UNIVERSITY OF MANITOBA

December 17, 2012
(6:00 pm – 9:00 pm)

FINAL EXAMINATION (+ formula sheet)

DEPARTMENT & COURSE NO.: PHYS 1020

TIME: 3 hours

EXAMINATION: General Physics 1

EXAMINER: R. Cameron, W. Ens, A. Shalchi

All questions are of equal value. No marks are subtracted for wrong answers.

Record all answers on the computer score sheet provided. **USE PENCIL ONLY!** Black pen will look good but may not be read reliably by the scoring machine. **Mark only <u>one</u> answer for each question!** Select the answer which is closest to yours.

A formula sheet is provided for your use; you may **not** use your own formula sheet. Calculators of any type are allowed, but not devices that store text or that can communicate with other such devices.

An answer should NOT be considered to be incorrect if the number of significant figures does not match the significant figures supplied in the question.

Be sure your name and student number are printed on the score sheet and the student number correctly coded in the box at the top right-hand side of the sheet.

TABLE OF CONSTANTS

$G = 6.673\times10^{-11}\text{m}^3\text{kg}^{-1}\text{s}^{-2}$	Standard atmospheric pressure = 1.013×10^5 Pa
$g = 9.8$ m/s^2	Specific heat capacity of water = 4186 J/(kg C°)
$\rho_{water} = 10^3$ kg/m^3	Specific heat capacity of ice = 2000 J/(kg C°)
Mass of the earth = 5.98×10^{24} kg	Latent heat of fusion of water, $L_f = 33.5\times10^4$ J/kg
Radius of the earth = 6.38×10^3 km	Latent heat of vaporization of water, $L_v = 22.6\times10^5$ J/kg

---

1. A certain mountain road is inclined 3.1° with respect to the horizon. What is the change in altitude of the car as a result of its traveling 2.90 km along the road?

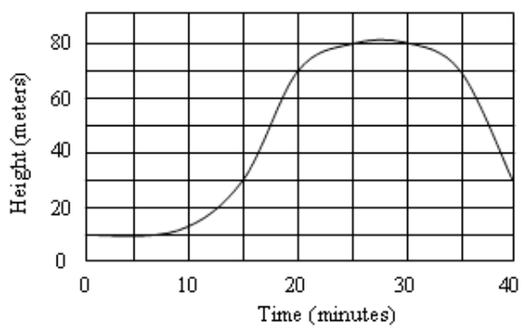
   (a) 157 m (b) 181 m (c) 116 m (d) 203 m (e) 289 m

2. For which one of the following situations will the distance travelled equal the magnitude of the displacement?

   (a) A toy train is traveling around a circular track.
   (b) A ball is rolling down an inclined plane.
   (c) A train travels 5 miles east before it stops. It then travels 2 miles west.
   (d) A ball rises and falls after being thrown straight up from the earth's surface.
   (e) A ball on the end of a string is moving in a vertical circle.

3. The graph shows the height versus time of an object moving vertically. Estimate the instantaneous velocity, in m/s, of the object at time $t = 15$ min.

   (a) 0.90 m/s (b) 0.70 m/s (c) 0.50 m/s
   (d) –0.30 m/s (e) 0.10 m/s



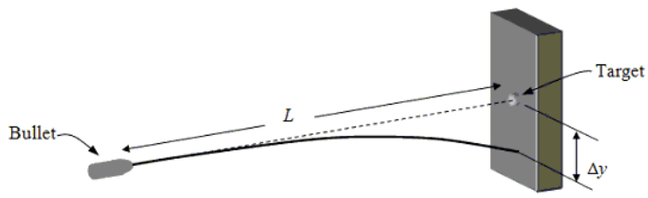
4. A rock, dropped from rest near the surface of an atmosphere-free planet (not Earth!), attains a speed of 20.0 m/s after falling 8.0 meters. How long did it take the object to fall the 8.0 meters mentioned?

(a) 0.40 s (b) 0.80 s (c) 1.3 s (d) 2.5 s (e) 16 s

5. At time $t = 0$ s, a puck is sliding on a horizontal table with a velocity 3.60 m/s, 35.0° above the $+x$ axis. As the puck slides, a constant acceleration acts on it that has the following components: $a_x = -0.360$ m/s^2 and $a_y = -0.980$ m/s^2. What is the velocity of the puck at time $t = 1.50$ s?

(a) 1.83 m/s, 12.0° above the $+x$ axis
(b) 2.04 m/s, 21.2° above the $+x$ axis
(c) 1.06 m/s, 11.7° above the $+x$ axis
(d) 2.48 m/s, 13.9° above the $+x$ axis
(e) 1.38 m/s, 15.2° above the $+x$ axis

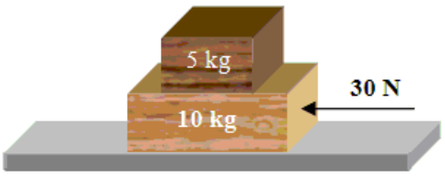
6. A bullet is aimed horizontally at a target on the wall a distance L away from the firing position. Because of gravity, the bullet strikes the wall a distance Δy below the mark as suggested in the figure.
Note: *The drawing is not to scale.*



If the distance L was half as large and the bullet had the same initial velocity, how would Δy be affected?

(a) Δy will double.
(b) Δy will be half as large.
(c) Δy will be four times larger.
(d) Δy will be one fourth as large.
(e) Δy is not possible to determine unless numerical values are given for the distances.

7. Two blocks rest on a horizontal *frictionless* surface as shown. The surface between the top and bottom blocks is roughened so that there is no slipping between the two blocks. A 30-N force is applied to the bottom block as suggested in the figure. What is the minimum coefficient of static friction necessary to keep the top block from slipping on the bottom block?

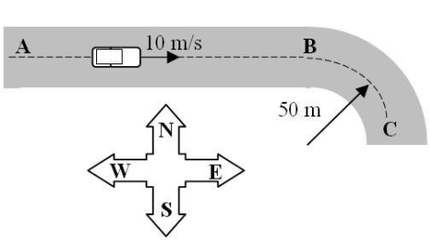


(a) 0.05 (b) 0.10 (c) 0.20 (d) 0.30 (e) 0.40

8. An indoor track is to be designed such that each end is a banked semi-circle with a radius of 24 m. What should the banking angle be for a person running at speed $v = 6.0$ m/s?

(a) 8.7° (b) 11° (c) 14° (d) 22° (e) 45°

9. A 1800-kg Jeep travels along a straight 500-m portion of highway (from **A** to **B**) at a constant speed of 10 m/s. At **B**, the Jeep encounters an unbanked curve of radius 50 m. The Jeep follows the road from **B** to **C** traveling at a constant speed of 10 m/s while the direction of the Jeep changes from east to south.



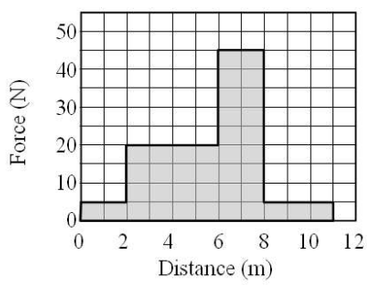
What is the magnitude of the frictional force between the tires and the road as the Jeep negotiates the curve from B to C?

(a) 9600 N (b) 7200 N (c) 3600 N (d) 1800 N (e) 1000 N

10. A satellite (mass 1200 kg) orbits the earth in a circular orbit at a height of 6.2×10^3 km above the surface of the earth. What is the work done on the satellite by the gravitational force during one orbit?

(a) 1.5×10^{11} J (b) 4.9×10^{11} J (c) 6.2×10^{8} J (d) 450 J (e) zero joules

11. The graph shows the force component along the displacement as a function of the magnitude of the displacement. Determine the work done by the force during the interval from 2 to 10 m.



(a) 140 J (b) 180 J (c) 270 J
(d) 450 J (e) 560 J

12. A 0.2-kg steel ball is dropped straight down onto a hard, horizontal floor and bounces straight up. The ball's speed just before *and just after* impact with the floor is 10 m/s. Determine the magnitude of the impulse delivered to the floor by the steel ball.

(a) zero N · s (b) 2 N · s (c) 4 N · s (d) 20 N · s (e) 200 N · s

13. A sled of mass *m* is coasting on the icy surface of a frozen river. While it is passing under a bridge, a package of equal mass *m* is dropped straight down and lands on the sled (without causing any damage). The sled plus the added load then continue along the original line of motion. How does the kinetic energy of the (sled + load) compare with the original kinetic energy of the sled?

(a) It is 1/4 the original kinetic energy of the sled.
(b) It is 1/2 the original kinetic energy of the sled.
(c) It is 3/4 the original kinetic energy of the sled.
(d) It is the same as the original kinetic energy of the sled.
(e) It is twice the original kinetic energy of the sled.

14. A 7.30-kg bowling ball strikes a 1.60-kg pin at rest head-on. Before the collision, the velocity of the ball is +6.00 m/s. After the collision, the velocity of the ball is +5.40 m/s. What is the velocity of the pin immediately after the collision?

(a) +0.6 m/s (b) +5.4 m/s (c) +1.2 m/s (d) +2.7 m/s (e) +3.2 m/s

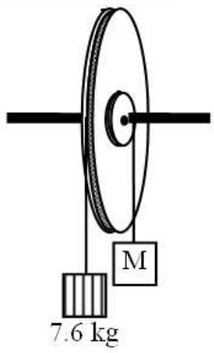
15. The blades of a fan running at low angular speed turn at 250 rpm (revolutions per minute). When the fan is switched to high speed, the angular speed increases uniformly to 350 rpm in 5.75 s. How many revolutions do the fan blades go through while the fan is accelerating?

(a) 28.8 rev (b) 1 rev (c) 1750 rev (d) –6.75 rev (e) 14.2 rev

16. The tangential speed of a particle 0.50 m from the axis of rotation is 13 m/s. What is the tangential speed of an object 0.35 m from the axis of rotation?

(a) 19 m/s (b) 13 m/s (c) 9.1 m/s (d) 6.4 m/s (e) 12 m/s

17. In the drawing shown, the large wheel has a radius of 7.1 m. A rope is wrapped around the edge of the wheel and a 7.6 kg-box hangs from the rope. A smaller disk of radius 1.38 m is attached to the wheel. A rope is wrapped around the edge of the disk as shown. An axis of rotation passes through the center of the wheel-disk system. What is the value of the mass M that will prevent the wheel from rotating?



(a) 34 kg (b) 12 kg (c) 17 kg
(d) 39 kg (e) 46 kg

18. A spinning star begins to collapse under its own gravitational pull. Which one of the following occurs as the star becomes smaller?

(a) The star's angular velocity decreases.
(b) The star's angular momentum remains constant.
(c) The star's angular momentum increases.
(d) The star's angular velocity remains constant.
(e) Both the star's angular momentum and its angular velocity remain constant.

19. A uniform rod has a moment of inertia (rotational inertia) of 0.0070 kg · m^2 about an axis that runs through one end of the rod. Initially, a beetle (mass 0.025 kg) is located on the rod 0.10 m from the axis and the rod rotates with an angular speed of 5.7 rad/s. The beetle walks to a final location on the rod that is 0.45 m from the axis. What is the final angular speed of the rod?

(a) 5.7 rad/s (b) 1.3 rad/s (c) 26 rad/s (d) 9.5 rad/s (e) 3.4 rad/s

20. Which one of the following statements is true concerning an object executing simple harmonic motion?

(a) The object's velocity is never zero.
(b) The object's acceleration is never zero.
(c) The object's velocity and acceleration are simultaneously zero.
(d) The object's velocity is zero when its acceleration is a maximum.
(e) The object's maximum acceleration is equal to its maximum velocity.

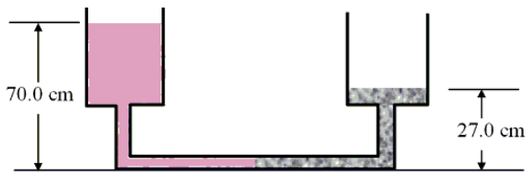
21. An object attached to a horizontal spring is on a horizontal, frictionless surface, and undergoes simple harmonic with a frequency of 1.3 Hz. If the same object is suspended vertically by the same spring, what is the frequency of the motion?

(a) 1.3 Hz (b) 2.6 Hz (c) 0.41 Hz (d) 8.2 Hz
(e) It depends on the mass and spring constant

22. A 2.2-kg object is suspended from a spring with k = 18 N/m. The mass is pulled 0.35 m downward from its equilibrium position and allowed to oscillate. What is the maximum kinetic energy of the object?

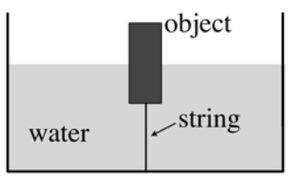
(a) 0.25 J (b) 0.50 J (c) 1.1 J (d) 2.0 J (e) 4.0 J

23. A column of oil of height 70.0 cm supports a column of an unknown liquid as suggested in the figure (not drawn to scale). Assume that both liquids are at rest and that the density of the oil is 840 kg/m^3. Determine the density of the unknown liquid.



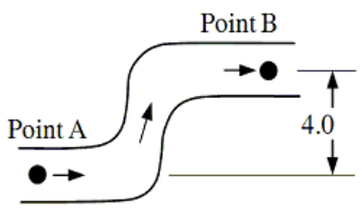
(a) 3.2×10^2 kg/m^3 (b) 2.2×10^3 kg/m^3 (c) 2.6×10^3 kg/m^3
(d) 3.6×10^3 kg/m^3 (e) 4.9×10^3 kg/m^3

24. A 2-kg object is tied down as shown in the figure; and it displaces 5 kg of water. What is the tension in the string?



(a) 10 N (b) 20 N (c) 30 N
(d) 70 N (e) 100 N

25. Oil ($\rho = 925$ kg/m^3) is flowing through a pipeline at a constant speed when it encounters a vertical bend in the pipe raising it 4.0 m. The cross sectional area of the pipe does not change. What is the difference in pressure ($P_B - P_A$) in the portions of the pipe before and after the rise?



(a) $+2.4 \times 10^4$ Pa (b) -3.6×10^4 Pa
(c) $+5.1 \times 10^5$ Pa (d) -7.2×10^5 Pa
(e) -1.8×10^3 Pa

26. A circular hole in an copper plate is 2.925 cm in diameter at 20.0 ºC. What is the diameter of the hole if the temperature of the plate is raised to 120.0 ºC? The coefficient of linear expansion of copper is 17×10^{-6}/Cº.

(a) 2.925 cm (b) 2.929 cm (c) 2.933 cm (d) 2.957 cm (e) 2.988 cm

27. A thermos bottle contains 3.0 kg of water and 2.0 kg of ice in thermal equilibrium at 0 ºC. How much heat is required to bring the system to thermal equilibrium at 50 ºC?

(a) 1.05×10^6 J (b) 1.30×10^6 J (c) 1.72×10^6 J (d) 2.26×10^6 J (e) 1.13×10^7 J

28. Complete the following statement: The *atomic mass unit* (u) is defined so that 1 u is exactly equal to the mass of

(a) a single hydrogen atom. (b) 1/4 of a helium molecule.
(c) 1/16 of an oxygen-16 atom. (d) 1/32 of an oxygen molecule.
(e) 1/12 of a carbon-12 atom.

29. An ideal gas is contained in a vessel with a movable piston. Initially, the gas has a volume of 0.024 m^3, an absolute pressure of 1.8 atm, and a temperature of 35.0 °C. The pressure is 0.90 atm when the volume of the container is decreased to 0.012 m^3. What is the final temperature of the gas?

(a) 77 K (b) 85 K (c) 170 K (d) 154 K (e) 282 K

30. Which one of the following properties of a gas is not consistent with kinetic theory?

(a) The average speed of the gas molecules is smaller at high temperatures.
(b) Gas molecules are widely separated.
(c) Gases fill whatever space is available to them.
(d) Gas molecules move rapidly in a random fashion.
(e) Gas molecules make elastic collisions with the walls of the containing vessel.

THE END

UNIVERSITY OF MANITOBA

December 17, 2012
(6:00 pm – 9:00 pm)

FINAL EXAMINATION (+ formula sheet)

DEPARTMENT & COURSE NO.: PHYS 1020

TIME: 3 hours

EXAMINATION: General Physics 1

EXAMINER: R. Cameron, W. Ens, A. Shalchi

ANSWER KEY

1. A
2. B
3. E
4. B
5. D
6. D
7. C
8. A
9. C
10. E
11. B
12. C
13. B
14. D
15. A
16. C
17. D
18. B
19. E
20. D
21. A
22. C
23. B
24. C
25. B
26. B
27. C
28. E
29. A
30. A