}}$$
$$= 465 \text{ m/s}$$

17. A.

One day – the same as the length of time for Earth to spin on its axis.

18. C.

The mass will travel the same as a projectile following a parabolic path towards the ground.

19. B.

Velocity is constant, forces must be balanced.

$$\vec{F}_a + \vec{F}_f = 0$$

$$20\ \text{N [E]} + \vec{F}_f = 0$$

$$\vec{F}_f = 20\ \text{N [W]}$$

20. C.

$$\sum \vec{F} = \sum \vec{F}_x + \sum \vec{F}_y$$

$$= (1\overline{0}\ \text{N [E]} + 5.0\ \text{N [W]}) + (1\overline{0}\ \text{N [up]} + 1\overline{0}\ \text{N [down]})$$

$$= 5\ \text{N [E]}$$

Forces are unbalanced so acceleration will occur in the direction of the unbalanced force. (Newton's Second Law)

21. C.

$$\vec{F}_1 = m_1 \vec{a}_1$$

$$\frac{\vec{F}_1}{m_1} = 6.0\ \text{m/s}^2\ \text{[E]}$$

$$\vec{F}_2 = 3\vec{F}_1$$

$$m_2 = 2\ m_1$$

$$\vec{F}_2 = m_2 \vec{a}_2$$

$$\frac{\vec{F}_2}{m_2} = \vec{a}_2$$

$$\frac{3\vec{F}_1}{2m_1} = \vec{a}_2$$

$$\frac{3}{2}\left(\frac{\vec{F}_1}{m_1}\right) = \vec{a}_2$$

$$\frac{3}{2}(6.0\ \text{m/s}^2\ \text{[E]}) = \vec{a}_2$$

$$\vec{a}_2 = 9.0\ \text{m/s}^2\ \text{[E]}$$

22. B.

$$R = 2\bar{0}\text{ N [S]} + 3\bar{0}\text{ N [N]} + 25\text{ N [S]}$$
$$= 1\bar{0}\text{ N [N]} + 25\text{ N[S]}$$
$$= 15\text{ N [S]}$$

$$\vec{a} = \frac{\vec{F}}{m}$$
$$= \frac{15\text{ N [S]}}{3.0\text{ kg}}$$
$$= 5.0\text{ m/s}^2\text{ [S]}$$

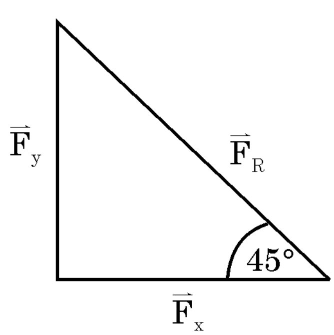
23. B.

$$\vec{F}_g \sin 30° = 98\text{ N }(0.5)$$
$$= 49\text{ N}$$

NR3. 30

$$c^2 = a^2 + b^2 - 2ab\cos c$$
$$c^2 = (3000\text{ N})^2 + (42.4\text{ N})^2 - 2(30.0)(42.4)\cos 45°$$
$$c^2 = 899\text{ N}$$
$$c = 3\bar{0}\text{ N}$$

OR



$$\vec{F}_x = \vec{F}_2 \cdot \cos 45°$$
$$= (42.4\text{ N})(0.7071)$$
$$= 30\text{ N [W]}$$
$$\vec{F}_y = \vec{F}_2 \cdot \sin 45°$$
$$= 30\text{ N [N]}$$

$\vec{F}_1 + \vec{F}_x = 0$ equal magnitude, opposite direction

$$\sum \vec{F} = \vec{F}_1 + \vec{F}_2$$
$$= (\vec{F}_1 + \vec{F}_x) + \vec{F}_y$$
$$= \vec{F}_y$$
$$= 30\text{ N [N]}$$

24. C.

$$c^2 = a^2 + b^2$$
$$c = \sqrt{100^2 + 100^2}$$
$$c = 141\ \text{N}$$

$$F = ma$$
$$141 = 10\,a$$
$$a = 14.1\ \text{m/s}^2$$

$$d = \frac{1}{2}at^2$$
$$= \frac{1}{2}(14.1\ \text{m/s}^2)(10)^2$$
$$= 705\ \text{m}$$
$$= 7.05 \times 10^2\ \text{m}$$

25. B.

A maximum velocity is achieved when gravitational force is equal to the drag force.

26. C.

Energy transferred = work done
$Fmgd = (5.44\ \text{kg})(9.81\ \text{m/s}^2)(3.66\ \text{m})$
$= 195\ \text{J}$

27. A.

The shortest distance will have the fastest speed which requires the greatest power.

28. B.

The energy generated by the cyclist's muscles is put into the bicycle.

29. B.

$$E = mgh + \frac{1}{2}mv^2$$
$$= (400\ kg)(9.80\ N/kg)(10.00\ m) + \frac{1}{2}(400\ kg)(2.00 m/s)^2$$
$$= 40\,000\ J$$

$$40\,000\ J = (400\ kg)(9.80\ N/kg)(2.00\ m) + \frac{1}{2}(400\ kg)(v^2)$$
$$v^2 = \frac{32\,160}{200}$$
$$v = 12.7\ m/s$$

30. D.

$$E_k\ final = (0.55)(E_k\ initial)$$
$$= (0.55)(117\ J)$$
$$= 64.4$$
$$E_k = \frac{1}{2}mv^2$$
$$64.4\ J = \frac{1}{2}\left(\frac{35.2\ g}{1000}\right)v^2$$
$$v^2 = 3659$$
$$v = 60.5\ m/s$$

31. B.

Energy output = mgh
= (1590 kg)(9.80 N/kg)(2.75 m)
= 42 850.5 J
Energy input = Fd
= (29 900)(2.75 m)
= 82 225 J
Difference = 82 225 – 42 850.5
= 39 400 J

32. B.

$$W = mgh$$
$$= (215\ \text{kg})(9.80\ \text{N/kg})(0.914\ \text{m})$$
$$= 1925\ \text{J}$$

$$\text{Energy input} = Fd$$
$$= (995\ \text{N})(2.44\ \text{m})$$
$$= 2427.8\ \text{J}$$

$$\text{Efficiency} = \frac{1925\ \text{J}}{2427.8\ \text{J}} \times 100$$
$$= 79.3\%$$

33. A.

For an object to have non-zero momentum, the object must be moving.

34. B.

$$p = mv$$
$$= (0.145\ \text{kg})(40.0\ \text{m/s})$$
$$= 5.80\ \text{kg} \cdot \text{m/s}$$

35. C.

The Law of Conservation of Momentum states that momentum in a closed system is conserved. The size of the vehicles does not matter; both will experience the same change in magnitude of momentum.

NR4. 12

$$m_1v_1 + m_2v_2 = m_1v_1 + m_2v_2$$
$$(50\ \text{kg})(60\ \text{m/s}) + 0 = 0 + (25\ \text{kg})(v_2)$$
$$v_2 = \frac{300}{25}$$
$$= 12\ \text{m/s}$$

36. B.

By crumpling, the collision occurs over a greater time period (Δt increases). Due to the conservation of momentum, this results in a decrease in the force applied to the passengers.

37. A.

$$g = \frac{Gm}{r^2}$$
$$= \frac{\left(6.67\times10^{-11}\ \frac{\text{Nm}^2}{\text{kg}^2}\right)\left(3.301\times10^{23}\ \text{kg}\right)}{(2.4397\times10^{6}\ \text{m})^2}$$
$$= 3.70\ \text{N/kg}$$

38. C.

$$F = \frac{Gm_1m_2}{r^2}$$
$$= \frac{\left(6.67\times10^{-11}\ \frac{\text{Nm}^2}{\text{kg}^2}\right)\left(0.0185\ \text{kg}\right)\left(0.0185\ \text{kg}\right)}{(0.050\ \text{m})^2}$$
$$= 9.13\times10^{-12}\ \text{N}$$

39. D.

The gravitational force will be extremely small due to the small mass. The electrostatic force is strong enough to move the marbles.

40. C.

Dark matter cannot be seen by an electron microscope.

41. B.

If you drop a ball, it will accelerate straight down toward the center of the earth in a state of constant free fall. If you throw a ball horizontally it will accelerate straight down towards the center of the earth in a state of constant free fall but it will also travel horizontally resulting in a parabolic trajectory before reaching the Earth's surface. If it is thrown horizontally fast enough its parabolic trajectory will match the curvature of the earth and it will never reach the earth's surface even though it is continuously accelerating towards the center of the Earth. It will remain in orbit. Because of this motion, falling and forward, Chris and all the astronauts on the International Space Station experience weightlessness.

42. B.

A black hole is an area of space that contains a large amount of matter in a small area creating a very large gravitational field.

43. A.

The magnetic and geographic poles of the Earth are not in the same location.

44. D.

Field lines go from positive to negative in straight lines, no gap in the field between the charges.

NR5. 4

$$F = \frac{kq_1q_2}{d_2}$$

$$d = \sqrt{\frac{kq_1q_2}{F}}$$

$$d = \sqrt{\frac{\left(8.99\times10^{9}\ \frac{\text{Nm}^2}{\text{c}^2}\right)(1.8\times10^{8}\ \text{C})(1.8\times10^{8}\ \text{C})}{1.82\times10^{25}\ \text{N}}}$$

$$d = 4\ \text{m}$$

45. D.

Using the left-hand rule, the thumb points in the direction of the electron (negative) current flow. Wrap the fingers around the wire to indicate the direction of the magnetic field lines.