PURDUE UNIVERSITY
West Lafayette, Indiana

Physics 152 Study Guide

This study guide is intended to aid students in ascertaining whether or not they have sufficient preparation in physics to be successful in testing out of Physics 152. It is important to realize that this course consists of lecture, laboratory, recitation, tutorials and much homework. One written exam is not able to test all of a student's experiences in Physics 152. The way to make sure that you have had the equivalent of Physics 152 in preparation for later courses is to take this one for credit. However, if you feel that you have had a true equivalent, you may try to test out of Physics 152 only one time.

The following problems are taken from an earlier Physics 152 exam. Note that the advanced credit exam is made up of conceptual questions and numerical problems. All are in a multiple-choice format. Most require use of several physics principles to obtain an answer.

The examination lasts 3 hours: calculators may be used. A set of equations that may be useful will be provided; do not bring your own equation sheet. A score of 80% is required in order to pass this exam.

PLEASE NOTE: Double line display, non-programmable calculators can be used during the physics credit exam. If you show up with a programmable calculator, you will not be allowed to use it.

(Answers to test questions are <u>not</u> provided.)

A STUDENT CANNOT TRY TO TEST OUT OF PHYSICS 152 MORE THAN ONCE.

1. A car is travelling a constant 90 m/s. A police car starts from rest just as the speeder passes it and accelerates at a constant rate of 7 m/s^2. How far have the cars traveled (in kilometers) when the police car catches the speeder?

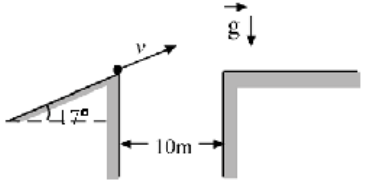
(1) 2.3 (2) 2.0 (3) 1.8 (4) 4.6

(5) 1.2 (6) 12.8 (7) 0.31

$v = v_i + at$ $\quad x = x_0 + v_0 t + \frac{1}{2}at^2$ $\quad x = \frac{1}{2}ax^2$

$v = \frac{x}{t} \Rightarrow t = x/v$ $\quad x = \frac{2v^2}{a}$ $\quad x = \frac{2(8100)}{7}$

2. A bicycle comes to a ditch. A ramp with an incline of 17° has been built so the bike can jump the ditch. If the bike needs to jump a horizontal distance of 10 m, at what minimum speed must it be going when it leaves the ramp? Assume the bicycle leaves the ramp and lands at the same height.



(1) 16.6 m/s (2) 11.9 m/s (3) 10.6 m/s

(4) 15.4 m/s (5) 13.2 m/s (6) 14.7 m/s (7) 17.3 m/s

vp

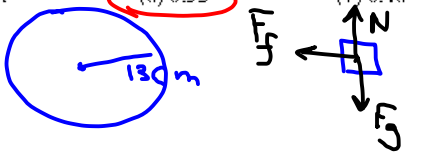
$d_x = \frac{v^2 \sin 2\theta}{g} \Rightarrow v = \sqrt{\frac{10 m/s^2 (10)}{\sin 2(17°)}}$

3. A 0.25 kg mass is placed on a horizontal rotating turntable 13 cm from the axis or rotation. If the mass just begins to slide when the turntable is rotating at 1 revolution per second, what is the coefficient of static friction?

$2\pi r \cdot 1 \frac{rev}{sec}$

(1) 0.79 (2) 0.73 (3) 0.84 (4) 0.64

(5) 0.91 (6) 0.52 (7) 0.46



$\Sigma F_x = ma_c = F_f$

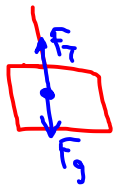
$m\frac{v^2}{r} = \mu N$

$m\frac{(2\pi r)^2}{r} = \mu mg$

4. A woman holding a 12 kg block by a cord designed to break at a tension of 180 N steps into an elevator. When the elevator starts up, the cord breaks. What was the minimum possible acceleration of the elevator?

(1) 5.2 m/s^2 (2) 3.2 m/s^2 (3) 4.7 m/s^2 (4) 6.1 m/s^2

(5) 1.1 m/s^2 (6) 2.4 m/s^2 (7) 3.9 m/s^2

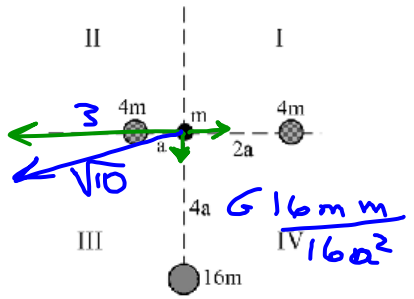


$\Sigma F = ma = F_T - F_g$

$ma = 180N - 120N$

$a = 60N/12kg$

5. Mass m is located between three other masses. See the figure, which shows a co-ordinate origin centered at m. All masses are at rest. Find the total force of gravity on m due to the other masses. Specify its magnitude (and direction by stating which quadrant the force points toward).



(1) $\sqrt{10}$ GmM/a^2 in III

(2) 4 GmM/a^2 in III

(3) $\sqrt{18}$ GmM/a^2 in I

(4) 4 GmM/a^2 in IV

(5) 6 GmM/a^2 in IV

(6) 6 GmM/a^2 in III

(7) GmM/a^2 toward 16M

$F = G\frac{m_1 m_2}{r^2}$ $\quad G\frac{16mm}{16a^2}$

$F_x = G\frac{4mm}{a^2} - G\frac{4mm}{4a^2}$

$F_x = 3G\frac{mm}{a^2}$

6. Water flows over Victoria Falls, which is 100 m high, at a rate of 1.4×10^6 kg/s. If all the potential energy were converted into electrical energy, how much power (in watts) could be produced by these falls? Neglect the water speed at the top of the falls.

(1) 2.6×10^9 (2) 1.9×10^9 (3) 1.4×10^9 (4) 9.3×10^8

(5) 8.7×10^8 (6) 7.2×10^8 (7) 6.6×10^8

$PE = mgh$

$\text{Power} = \frac{\text{Energy}}{\text{time}}$

$\text{Power} = (\text{height})(\text{acceleration gravity})(\text{rate})$

$= (100\text{m})(10)(1.4\times10^6 \frac{\text{kg}}{\text{s}})$

7. A 50.0 kg boy starts from rest and slides down a hill that slopes 60° down from the horizontal and is 50.0 m long. His speed at the bottom is 8.00 m/s. The heat energy shared by his pants and the hill is

(1) 10.7×10^3 J (2) $1.23 \times .10^3$ J (3) 19.6×10^3 J (4) 565 J

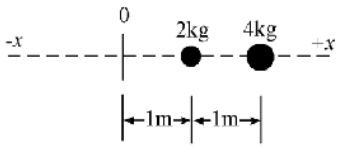
(5) 21.2×10^3 J (6) 5.11×10^3 J (7) 123 J

8. A 5.0 kg object with an initial velocity of 4.0 m/s collides head-on with a 10 kg object with an initial velocity of 3.0 m/s in the opposite direction. After the collision, the 10 kg object is at rest. How much of the initial kinetic energy is converted into heat?

(1) 170 J (2) 85 J (3) 68 J (4) 61 J

(5) 57 J (6) 125 J (7) 75 J

9. Two objects of mass 2 kg and 4 kg are placed on the x-axis as shown in the figure. At what position, x, should a third mass of 3 kg be placed to have the center of mass of all three objects be at $\bar{x} = 0$?



(1) $x = -1.00$ m

(2) $x = 0$

(3) $x = 11.66$ m

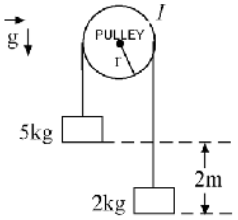
(4) $x = -3.33$ m

(5) none of the other answers

(6) $x = 11.00m$

(7) x = -1.66 m

10. Two masses, 5 kg and 2 kg, are connected by a massless cord. The cord passes over a pulley with radius = 1 m and $I = 3$ kg-m^2, without slipping. Initially, the masses are at rest and the 5 kg mass is 2 m above the 2 kg mass. Find the speed of the masses when they are at the same height. Neglect heat losses.



(1) 0.8 m/s (2) 3.3 m/s (3) 3.9 m/s

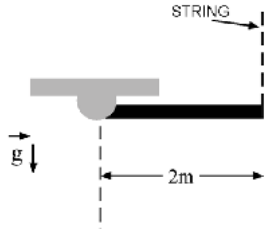
(4) 2.4 m/s (5) 1.3 m/s (6) 1.8 m/s

(7) 2.7 m/s

11. A disk-shaped grindstone of mass 2 kg is uniformly dense. Its radius is 8 cm and it is spinning at 800 rev/min when the power is shut off. If it takes 60 s to stop, what average frictional torque (in $N \cdot m$) is exerted by the bearings?

(1) 8.9×10^{-3} (2) 9.7×10^{-3} (3) 1.6×10^{-2} (4) 1.9×10^{-2}
(5) 2.3×10^{-2} (6) 2.8×10^{-2} (7) 3.4×10^{-2}

12. A uniform rod of length 2 m is hinged by a pivot attached to one end and held in a horizontal position by a vertical massless string attached to the other end. The string is released. (Assume the rod is free to rotate in a vertical plane, take $I_{rod} = mL^2/3$, and neglect friction.) Find the angular velocity (in rad/s) of the bar when it swings through the bottom vertical position.

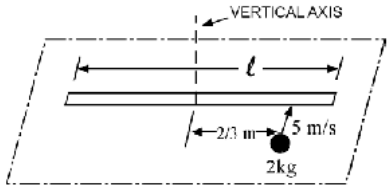


(1) 14.7 (2) 3.8 (3) 5.4
(4) 29.4 (5) 7.3 (6) 22.1
(7) None of the other answers.

13. An ice skater spins with arms extended at a rate of 2.0 rev/second. As she draws her arms inward, her spin rate increases to 3.5 rev/s. What is the ratio of her final moment of inertia to her initial moment of inertia, I_f/I_i?

(1) 3.06 (2) 0.57 (3) 1.75 (4) 1.00
(5) 0.33 (6) 0.76 (7) 1.32

14. A 4 kg rod of length ℓ is at rest on a horizontal frictionless surface. It is free to pivot about its center. A 2 kg piece of putty approaches with velocity 5 m/s perpendicular to the rod and strikes the rod at a distance of 2/3 meter from the pivot. The putty sticks. If the final value of ω is 2 rad/s, what is the value of ℓ?



(1) 1.66 m (2) 0.66 m (3) 0.6m (4) 2.71 m

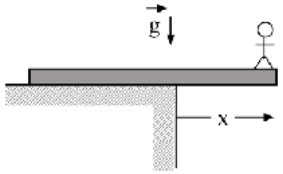
(5) 1.75 m (6) 1.0 m (7) 2.0 m

15. A 100 N uniform ladder which is 8.0 m long rests against a smooth vertical wall. The coefficient of static friction between ladder and floor is 0.40. If the ladder makes a 65° angle with the wall, what is the frictional force acting at the bottom of the ladder?

(I) 140.0 N (2) 40.0 N (3) 107.2 N (4) 70.0 N

(5) 46.6 N (6) 23.3 N (7) None of the other answers.

16. A uniform 12 meter beam of mass 300 kg extends a distance x past the edge of a horizontal roof. If a 60 kg student can just walk to the end without tipping the beam, what is x?



(1) 2.5 m (2) 3.5 m (3) 4.5 m

(4) 5.5 m (5) 3 m (6) 4 m

(7) 5 m

17. A car sinks in a lake to a depth of 8 m. If the area of the car door is 0.5 m^2 what is the force exerted on the outside of the door due only to the water (neglect atmosphere pressure on top of the lake)? Assume the pressure is constant over area of door.

(1) 3.4 x 10^4 N (2) 5.6 x 10^4 N (3) 6.9 x 10^4 N (4) 4.5 x 10^4 N

(5) 2.9 x 10^4 N (6) 3.9 x 10^4 N (7) 6.1 x 10^4 N

18. A solid block or unknown material weighs 7.00 N in air and 6.25 N when fully submerged in water. What is the volume of the block (in m^3)?

(1) 8.93 x 10^{-5} (2) 4.46 x 10^{-5} (3) 6.22 x 10^{-5} (4) 2.21 x 10^{-5}

(5) 3.18 x 10^{-5} (6) 3.73 x 10^{-5} (7) 7.65 x 10^{-5}

19. Blood flows in a blood vessel of radius 8.5 mm at 35 cm/s. If the blood from this vessel flows into many smaller vessels at the same height, where the speed of flow in each vessel is measured to be 0.13 cm/s, calculate the total cross-sectional area of the small vessels.

(1)790 cm^2 (2) 730 cm^2 (3) 570 cm^2 (4) 470 cm^2

(5) 530 cm^2 (6) 610 cm^2 (7) 680 cm^2

20. A 15,000 N auto on a hydraulic lift rests on a cylinder with a piston radius of 0.20 m. If a connecting cylinder with a piston radius of 0.040 m is driven by compressed air, what force must be applied to this smaller piston in order to lift the auto?

(1) 15,000 N (2) 5900 N (3) 1500 N (4) 3750 N

(5) 600 N (6) 6000 N (7) 150 N

21. A mass, moving with simple harmonic motion, has an amplitude of 0.020 m and experiences a maximum acceleration of 40 m/s^2. What is the frequency of this motion?

(1) 0.60 Hz (2) 3.7 Hz (3) 5.1 Hz (4) 7.1 Hz

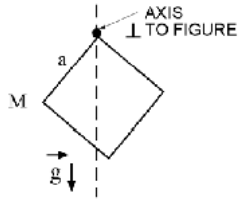
(5) 16 Hz (6) 32 Hz (7) 45 Hz

22. A spring of negligible mass is hanging vertically. An object of unknown mass is hung on the end of the unstretched spring and is released from rest. If it falls 5.6 cm before first coming to rest, find the period of the subsequent vibration. Neglect frictions.

(1) 0.18 sec (2) 0.11 sec (3) 0.23 sec (4) 0.29 sec

(5) 0.34 sec (6) 0.42 sec (7) 0.48 sec

23. A square metal plate of mass M and edge length 'a' is suspended at one corner on a horizontal axis which is perpendicular to the plate's area. The plate is set into small-amplitude oscillation by pulling it aside from its equilibrium position by an angle of 0.10 radians and releasing it from rest. The moment of inertia of the plate about an axis thru its center of mass, parallel to the actual axis of rotation, is $Ma^2/6$. The period of oscillation will be, in the absence of friction:



(1) $2\pi\sqrt{\left(\frac{a}{g}\right)}$ (2) $2\pi\sqrt{\left(\frac{4a}{3g}\right)}$ (3) $2\pi\sqrt{\left(\frac{4}{3\sqrt{2}}\frac{a}{g}\right)}$ (4) $2\pi\sqrt{\left(\frac{4a}{g}\right)}$

(5) $2\pi\sqrt{\left(\frac{a}{3g}\right)}$ (6) $2\pi\sqrt{\left(\frac{3a}{4g}\right)}$ (7) None of the other answers

24. A transverse wave of frequency 80 Hz propagates down a string. Two points 5 cm apart are out of phase by $\pi/6$. What is the wave velocity?

(1) 48 m/s (2) 54 m/s (3) 43 m/s (4) 39 m/s

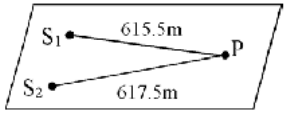
(5) 35 m/s (6) 30 m/s (7) 27 m/s

25. Two adjacent strings on a guitar are tuned to frequencies which have a ratio of 3 to **4**. Both strings are of the same length and experience the same tension. The mass of the higher frequency string divided by the mass of the lower is:

(1) 2.60 (2) 1.78 (3) 1.15 (**4**) 0.75

(5) 1.33 (6) 0.87 (7) 0.56

26. Two waves of the same frequency travel on the surface of water, see figure. If the sources are in phase and constructive interference occurs at P, then the wavelength of the waves cannot be:

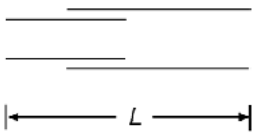


(1) 0.5 m (2) 0.25 m (3) 1 m

(**4**) 2 m (5) 3 m (6) 0.125 m

(7) 0.0625 m

27. A vibrating fork is held at one end of a pipe open at both ends (see figure) whose effective length can be changed because of its telescoping nature (one inside the other). Resonance will occur when the air column is successively the following number of wavelengths long:



(1) 1/2, 3/2, 5/2, 7/2

(2) 1, 2, 3, **4**

(3) 1/**4**, 1/2, 3/**4**, 1

(**4**) 1/2, 1, 3/2, 2

(5) 1/**4**, 3/**4**, 5/**4**, 7/**4**

(6) 1, 3, 5, 7

(7) 2, **4**, 6, 8

28. The motor of an airplane is emitting a sound whose frequency is 800 Hz. When the plane is flying toward a stationary observer the latter hears a sound whose apparent frequency is 1200 Hz. What is the velocity of the plane? (Assume that the speed of sound is 1000 ft/s.)

(1) 1667 ft/s (2) 1500 ft/s (3) 500 ft/s (**4**) 333 ft/s

(5) 750 ft/s (6) 2000 ft/s (7) 666 ft/s

29. The conductor of an orchestra can tell if two instruments are in tune by having each play the same note while he listens for beats. The basic physical principle involved in the production of beats is:

(1) polarization of waves

(2) the equation of continuity

(3) resonance

(**4**) Doppler effect

(5) the transverse nature of the wave

(6) superposition

(7) the longitudinal nature of the wave.

30. A 50 person choir sings at an average intensity level or 80 dB as measured by a sound level meter. What would be the reduction in average intensity level on a day when 10 choir members were absent? (Assume all voices have equal strength.)

(1)0.10 dB (2)1.0 dB (3)2.2 dB (**4**)8.0 dB

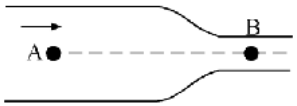
(5) 10 dB (6) 16 dB (7) 23 dB

31. A force is applied to the surface of a sphere with radius 2 m. The force is $\vec{F} = 3i + 4j + 5k$ and is applied to the North pole. The z-axis runs from south to north pole; and the force is expressed in newtons. What is the torque (in $N \cdot m$) about the center of the sphere?

(1) $16i - 8j$ (2) $16i - 10j$ (3) $-8i + 6j$ (**4**) $16i + 8j$

(5) $-6i + 8j$ (6) $-6i - 8j$ (7) $18i - 6j$

32. An incompressible fluid is flowing smoothly through this horizontal glass tube. The velocity of the fluid is 0.6 m/s at A and 1.2 m/s at B. The density of the fluid is 8.0 x 10^2 kg/m^3. What is the difference in pressure between points A and B?



(1) 2.**4** x 10^2 N/m^2 (2) **4**.3 x 10^2 N/m^2 (3) 7.2 x 10^2 N/m^2 (**4**) 8.6 x 10^2 N/m^2

(5) **4**.2 x 10^3 N/m^2 (6) 10.**4** x 10^2 N/m^2

The following five questions are each worth 2 points.

A wave travelling along a string may be represented by the mathematical expression $D = a \sin(bx + ct)$ where a, b and c are positive constants.

33. The amplitude is
(1) a (2) b (3) c (4) ab (5) ac (6) bc (7) b/c

34. The frequency is
(1) c (2) 1/c (3) c/2π (4) 2πc (5) $\frac{1}{2\pi c}$ (6) 2π/c (7) c/b

35. The wavelength is
(1) b (2) 1/b (3) b/2π (4) 2πb (5) $\frac{1}{2\pi b}$ (6) 2π/b (7) b/c

36. The propagation speed is
(1) $\frac{b}{a}$ (2) $\frac{c}{b}$ (3) $2\pi\frac{b}{c}$ (4) $2\pi\frac{c}{b}$ (5) $\frac{b}{2\pi c}$ (6) $\frac{c}{2\pi b}$ (7) $c \cdot b$

37. This wave is travelling
(1) along the +x-axis
(2) along the -x-axis
(3) with equal components in each of the two directions.