**UNIVERSITY OF MANITOBA**

December 8, 2014 FINAL EXAMINATION
(1:30 PM – 4:30 PM) 
(+ formula sheet)
DEPARTMENT & COURSE NO.: PHYS 1020 TIME: 3 hours

EXAMINATION: General Physics 1 EXAMINERS: W. Ens, K. Shamseddine, P. Zetner

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**

| | |
|---|---|
| $G = 6.673\times10^{-11}\,m^3kg^{-1}s^{-2}$ | Standard atmospheric pressure = $1.013\times10^5$ 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 and steam = 2000 J/(kg C°) |
| Mass of the earth = $5.98\times10^{24}$ kg | Latent heat of fusion of water, $L_f = 33.5\times10^4$ J/kg |
| Radius of the earth = $6.38\times10^3$ km | Latent heat of vaporization of water, $L_v = 22.6\times10^5$ J/kg |

1. Carl Lewis set a world record for the 100.0-m run with a time of 9.86 s. If, after reaching the finish line, Mr. Lewis walked directly back to his starting point in 90.9 s, what is the magnitude of his average velocity for the 200.0 m?

   A) 0 m/s B) 1.10 m/s C) 1.98 m/s D) 5.60 m/s E) 10.1 m/s

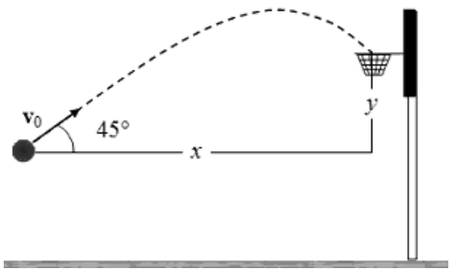
2. Ryan throws a tennis ball vertically upward. The ball returns to the point of release after 3.5 s. What is the speed of the ball as it is released?

   A) 0 m/s B) 14 m/s C) 17 m/s D) 21 m/s E) 34 m/s

3. A physics student standing on the edge of a cliff throws a stone vertically *downward* with an initial speed of 10.0 m/s. The instant before the stone hits the ground below, it is traveling at a speed of 30.0 m/s. If the physics student were to throw the rock *horizontally outward* from the cliff instead, with the same initial speed of 10.0 m/s, what is the magnitude of the velocity of the stone just before it hits the ground?

   A) 10.0 m/s B) 20.0 m/s C) 30.0 m/s D) 40.0 m/s
   E) The height of the cliff must be specified to answer this question.

4. A basketball is launched with an initial speed of 8.0 m/s and follows the trajectory shown. The ball enters the basket 0.96 s after it is launched. What are the distances $x$ and $y$? **Note**: *The drawing is not to scale.*

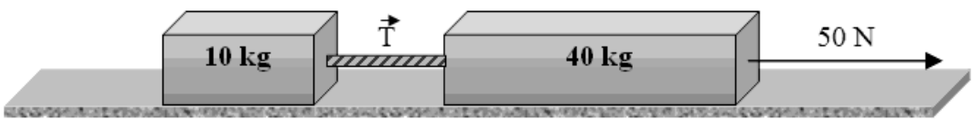



| | $x$ | $y$ |
|---|---|---|
| A) | 5.4 m | 0.73 m |
| B) | 7.7 m | 0.91 m |
| C) | 5.4 m | 0.91 m |
| D) | 5.7 m | 0.73 m |
| E) | 5.4 m | 5.4 m |

5. An astronaut orbits the earth in a space capsule whose height above the earth is equal to the earth's radius. How does the force of gravity on the astronaut in the capsule compare to her weight on the earth?

A) The force is equal to zero newtons.
B) The force is approximately equal to one-fourth her weight on earth.
C) The force is approximately equal to one-half of her weight on earth.
D) The force is approximately equal to one-third of her weight on earth.
E) The force is approximately equal to one-sixteenth her weight on earth.

6. A 10-kg block is connected to a 40-kg block as shown in the figure. A force of 50 N pulls the blocks to the right. What is the magnitude of the tension $\vec{T}$ in the rope that connects the two blocks? Assume that the coefficient of kinetic friction between each of the two blocks and the surface is 0.051.




A) 0 N B) 10 N C) 20 N D) 40 N E) 50 N

7. Consider a hypothetical planet in our solar system whose average distance from the Sun is about four times that of Earth. Determine the orbital period for this hypothetical planet.

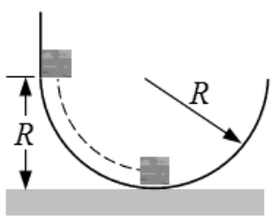
A) 0.25 year B) 2.5 years C) 4 years D) 8 years E) 16 years

8. An engineer is asked to design a playground slide such that the speed a child reaches at the bottom does not exceed 6.0 m/s.

Determine the maximum height that the slide can be.

A) 1.8 m B) 2.9 m C) 3.2 m D) 4.5 m E) 7.4 m

9. A block of mass $m$ is released from rest at a height $R$ above a horizontal surface. The acceleration due to gravity is $g$. The block slides along the inside of a frictionless circular hoop of radius $R$. What is the magnitude of the normal force exerted on the block by the hoop when the block reaches the bottom of the hoop?




A) zero newtons B) $mg^2/R$ C) $mg$ D) $2mg$ E) $3mg$

10. An escalator is 30.0 meters long and is inclined at 30.0° relative to the horizontal. If it moves at 1.00 m/s, at what rate does it do work in lifting a 50.0-kg woman from the bottom to the top of the escalator?

A) 49.3 W B) 98.0 W C) 245 W D) 292 W E) 495 W

11. A model rocket is constructed with a motor that can provide a total impulse of 19.0 N·s. The mass of the rocket is 0.15 kg. What is the speed that this rocket achieves when launched from rest? Neglect the effects of gravity and air resistance.

A) 95 m/s B) 127 m/s C) 159 m/s D) 191 m/s E) 223 m/s

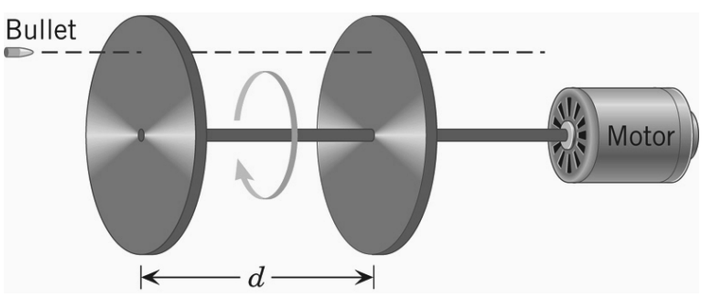
12. A lumberjack (mass = 112 kg) is standing at rest on one end of a floating log (mass = 250 kg) that is also at rest. The lumberjack runs to the other end of the log, attaining a speed of 3.0 m/s relative to the shore, and then hops onto an identical floating log that is initially at rest. What is the speed of the first log relative to the second log when the lumberjack comes to rest with respect to the second log? Neglect any friction and resistance between the logs and the water.

A) 0.93 m/s B) 1.3 m/s C) 2.3 m/s D) 3.0 m/s E) 4.0 m/s

13. Object A and object B collide and stick together in a completely inelastic collision. Object A has a mass of $m_A$ = 15.0 kg and an initial velocity of $\mathbf{v_{0A}}$ = 11.00 m/s , due east. Object B has a mass of $m_B$ = 35.0 kg and an initial velocity of $\mathbf{v_{0B}}$ = 7.00 m/s, due south. Find the magnitude and direction of the velocity of the two-object system after the collision.

A) 18 m/s, 33 degrees S of E
B) 4.0 m/s, 33 degrees S of E
C) 4.0 m/s, 33 degrees S of E
D) 5.9 m/s, 56 degrees S of E
E) 5.9 m/s, 56 degrees N of E

14. The drawing shows a device that can be used to measure the speed of a bullet. The device consists of two rotating disks, separated by a distance of d = 0.75 m, and rotating with an angular speed of 85.0 rad/s. The bullet first passes through the left disk and then through the right disk. It is found that the angular displacement between the two bullet holes is 0.22 rad. From these data, determine the speed of the bullet.

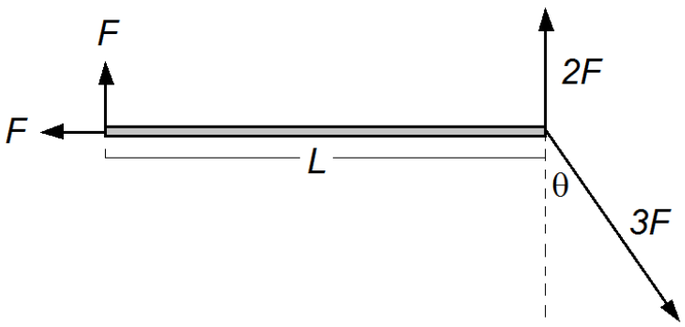



A) 148 m/s B) 183 m/s C) 210 m/s D) 253 m/s E) 290 m/s

15. The drive propeller of a ship starts from rest and accelerates at $2.70 \times 10^{-3}$ rad/s$^2$ for $2.5 \times 10^3$ s. For the next $1.70 \times 10^3$ the propeller rotates at a constant angular speed. Find the total angular displacement of the propeller.

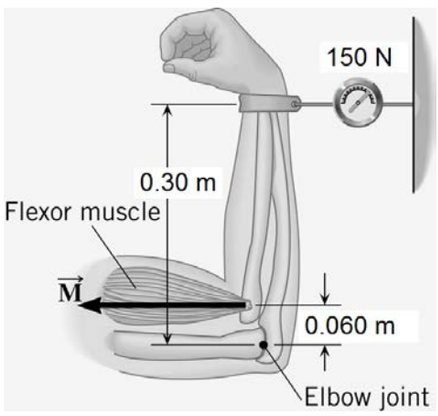
A) $8.4 \times 10^3$ rad  B) $1.1 \times 10^4$ rad  C) $2.0 \times 10^4$ rad  D) $2.8 \times 10^4$ rad  E) $3.1 \times 10^4$ rad

16. Four forces of magnitudes $F$, $F$, $2F$ and $3F$ are applied to the ends of a rod of length $L$, as shown in the figure. The rod is lying on a tabletop and the four force vectors are horizontal. What must be the angle $\theta$ in order to satisfy the two conditions of equilibrium, namely, zero net force and zero net torque ?



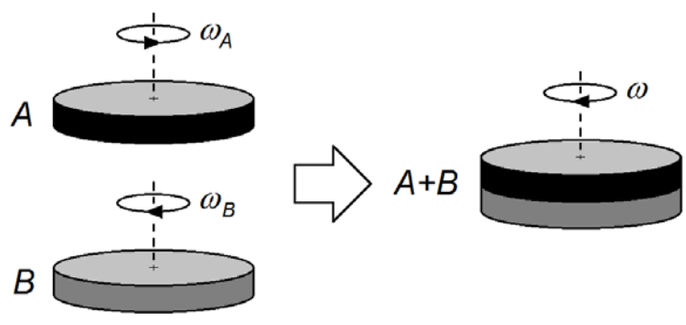

(A) $\cos\theta = 2/3$
(B) $\sin\theta = 2/3$
(C) $\tan\theta = 2/3$
(D) $\tan\theta = 1/2$
(E) There is no value of θ to satisfy the two conditions of equilibrium.

17. A person exerts a horizontal force of 150 N in the test apparatus shown in the drawing. Find the magnitude of the horizontal force M that his flexor muscle exerts on his forearm.




A) 630 N
B) 670 N
C) 710 N
D) 750 N
E) 790 N

18. Two disks are rotating about the same axis. Disk A has a moment of inertia of 3.0 kg.m$^2$ and an angular velocity of +5.2 rad/s . Disk B is rotating with an angular velocity of -10.5 rad/s. The two disks are then linked together without the aid of any external torques, so that they rotate as a single unit with an angular velocity of -2.0 rad/s. The axis of rotation for this unit is the same as that for the separate disks. What is the moment of inertia of disk B?

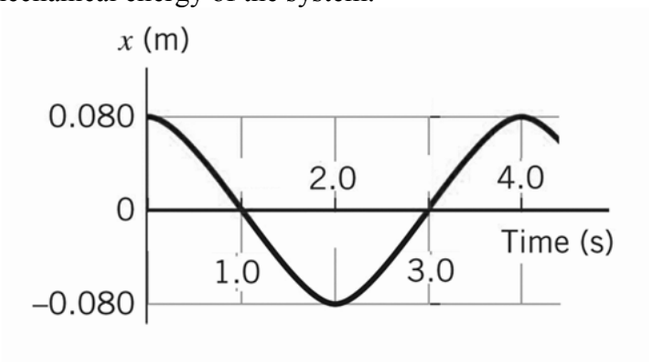



A) 1.2 kg.m$^2$  B) 1.4 kg.m$^2$  C) 2.0 kg.m$^2$  D) 2.5 kg.m$^2$  E) 3.0 kg.m$^2$

19. A block of mass $m$ is suspended from the ceiling by a spring. A second block is attached to the first one, and the amount that the spring stretches from its unstrained length increases by a factor of four. What is the mass of the second block?

A) $3m$ B) $4m$ C) $5m$ D) $9m$ E) $16m$

20. An 0.85-kg object is attached to one end of a spring and the system is set into simple harmonic motion. The displacement $x$ of the object as a function of time is shown in the drawing. With the aid of these data, determine the mechanical energy of the system.



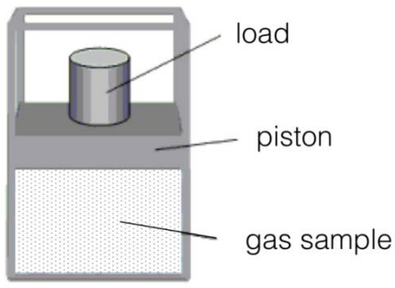

A) $5.4\times10^{-3}$ J B) $6.7\times10^{-3}$ J C) $8.0\times10^{-3}$ J D) $9.3\times10^{-3}$ J E) $1.1\times10^{-2}$ J

21. The length of a simple pendulum is 0.69 m and the mass of the particle (the "bob") at the end of the cable is 0.20 kg. The pendulum is pulled away from its equilibrium position by an angle of 7.50 degrees and released from rest. Assume that friction can be neglected and that the resulting oscillatory motion is simple harmonic motion. What is the speed of the bob 0.80 seconds after release?
A) 0 m/s B) 0.042 m/s C) 0.083 m/s D) 0.14 m/s E) 0.34 m/s

22. A spherical object with mass $m$ floats in a liquid so that its equator coincides with the water level. The object is then pulled completely under the surface with a rope tied to it. What is the tension in the rope?

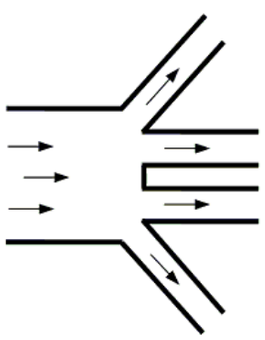
(a) ¾ $mg$ (b) ½ $mg$ (c) $mg$ (d) 2 $mg$ (e) 4/3 $mg$

23. A gas sample is confined within a chamber that has a movable piston. A small load is placed on the piston; and the system is allowed to reach equilibrium. If the total weight of the piston and load is 70.0 N and the piston has an area of $5.0 \times 10^{-4}$ m$^2$, what is the pressure exerted on the piston by the gas? Atmospheric pressure is 101.3 kPa.



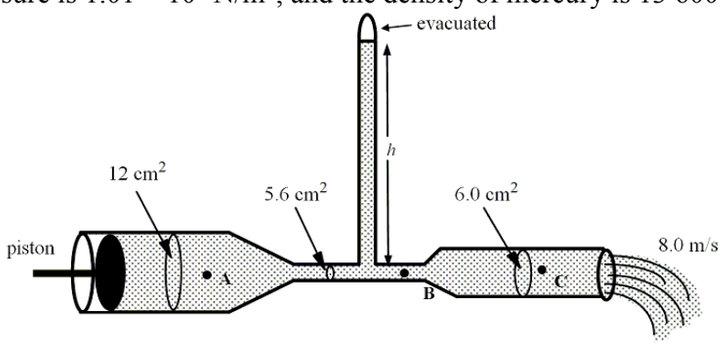

A) $2.8 \times 10^4$ Pa
B) $5.6 \times 10^4$ Pa
C) $7.3 \times 10^4$ Pa
D) $1.4 \times 10^5$ Pa
E) $2.4 \times 10^5$ Pa

24. Water is flowing through a rectangular channel that is 12 m wide with a speed of 0.75 m/s. The water then flows into four identical rectangular channels that have a width of 3.0 m. The depth of the water does not change as it flows into the four channels. What is the speed of the water in one of the smaller channels?



A) 0.56 m/s B) 2.3 m/s
C) 0.25 m/s D) 0.75 m/s
E) 3.0 m/s

25. A glass tube has several different cross-sectional areas with the values indicated in the figure. A piston at the left end of the tube exerts pressure so that mercury within the tube flows from the right end with a speed of 8.0 m/s. The drawing is not drawn to scale. Determine the height *h* of mercury in the manometer with the evacuated upper end.
Atmospheric pressure is $1.01 \times 10^5$ N/m$^2$; and the density of mercury is 13 600 kg/m$^3$.




A) 140mm B) 240 mm C) 280 mm D) 370 mm E) 390 mm

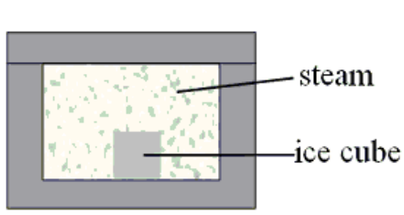
26. At a certain temperature, a simple pendulum has a period of 1.500 seconds. The support wire is made of brass and has a coefficient of linear thermal expansion of $1.90 \times 10^{-5}$ C$^{o-1}$. How much must the temperature be increased to increase the period to 1.506 seconds?

A) 118 C$^o$ B) 221 C$^o$ C) 316 C$^o$ D) 422 C$^o$ E) 528 C$^o$

27. A gold sphere has a radius of 1.000 cm at 25.0 ºC. If 7650 J of heat is added to the sphere, what will the final volume of the sphere be? Gold has a density of 19 300 kg/m$^3$ at 25.0 ºC, a specific heat capacity of 129 J/(kg · C$^o$), and a coefficient of volume expansion of $42.0 \times 10^{-6}$ C$^{o-1}$. The volume of a sphere is $\frac{4}{3}\pi r^3$.

A) $2.88 \times 10^{-6}$ m$^3$ B) $3.01 \times 10^{-6}$ m$^3$ C) $3.33 \times 10^{-6}$ m$^3$ D) $3.91 \times 10^{-6}$ m$^3$ E) $4.32 \times 10^{-6}$ m$^3$

28. A 0.020-kg ice cube at 0 ºC is placed in an insulated box that contains a fixed quantity of steam at 150 ºC. When thermal equilibrium of this closed system is established, its temperature is found to be 33 ºC. Determine the original mass of the steam at 150 ºC.




A) 0.17 g
B) 1.7 g
C) 2.5 g
D) 3.6 g
E) 5.0 g

29. A sealed container has a volume of 0.020 m$^3$ and contains 15.0 g of molecular nitrogen ($N_2$), which has a molecular mass of 28.0 u. The gas is at 525 K. What is the absolute pressure of the nitrogen gas?

A) $3.9 \times 10^{-19}$ Pa B) $4.3 \times 10^{-5}$ Pa C) $1.2 \times 10^5$ Pa D) $1.9 \times 10^5$ Pa E) $4.3 \times 10^6$ Pa

30. Complete the following statement: The internal kinetic energy of an ideal monatomic gas is

A) proportional to the pressure and inversely proportional to the volume of the gas.
B) independent of the number of moles of the gas.
C) proportional to the Kelvin temperature of the gas.
D) dependent on both the pressure and the temperature of the gas.
E) a constant that is independent of pressure, volume or temperature.

**ANSWERS**

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1. A
2. C
3. C
4. C
5. B
6. B
7. D
8. A
9. E
10. C
11. B
12. C
13. D
14. E
15. C
16. E
17. D (corrected Dec 7, 2015)
18. D
19. A
20. B
21. B
22. C
23. E
24. D
25. C
26. D
27. E
28. D
29. C
30. C