Study Guide

For Placement into Physics 30 (PHYS 182)

Academic Upgrading Placement Test | Version: 9 Jan 2025

Important Information

The Physics Placement test is a free assessment designed for Academic Upgrading placement purposes only. No section of the test may be used for admission to any SAIT program other than Academic Upgrading. The Physics Placement Test is not accepted for admission to any other institution.

- The passing mark required for eligibility to register in PHYS-182 (Physics 30) is 60%.
- We aim to put students' passing marks on our system within 2 business days of successful completion of the test.
- Students who have been accepted into the Academic Upgrading program can register for the course they are placed into once we have granted them permission based on their passing grades.
- Students who have already taken and passed SAIT's Academic Upgrading courses in Math and Physics ARE NOT required to take a placement test.

Physics Placement Study Guide

This study guide is designed to prepare students for the Academic Upgrading Physics Placement test for entry into PHYS 182 (Physics 30). Please use the following practice material from Physics 20 to prepare for your online placement test to meet eligibility for PHYS 182. An answer key is included at the end of this guide.

This test is for placement into grade Physics 30 equivalency (PHYS 182):

- The study guide consists of 16 questions for practice. The actual test will consist of 17 questions.
- **You will need to bring a scientific calculator for the test (graphing calculators are not permitted.** You will be provided with a formula sheet, which is also provided in this guide.
- Students should allow for 60 minutes to complete the test. An additional 30 minutes has been added to allow for accommodated time, for a total test time of 90 minutes.
- A passing mark of 60% or greater is required in this test for eligibility to register in PHYS 182.

- This test is to be written in the Testing Centre.
- You may choose to utilize a Physics 20 Study Guide from the Calgary Public Library or bookstore for additional review.

SAIT Academic Upgrading Course Sequence

APSC 180
Science Prep

→

PHYS 181
Physics 20 Equivalent

→

PHYS 182
Physics 30 Equivalent

Copyright information

Learning Aids

scientific calculator, formula sheet

Physics I – PHYS 181 (PHYS 20)

Course Content

Below is presented a list of the learning modules used to achieve the learning outcome(s) for this course….

1. : Kinematics

Learning Outcome:

Students will describe motion in terms of displacement, velocity, acceleration and time.

Objectives:

1. define, qualitatively and quantitatively, displacement, velocity and acceleration

2. define, operationally, and compare and contrast scalar and vector quantities.

3. explain, qualitatively and quantitatively, uniform and uniformly accelerated motion when provided with written descriptions and numerical and graphical data.

4. interpret, quantitatively, the motion of one object relative to another, using displacement and velocity vectors.

5. explain, quantitatively, two-dimensional motion in a horizontal or vertical plane, using vector components.

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2. : Dynamics

Learning Outcome:

Students will explain the effects of balanced and unbalanced forces on velocity.

Objectives:

1. explain that a nonzero net force causes a change in velocity
2. apply Newton's first law of motion to explain, qualitatively, an object's state of rest or uniform motion.
3. apply Newton's second law of motion to explain, qualitatively, the relationships among net force, mass and acceleration.
4. apply Newton's third law of motion to explain, qualitatively, the interaction between two objects, recognizing that the two forces, equal in magnitude and opposite in direction, do not act on the same object.
5. explain, qualitatively and quantitatively, static and kinetic forces of friction acting on an object.
6. calculate the resultant force, or its constituents, acting on an object by adding vector components graphically and algebraically.
7. apply Newton's laws of motion to solve, algebraically, linear motion problems in horizontal, vertical and inclined planes near the surface of Earth, ignoring air resistance.
8. analyze data and apply mathematical and conceptual models to develop and assess possible solutions
9. use free-body diagrams to describe the forces acting on an object.

Learning Outcome:

Students will explain that gravitational effects extend throughout the universe.

Objectives:

1. identify the gravitational force as one of the fundamental forces in nature.
2. describe, qualitatively and quantitatively, Newton's law of universal gravitation.
3. explain, qualitatively, the principles pertinent to the Cavendish experiment used to determine the universal gravitational constant, G.
4. define the term "field" as a concept that replaces "action at a distance" and apply the concept to describe gravitational effects.

5. relate, qualitatively and quantitatively, using Newton's law of universal gravitation, the gravitational constant to the local value of the acceleration due to gravity

6. predict, quantitatively, differences in the weight of objects on different planets.

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3. : Circular Motion, Work and Energy

Learning Outcome:

Students will explain circular motion, using Newton's laws of motion.

Objectives:

1. describe uniform circular motion as a special case of two-dimensional motion.

2. explain, qualitatively and quantitatively, that the acceleration in uniform circular motion is directed toward the centre of a circle.

3. explain, quantitatively, the relationships among speed, frequency, period and radius for circular motion.

4. explain, qualitatively, uniform circular motion in terms of Newton's laws of motion.

5. explain, quantitatively, planetary and natural and artificial satellite motion, using circular motion to approximate elliptical orbits.

6. predict the mass of a celestial body from the orbital data of a satellite in uniform circular motion around the celestial body.

7. explain, qualitatively, how Kepler's laws were used in the development of Newton's law of universal gravitation.

Learning Outcome:

Students will explain that work is a transfer of energy and that conservation of energy in an isolated system is a fundamental physical concept.

Objectives:

1. define mechanical energy as the sum of kinetic and potential energy..

2. determine, quantitatively, the relationships among the kinetic, gravitational potential and total mechanical energies of a mass at any point between maximum potential energy and maximum kinetic energy.

3. analyze, quantitatively, kinematics and dynamics problems that relate to the conservation of mechanical energy in an isolated system.

4. recall work as a measure of the mechanical energy transferred and power as the rate of doing work.

5. describe power qualitatively and quantitatively.

6. describe, qualitatively, the change in mechanical energy in a system that is not isolated.

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4. : Oscillatory Motion and Mechanical Waves

Learning Outcome:

Students will describe the conditions that produce oscillatory motion.

Objectives:

1. describe oscillatory motion in terms of period and frequency.

2. define simple harmonic motion as a motion due to a restoring force that is directly proportional and opposite to the displacement from an equilibrium position.

3. explain, quantitatively, the relationships among displacement, acceleration, velocity and time for simple harmonic motion, as illustrated by a frictionless, horizontal mass-spring system or a pendulum, using the small-angle approximation.

4. determine, quantitatively, the relationships among kinetic, gravitational potential and total mechanical energies of a mass executing simple harmonic motion.

5. define mechanical resonance.

Learning Outcome:

Students will describe the properties of mechanical waves and explain how mechanical waves transmit energy.

Objectives:

1. describe mechanical waves as particles of a medium that are moving in simple harmonic motion.

2. compare and contrast energy transport by matter and by waves

3. define longitudinal and transverse waves in terms of the direction of motion of the medium particles in relation to the direction of propagation of the wave.

4. define the terms wavelength, wave velocity, period, frequency, amplitude, wave front and ray as they apply to describing transverse and longitudinal waves.

5. describe how the speed of a wave depends on the characteristics of the medium.

6. predict, quantitatively, and verify the effects of changing one or a combination of variables in the universal wave equation $v = f\lambda$.

7. explain, qualitatively, the phenomenon of reflection as exhibited by mechanical waves.

8. explain, qualitatively, the conditions for constructive and destructive interference of waves and for acoustic resonance.

9. explain, qualitatively and quantitatively, the Doppler effect on a stationary observer of a moving source.

Self-Assessment

This assessment is only meant to give students an idea of what the multiple choice questions will look like. Refer to the objectives so that you make sure to study all topic areas.

1. A truck (mass = 2.50×10^3 kg) is traveling at 90.0 km/h on a level road. The driver applies the brakes and decelerates at -3.30 m/s^2.

   Find:
   a) the time taken for the truck to stop
   b) the velocity of the truck for the first 8 seconds and fill in the table below

Time /s	Velocity /ms^{-1}
1	
2	
3	
4	
5	
6	
7	
8	

   c) the displacement of the truck when it stops.
   d) Explain why the velocity of the truck at 8 seconds cannot be -1.4 m/s.

2. A basketball rebounds of the ground with an upward vertical velocity of 20.2 m/s

   Find:
   a) the velocity of the basketball at one second intervals until it hits the ground again.
   b) the maximum height that the basketball reaches.

3. Find the magnitude and standard angle of the resultant for the following three vectors:
   A=20.0 N @ 24° B = 24.0 N @ 270° C = 12.0 N @ 122°

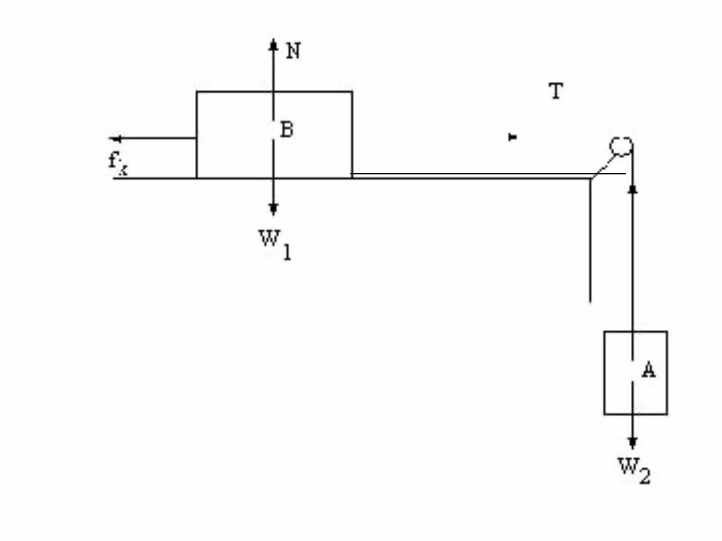
4. A student throws a ball horizontally from the top of the Senator Burns Building. The building is 120.0 m high, and the ball lands 55.0 m from the building. (*g=9.81* m/s^2)

   Find:
   a) the initial velocity of the ball.
   b) the velocity, at t = 2.80 s.

5. You have a mass of 75.0 kg and you are in an elevator and you are standing on a scale that reads your weight on Newtons. If the elevator accelerates downward at 1.90 m/s^2, what is the scale reading?

6. Two masses A and B are connected by a light cord. Mass B is 4.00 kg and rests on a horizontal table top. There is friction between mass B and the table. The kinetic coefficient is 0.330. Mass A (3.00 kg) hangs over the table edge by means of frictionless pulley and is falling downward at 1.00 m/s at this instant.

Find:
   a) the velocity when mass A has fallen 2.00 m
   b) the tension in the cord.



7. Calculate the centripetal acceleration of the Earth in its orbit around the Sun and net force exerted on the Earth. (see data tables at end of formula sheet)

8. A spring (k = 400.0 N/m) is initially hung vertically.
   a) If a 5.000 kg mass is attached to the end of the spring and gently lowered to rest position, how much will the spring extend by?
   b) If the mass-spring system is placed on a horizontal frictionless surface and the mass is displaced by the amount calculated in part a), determine the maximum velocity of the mass once it is released.
   c) What is the potential energy of the spring when it is stretched to 8.00 cm from equilibrium?

9. You are riding on the C-Train on a warm (30° C) day in July. The windows are open and you can hear the "clang clang" of the crossing bell on 36th Street. The normal frequency of the bell is 600.0 Hz. The speed of the train as it passes the crossing 90.0 km/h. What **change** in frequency is observed from when you approach the crossing bell to when you are moving away from the crossing bell? (*Speed of sound in air at 30°C = 331 m/s*)

10. Robert pushes a lawn mower on a level lawn with a constant force of 200.0 N at an angle of 30° to the horizontal. How far does he push the mower in doing 1440 J of work?

11. A girl swings back and forth on a swing with ropes that are 4.00 m long. The maximum height she reaches is 2.00 m above the ground. At the lowest point of the swing, she is 0.500 m above the ground. What is the girl's maximum speed at the bottom of the swing?

12. Calculate the speed of the moon Mimas as it orbits Saturn, using the information from the data tables included with the formula sheet.

13. A wave is travelling at 423.0 m/s and has a wavelength of 31.7 cm. What is the period of the wave?

14. A 10.0 kg box is placed on a 26.5° incline and allowed to slide down the slope. The coefficient of kinetic friction between the box and the slope is 0.111.
    a) What is the normal force acting on the box?
    b) What is the friction force acting on the box?
    c) Calculate the net acceleration of the box.

15. Calculate the gravitational field strength g, of the planet Neptune using the information from the data tables included with the formula sheet.

16. Review Newton's Laws, Kepler's Laws, Hooke's Law

Grade 11 Material: Answer Key
For placement into PHYS 182 (Physics 30)

1.
   a) 7.58 s
   b)

Time /s	Velocity /m/s
1	21.7
2	18.4
3	15.1
4	11.8
5	8.50
6	5.20
7	1.90
8	0.00

   c) 94.7 m
   d) because the brakes cause the truck to reach a stop, they will not cause it to reverse or speed up in the opposite direction.

2. a) 10.4, 0.580, -9.23 -19.0, 0.00 m/s b) 20.8 m

3. **Resultant** = 13.2 m @ 334°

4. a) 11.1 m/s horizontally only b) 29.6 m/s θ = 68° down from horizontal

5. 593 N

6. a) 3.23 m/s b) 22.4 N

7. $a_c = 5.89 \times 10^{-3}$ m/s^2 toward the sun (centripetal acceleration of Earth)
   $F_c = 3.52 \times 10^{22}$ N toward the sun (net force producing acceleration)

8. a) 0.1227 m or 12.27 cm
   b) 1.097 m/s
   c) 1.28 J

9. Δf = 91.0 Hz

10. 8.31 m

11. 5.42 m/s

12. 1.43×10^4 m/s (use $F_c = F_G$)

13. 7.49×10^{-4} s

14. a) +87.8 N b) +9.75 N c) -3.40 m/s^2

15. 11.2 m/s^2

Grade 11 Material: Formula Sheet
For placement into PHYS 182 (Physics 30)

Note: use 9.81 m/s^2 for the acceleration due to gravity and 6.67 x 10^{-11} N·m^2/kg^2 for the universal gravitation constant

$$v = \frac{d}{t} \qquad \vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t} \qquad v_{ave} = \frac{\Delta d}{\Delta t}$$

$$\overrightarrow{\Delta d} = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}t^2 \qquad \overrightarrow{\Delta d} = \left(\frac{\vec{v}_i + \vec{v}_f}{2}\right)t \qquad \Delta d = \vec{v}_f \Delta t - \frac{1}{2}\vec{a}t^2$$

$$a_{ave} = \frac{\Delta v}{\Delta t} \qquad \vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2a\overrightarrow{\Delta d} \qquad |v_c| = \frac{2\pi r}{T}$$

$$|a_c| = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2} \qquad \vec{F}_{net} = m\vec{a} \qquad F_c = \frac{mv^2}{r}$$

$$g = \frac{F_g}{m} \qquad |F_g| = \frac{Gm_1 m_2}{r^2} \qquad |g| = \frac{Gm}{r^2}$$

$$|F_f| = \mu |F_N| \qquad F_s = -kx$$

$$E_k = \frac{1}{2}mv^2 \qquad E_p = mgh \qquad E_p = \frac{1}{2}kx^2$$

$$E_m = E_k + E_p = \frac{1}{2}mv^2 + mgh \qquad W = |F||d|\cos\theta \qquad W = \Delta E$$

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad T = 2\pi\sqrt{\frac{m}{k}} \qquad T = \frac{1}{f}$$

$$f_d = f_{source}\left(\frac{v_{sound}}{v_{sound} \mp v_{source}}\right) \qquad K = \frac{T_A^2}{r_A^3} = \frac{T_B^2}{r_B^3} \qquad \%efficiency = \frac{W_{out}}{W_{in}} \times 100\%$$

$$T^2 = \left(\frac{4\pi^2}{GM_{Sun}}\right)r^3 \qquad v = f\lambda \qquad v = (331 + 0.6T_C)$$

Planet	Moons	Mass (kg)	Equatorial Radius (m)	Orbital Period (Earth days)	Mean Orbital Radius (m)
Earth	Moon	7.35×10^{22}	1.737×10^{6}	27.322	3.844×10^{8}
Mars	Phobos	1.063×10^{16}	1.340×10^{4}	0.3189	9.378×10^{6}
	Deimos	2.38×10^{15}	7.500×10^{3}	1.262	2.346×10^{7}
Jupiter (4 most massive)	Io	8.9316×10^{22}	1.830×10^{6}	1.769	4.220×10^{8}
	Europa	4.79982×10^{22}	1.565×10^{6}	3.551	6.710×10^{8}
	Ganymede	1.48186×10^{23}	2.634×10^{6}	7.154	1.070×10^{9}
	Callisto	1.07593×10^{23}	2.403×10^{6}	16.689	1.883×10^{9}
Saturn (7 most massive)	Mimas	3.75×10^{19}	2.090×10^{5}	0.942	1.855×10^{8}
	Enceladus	7×10^{19}	2.560×10^{5}	1.37	2.380×10^{8}
	Tethys	6.27×10^{20}	5.356×10^{5}	1.887	2.947×10^{8}
	Dione	1.10×10^{21}	5.600×10^{5}	2.74	3.774×10^{8}
	Rhea	2.31×10^{21}	7.640×10^{5}	4.52	5.270×10^{8}
	Titan	1.3455×10^{23}	2.575×10^{6}	15.945	1.222×10^{9}
	Iapetus	1.6×10^{21}	7.180×10^{5}	79.33	3.561×10^{9}
Uranus (5 most massive)	Miranda	6.6×10^{19}	2.400×10^{5}	1.41	1.299×10^{8}
	Ariel	1.35×10^{21}	5.811×10^{5}	2.52	1.909×10^{8}
	Umbriel	1.17×10^{21}	5.847×10^{5}	4.14	2.660×10^{8}
	Titania	3.53×10^{21}	7.889×10^{5}	8.71	4.363×10^{8}
	Oberon	3.01×10^{21}	7.614×10^{5}	13.46	5.835×10^{8}
Neptune (3 most massive)	Proteus	5.00×10^{19}	2.080×10^{5}	1.12	1.176×10^{8}
	Triton	2.14×10^{22}	1.352×10^{6}	5.8766	3.548×10^{8}
	Nereid	2.00×10^{19}	1.700×10^{5}	360.14	5.513×10^{9}

Table 1 – Planets and their large moons – Ackroyd et al, "Unit III Circular Motion, Work, and Energy" in Physics. 1st edition, Ontario, Canada, Pearson, 2009, Ch. 5, p274

Object	Mass (kg)	Radius of object (m)	Period of rotation on axis (s)	Mean radius of orbit (m)	Period of revolution orbit (s)
Sun	1.98×10^{30}	6.95×10^{8}	2.14×10^{6}	–	–
Mercury	3.28×10^{23}	2.57×10^{6}	5.05×10^{6}	5.79×10^{10}	7.60×10^{6}
Venus	4.83×10^{24}	6.31×10^{6}	2.10×10^{7}	1.08×10^{11}	1.94×10^{7}
Earth	5.98×10^{24}	6.38×10^{6}	8.61×10^{4}	1.49×10^{11}	3.16×10^{7}
Mars	6.37×10^{23}	3.43×10^{6}	8.85×10^{4}	2.28×10^{11}	5.91×10^{7}
Jupiter	1.90×10^{27}	7.18×10^{7}	3.54×10^{4}	7.78×10^{11}	1.74×10^{8}
Saturn	5.67×10^{26}	6.03×10^{7}	3.60×10^{4}	1.43×10^{12}	9.30×10^{8}
Uranus	8.80×10^{25}	2.67×10^{7}	3.88×10^{4}	2.87×10^{12}	2.66×10^{9}
Neptune	1.03×10^{26}	2.48×10^{7}	5.69×10^{6}	4.50×10^{12}	5.20×10^{9}
Pluto	6.00×10^{23}	3.00×10^{6}	5.51×10^{5}	5.90×10^{12}	7.82×10^{9}
Moon	7.34×10^{22}	1.74×10^{6}	2.36×10^{6}	3.80×10^{8}	2.36×10^{6}

Table 2 – Planets and their constants