UNIVERSITY OF MANITOBA

December 16, 2013
(6:00 pm – 9:00 pm)

FINAL EXAMINATION (+ formula sheet)

DEPARTMENT & COURSE NO.: PHYS 1020

TIME: 3 hours

EXAMINATION: General Physics 1

EXAMINERS: R. Cameron, W. Ens, A. Shalchi, K. Shamseddine

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

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1. A pole is held vertically by attaching wires at a height of 13.4 m above the ground. The other end of each wire is anchored in the ground at a distance of 9.54 m from the base of the pole. The pole makes a right angle with the ground. What is the length of each wire?

   A) 14.1 m B) 19.7 m C) 11.5 m D) 16.4 m E) 22.8 m

2. A physics student adds two displacement vectors with magnitudes of 8.0 km and 6.0 km. Which one of the following statements is true concerning the magnitude of the resultant displacement?

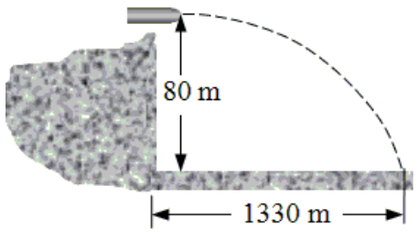
   A) It must be 10.0 km.
   B) It must be 14.0 km.
   C) It could be equal to zero kilometers, depending on how the vectors are oriented.
   D) No conclusion can be reached without knowing the directions of the vectors.
   E) It could have any value between 2.0 km and 14.0 km depending on how the vectors are oriented.

3. A train with a constant velocity of +28.6 m/s approaches a small town . The operator applies the brake, reducing the train's velocity to +11.4 m/s. If the average acceleration of the train during braking is –1.35 m/s^2, for what elapsed time does the operator apply the brake?

   A) 8.44 s B) 12.7 s C) 3.38 s D) 5.92 s E) 10.4 s

4. A shell is fired with a horizontal velocity in the positive x direction from the top of an 80-m high cliff. The shell strikes the ground 1330 m from the base of the cliff. The drawing is not to scale. Determine the initial speed of the shell.

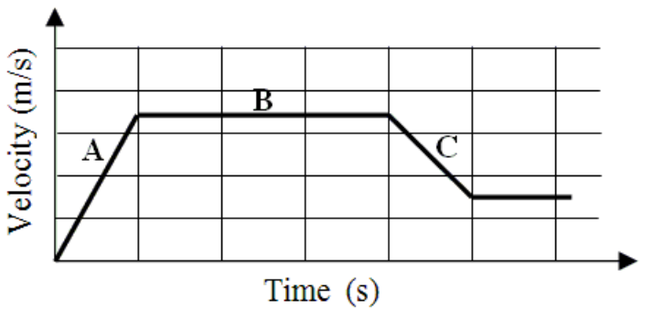
A) 4.0 m/s
B) 9.8 m/s
C) 82 m/s
D) 170 m/s
E) 330 m/s



5. A ferry can travel at an optimal speed of 8 km/h in still water measured relative to the shore. What is the optimal speed of the ferry, relative to the shore, if it moves perpendicular to a 6 km/h current?

A) 4 km/h B) 8 km/h C) 10 km/h D) 14 km/h E) 28 km/h

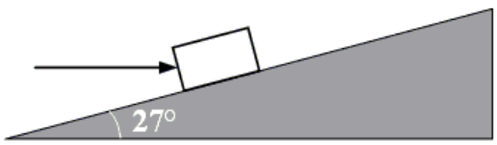
6. The figure shows the velocity versus time curve for a car traveling along a straight line. Which of the following statements is **false**?



A) No net force acts on the car during interval **B**.
B) Net forces act on the car during intervals **A** and **C**.
C) Opposing forces may be acting on the car during interval **B**.
D) Opposing forces may be acting on the car during interval **C**.
E) The magnitude of the net force acting during interval **A** is less than that during **C**.

7. A 250-N force is directed horizontally as shown to push a 29-kg box up an inclined plane at a constant speed. Determine the magnitude of the normal force, F_N, and the coefficient of kinetic friction, μ_k.

	F_N	μ_k
A)	330 N	0.31
B)	310 N	0.33
C)	250 N	0.27
D)	290 N	0.30
E)	370 N	0.26



8. A ball is whirled on the end of a string in a horizontal circle of radius R at constant speed v. Complete the following statement: The centripetal acceleration of the ball can be increased by a factor of 4 by

A) keeping the speed fixed and increasing the radius by a factor of 4.
B) keeping the radius fixed and increasing the speed by a factor of 4.
C) keeping the radius fixed and increasing the period by a factor of 4.
D) keeping the radius fixed and decreasing the period by a factor of 4.
E) keeping the speed fixed and decreasing the radius by a factor of 4.

9. Holly puts a box into the trunk of her car. Later, she drives around an unbanked curve that has a radius of 48 m. The speed of the car on the curve is 16 m/s, but the box remains stationary relative to the floor of the trunk. Determine the minimum coefficient of static friction for the box on the floor of the trunk.

A) 0.42 B) 0.54 C) 0.17 D) 0.33
E) This cannot be determined without knowing the mass of the box.

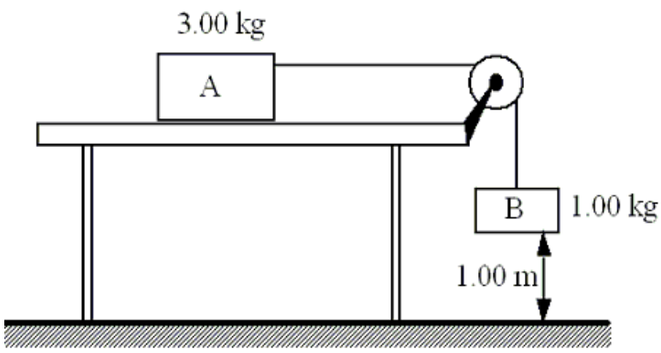
10. A space station is designed in the shape of a large, hollow donut that is uniformly rotating. The outer radius of the station is 350 m. With what period must the station rotate so that a person sitting on the outer wall experiences "artificial gravity," i.e. an acceleration of 9.8 m/s^2?

A) 38 s B) 170 s C) 110 s D) 76 s E) 230 s

11. A 2.0-kg cannon ball (initially at rest) is fired from a cannon. The velocity components of the cannon ball as it leaves the cannon are v_x = 30 m/s and v_y = 40 m/s. How much work was done in firing the cannon ball?

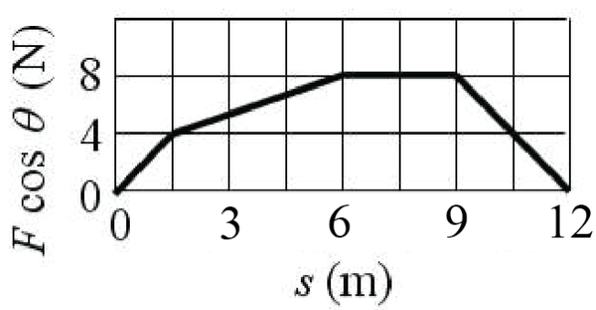
A) 900 J B) 1600 J C) 2500 J D) 4900 J E) 9800 J

12. Two boxes are connected to each other as shown. The system is released from rest and the 1.00-kg box falls through a distance of 1.00 m. The coefficient of kinetic friction between the surface of the table and Box A is 0.15. What is the kinetic energy of the two boxes just before Box B reaches the floor?



A) 2.45 J B) 9.8 J C) 5.39 J D) 6.21 J E) n.o.t.

13. The force component acting on an object along the displacement varies with the displacement s as shown in the graph. Determine the work done on the object as it travels from s = 0.0 to 12 m.



A) 48 J B) 57 J C) 72 J D) 66 J E) 81 J

14. A stationary bomb explodes in space breaking into a number of small fragments. At the location of the explosion, the net force due to gravity is zero newtons. Which one of the following statements concerning this event is true?

A) Kinetic energy is conserved in this process.
B) All of the fragments must have equal kinetic energies.
C) The sum of the kinetic energies of the fragments must be zero.
D) The vector sum of the linear momenta of the fragments must be zero.
E) The mass of any one fragment must be equal to the mass of any other fragment.

15. A 2.5-kg ball and a 5.0-kg ball have an elastic collision. Before the collision, the 2.5-kg ball was at rest and the other ball had a speed of 3.5 m/s. What is the kinetic energy of the 2.5-kg ball after the collision?

A) 27 J B) 3.4 J C) 8.1 J D) 14 J E) 1.7 J

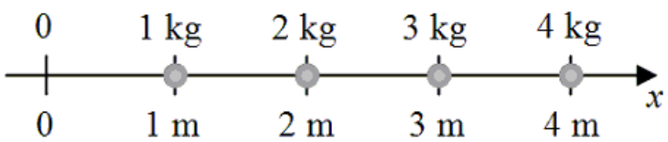
16. A 1.0-m roulette wheel reaches a maximum angular speed of 18 rad/s before it begins decelerating. After reaching this maximum angular speed, it turns through 35 revolutions (220 rad) before it stops. How long did it take the wheel to stop after reaching its maximum angular speed?

A) 12 s B) 48 s C) 3.7 s D) 8.8 s E) 24 s

17. A horizontal, 10-m plank weighs 100 N. It rests on two supports that are placed 1.0 m from each end as shown in the figure. How close to one end can an 800-N person stand without causing the plank to tip?

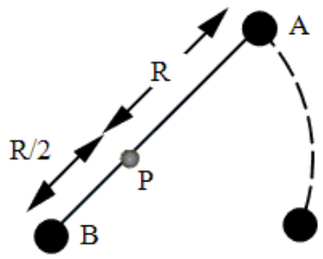
A) 0 m B) 0.3 m C) 0.5 m D) 0.7 m E) 0.9 m

18. Consider four point masses located as shown in the sketch. The acceleration due to gravity is the same everywhere. What is the *x* coordinate of the center of gravity for this system?



A) 2.0 m B) 2.7 m C) 3.0 m D) 3.3 m E) 3.8 m

19. Two equal spheres, labeled **A** and **B** in the figure, are attached to a massless rod with a frictionless pivot at the point P. The system is made to rotate clockwise with angular speed ω on a horizontal, frictionless tabletop. Sphere **A** collides with and sticks to another equal sphere that is at rest on the tabletop. **Note***: the masses of all three spheres are equal.*



What is the angular speed of the system immediately after the collision?

A) ω B) 0.82ω C) 0.65ω D) 0.56ω E) 0.29ω

20. A vertical block-spring system on earth has a period of 6.0 s. What is the period of this same system on the moon where the acceleration due to gravity is roughly 1/6 that of earth?

A) 1.0 s B) 2.4 s C) 6.0 s D) 15 s E) 36 s

21. The velocity of a certain simple harmonic oscillator is given by $v = -(12\text{ m/s}) \sin[(6.0\text{ rad/s})\,t]$. What is the amplitude of the simple harmonic motion?

A) 2.0 m B) 4.0 m C) 6.0 m D) 8.0 m E) 12 m

22. What is the period of a pendulum consisting of a 6-kg object oscillating on a 4-m string?

A) 0.25 s B) 0.50 s C) 1.0 s D) 2.0 s E) 4.0 s

23. A spring with constant $k = 78$ N/m is at the base of a frictionless, 30.0°-inclined plane. A 0.50-kg block is pressed against the spring, compressing it 0.20 m from its equilibrium position. The block is then released. If the block is not attached to the spring, how far up the incline will it travel before it stops?

A) 0.080 m B) 0.16 m C) 0.32 m D) 0.64 m E) 1.1 m

24. Using the value of atmospheric pressure at sea level, 1×10^5 Pa, estimate the total mass of the earth's atmosphere above a 5-m^2 area.

A) 5×10^4 kg B) 9×10^2 kg C) 2×10^{-4} kg D) 4×10^{-2} kg E) 3×10^5 kg

25. A woman is enjoying a tropical drink while lying on a beach. The acceleration due to gravity at her location is 9.78 m/s^2. What gauge pressure must exist in the woman's mouth if she is drinking through a straw extending 0.075 m above the surface of the drink? **Note**: Assume the drink has a density of 1020 kg/m^3.

A) 850 Pa B) 750 Pa C) 1100 Pa D) 1000 Pa E) 920 Pa

26. After a moving van drives onto a river ferry, the ferry sinks 0.0367 m. The length and width of the ferry are 15.24 m and 6.10 m, respectively. Determine the weight of the moving van.

A) 6.09×10^3 N B) 1.00×10^4 N C) 3.34×10^4 N D) 5.11×10^4 N E) 6.68×10^4 N

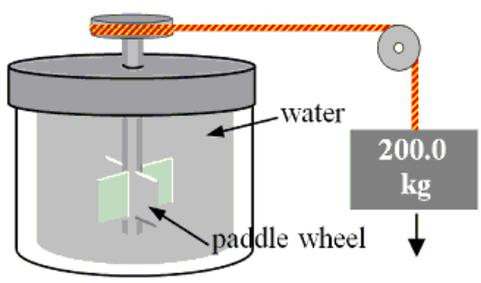
27. A thin, circular disc is made of lead and has a radius of 0.0350 cm at 20.0 °C. Determine the change in the area of the circle if the temperature is increased to 625.0 °C. The coefficient of linear thermal expansion for lead is 29.0×10^{-6}/K.

A) 4.33×10^{-5} cm^2 B) 1.36×10^{-4} cm^2 C) 1.89×10^{-4} cm^2
D) 3.19×10^{-4} cm^2 E) 5.92×10^{-4} cm^2

28. Complete the following statement: The term *heat* most accurately describes

A) the internal energy of an object.
B) a measure of how hot an object is.
C) the absolute temperature of an object.
D) the molecular motion inside of an object.
E) the flow of energy due to a temperature difference.

29. A 200.0-kg object is attached via an ideal pulley system to paddle wheels that are submerged in 0.480 kg of glycerin at 20.0 °C in an insulated container as shown. Then, the object falls through a distance of 5.00 m causing the paddle wheel to turn. Assuming all of the mechanical energy lost by the falling object goes into the water, determine the final temperature of the glycerin. The specific heat capacity of glycerin is 2410 J/(kg · K).



A) 4.90 °C
B) 28.5 °C
C) 24.9 °C
D) 40.4 °C
E) 8.47 °C

30. An ideal gas with a fixed number of molecules is maintained at a constant pressure. At 30.0 °C, the volume of the gas is 1.25 m^3. What is the volume of the gas when the temperature is increased to 150.0 °C?

A) 0.90 m^3 B) 1.50 m^3 C) 1.75 m^3 D) 2.45 m^3 E) 6.25 m^3

THE END

Final Examination Formula Sheet

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