UNIVERSITY OF MANITOBA

December 19, 2017
(1:30 pm – 4:30 pm)

FINAL EXAMINATION (+ formula sheet)

DEPARTMENT & COURSE NO.:
PHYS 1020 A01, A02, A03

TIME: 3 hours

EXAMINATION: General Physics 1

EXAMINERS: P. Basnet, R.M Guillermic, W. Ens

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 that meet ACT specifications are permitted, and this excludes devices that store text or that can communicate with other 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

$G = 6.674\times10^{-11}\ \text{m}^3\text{kg}^{-1}\text{s}^{-2}$	Standard atmospheric pressure = 1.013×10^5 Pa
$g = 9.8\ \text{m/s}^2$	Specific heat capacity of water = 4186 J/(kg C°)
$\rho_{water} = 10^3\ \text{kg/m}^3$	Specific heat capacity of ice = 2000 J/(kg C°)
Mass of the earth = 5.98×10^{24} kg	Latent heat of fusion of water, $L_f = 3.35\times10^5$ J/kg
Radius of the earth = 6.38×10^3 km	Latent heat of vaporization of water, $L_v = 2.26\times10^6$ J/kg

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1. Two cars are moving due north with different velocities. However, 10 seconds later, they have the same velocity. During this ten-second interval, car A has an average acceleration of 3.0 m/s^2 due north, while car B has an average acceleration of 5.0 m/s^2 due north. By how much did the speeds differ at the beginning of the ten-second interval, and which car was moving faster?

   (a) 10 m/s, car A (b) 10 m/s, car B (c) 20 m/s, car A
   (d) 20 m/s, car B (e) Speed did not differ in the beginning of ten-second interval.

2. On a certain planet, a rock is dropped from rest from a height 10.0 m above the ground. It falls and hits the ground with a speed of 15.0 m/s. From what height should the rock be dropped so that its speed on hitting the ground is 30.0 m/s? Neglect air resistance.

   (a) 20.0 m (b) 30.0 m (c) 40.0 m (d) 45.0 m (e) 55.0 m

3. A shot putter releases a shot some distance above the level ground with a velocity of 12.0 m/s, 51° above the horizontal. The shot hits the ground 2.08 s later. Ignore air resistance. How high was the ball when it was released?

   (a) 1.80 m (b) 0.500 m (c) 2.12 m (d) 23.0 m (e) 1.34 m

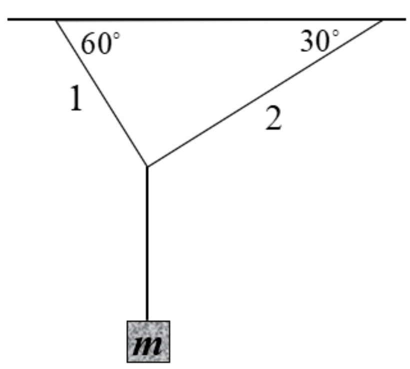
4. Airplane A flies due east at 250 km/h relative to the ground. At the same time, Airplane B flies 325 km/h, 35° north of east relative to the ground. What is the velocity of Airplane A relative to Airplane B?

(a) 16.0 km/h, due west
(b) 270 km/h, due north
(c) 210 km/h, 55° south of east
(d) 170 km/h, 15° north of east
(e) 187 km/h, 85° south of west

5. Two forces $\vec{F}_1$ and $\vec{F}_2$ are applied to an object whose mass is 10 kg. The larger force is $\vec{F}_1$. When both forces point due north, the object's acceleration has a magnitude of 1.0 m/s^2. However, when $\vec{F}_1$ points due north and $\vec{F}_2$ points due south, the acceleration is 0.80 m/s^2 due north. What is the magnitude of $\vec{F}_2$?

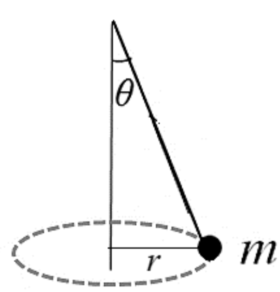
(a) 2.0 N (b) 1.5 N (c) 10 N (d) 5.5 N (e) 1.0 N

6. The system shown in the figure is in equilibrium. If the tension in string 1 is 5.0 N, find the mass *m* of the block. Ignore string masses.



(a) 1.0 kg (b) 1.4 kg (c) 0.59 kg (d) 3.2 kg (e) 0.72 kg

7. A ball of mass 300 gram is whirled on the end of a string in a horizontal circle of radius $r = 0.450$ m at a constant speed. If angle $\theta = 25.0^o$, the speed of the ball is



(a) 1.43 m/s (b) 2.33 m/s (c) 1.22 m/s (d) 1.96 m/s (e) 3.44 m/s

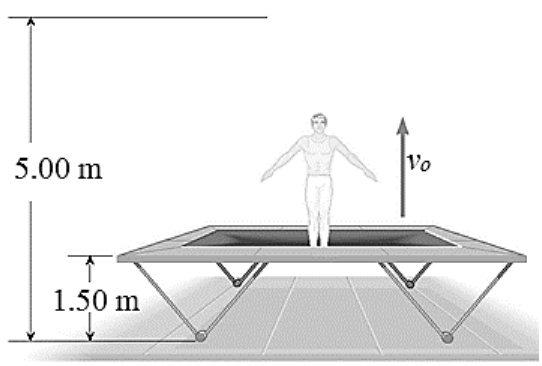
8. In an amusement park ride, a child stands against the wall of a cylindrical room that is then made to rotate. The floor drops downward and the child remains pinned against the wall. If the radius of the room is 4.25 m and the relevant coefficient of friction between the child and the wall is 0.650, what is the minimum tangential speed of the wall of the room if the child is to remain pinned against it?

(a) 7.26 m/s (b) 3.93 m/s (c) 12.1 m/s (d) 8.00 m/s (e) 9.80 m/s

9. A space probe of mass 500 kg has its initial velocity of 300 m/s. It experiences a constant force of 6.0×10^{-2} N as it is displaced through a distance of 2.45×10^{9} m. What is its final velocity?

(a) 823 m/s (b) 810 m/s (c) 930 m/s (d) 772 m/s (e) 866 m/s

10. In the figure, the gymnast leaves the trampoline at an initial height of 1.50 m and reaches a maximum height of 5.00 m before falling back down. What was the initial speed of the gymnast?



(a) 7.25 m/s (b) 8.28 m/s (c) 9.33 m/s (d) 5.75 m/s (e) 19.6 m/s

11. The head of a hammer (m = 1.5 kg) moving at 4.5 m/s strikes a stubborn nail and bounces back with the same speed after an elastic collision lasting 0.075 s. What is the magnitude of the average force the hammer exerts on the nail? Ignore the effect of the handle.

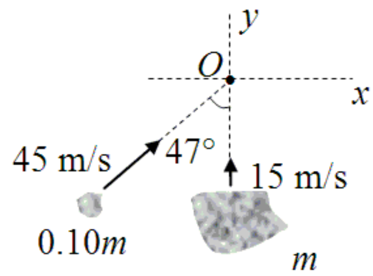
(a) 6.8 N (b) 60 N (c) 90 N (d) 180 N (e) 240 N

12. While on an interplanetary mission, a 58.5-kg astronaut is floating toward the front of her ship at 0.15 m/s, relative to the ship. She wishes to stop moving, relative to the ship. She decides to throw away the 2.50-kg book she's carrying. Relative to the ship, what should the approximate speed and direction of the book be to achieve her goal?

(a) 0.15 m/s, toward the front of the ship (b) 3.5 m/s, toward the back of the ship
(c) 3.7 m/s, toward the front of the ship (d) 0.30 m/s, toward the back of the ship
(e) 1.5 m/s, toward the front of the ship

13. Two asteroids are drifting in space with trajectories shown. Assuming the collision at point O between them is completely inelastic, at what angle from its original direction is the larger asteroid deflected?

(a) 80° above the $+x$ axis (b) 69° above the $+x$ axis
(c) 42° above the $+x$ axis (d) 47° above the $+x$ axis
(e) 90° above the $+x$ axis



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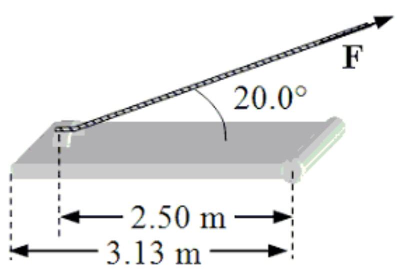
14. A bicycle travels 141 m along a circular track of radius 30 m. What is the angular displacement in radians of the bicycle from its starting position?

(a) 1.0 rad (b) 1.5 rad (c) 3.0 rad (d) 4.7 rad (e) 9.4 rad

15. A spinning disc rotating at 130 rev/min slows at a constant rate and stops 31 s later. How many revolutions did the disc make during this time?

(a) 34 (b) 67 (c) 8.4 (d) 17 (e) 4.2

16. One end of a rope is tied to the handle of a horizontally-oriented and uniform trap door. A force $\vec{F}$ is applied to the other end of the rope as shown in the drawing. The door has a weight of 145 N and is hinged on the right. What force $\vec{F}$ is required to begin to open the door?



(a) 145 N (b) 265 N (c) 381 N (d) 424 N (e) 530 N

17. A child standing on the edge of a freely spinning merry-go-round moves quickly to the center. Which one of the following statements is necessarily true concerning this event and why?

(a) The angular speed of the system decreases because the moment of inertia of the system has increased.
(b) The angular speed of the system increases because the moment of inertia of the system has increased.
(c) The angular speed of the system decreases because the moment of inertia of the system has decreased.
(d) The angular speed of the system increases because the moment of inertia of the system has decreased.
(e) The angular speed of the system remains the same because the net torque on the merry-go-round is zero N · m.

18. When a force of 19 N is applied to a spring, it elongates 0.085 m. Determine the period of oscillation of a 4.0-kg object suspended from this spring.

(a) 0.8 s (b) 1.2 s (c) 3.1 s (d) 4.1 s (e) 6.3 s

19. The acceleration of a certain simple harmonic oscillator is given by $a = -(15.8 \text{ m/s}^2) \cos[(2.51 \text{ rad/s})\, t)]$. What is the amplitude of the simple harmonic motion?

(a) 2.51 m (b) 4.41 m (c) 6.30 m (d) 11.1 m (e) 15.8 m

20. A pendulum is transported from sea-level, where the acceleration due to gravity g is 9.80 m/s^2, to the bottom of Death Valley. Suppose at this location, the period of the pendulum is decreased by 3.00%. According to these data, what is the value of g in Death Valley?

(a) 9.22 m/s^2 (b) 9.51 m/s^2 (c) 9.80 m/s^2 (d) 10.1 m/s^2 (e) 10.4 m/s^2

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21. A solid cylinder has a radius of 0.051 m and a height of 0.0030 m. The cylinder is composed of two different materials with mass densities of 1950 kg/m^3 and 1470 kg/m^3. The cylinder contains an equal mass *m* of each of the two materials, so that the total mass is $M = 2m$. What is the mass *m*?

(a) 8.4×10^{-2} kg (b) 2.1×10^{-2} kg (c) 1.4×10^{-2} kg
(d) 6.5×10^{-2} kg (e) 4.2×10^{-2} kg

22. A child wants to pump up a bicycle tire so that its pressure is 1.2×10^5 Pa above that of atmospheric pressure. If the child uses a pump with a circular piston 0.035 m in diameter, what force must the child exert?

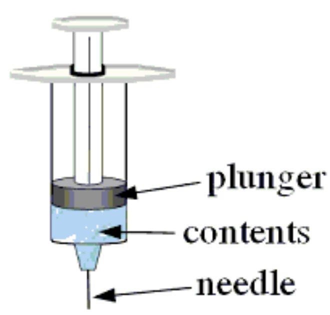
(a) 120 N (b) 89 N (c) 76 N (d) 54 N (e) 240 N

23. A curtain hangs straight down in front of an open window. A sudden gust of wind blows past the window; and the curtain is pulled out of the window. Which law, principle, or equation can be used to explain this movement of the curtain?

(a) Poiseuille's law (b) Bernoulli's equation (c) the equation of continuity
(d) Archimedes' principle (e) Pascal's principle

24. A hypodermic needle consists of a plunger of circular cross-section that slides inside a hollow cylindrical syringe. When the plunger is pushed, the contents of the syringe are forced through a hollow needle (also of circular cross-section). If a 4.0-N force is applied to the plunger and the diameters of the plunger and the needle are 1.2 cm and 2.5 mm, respectively, what force is needed *to prevent* fluid flow at the needle?

(a) 0.17 N (b) 0.27 N (c) 0.43 N
(d) 0.83 N (e) 2.7 N



25. An aluminum tank of volume 0.0300 m^3 is filled to the top with mercury at 20.0 ºC. The tank is placed inside a heating chamber with an interior temperature of 70.0 ºC. The coefficient of volume expansion for mercury is 1.82×10^{-4}/Cº; and the coefficient of linear expansion of aluminum is 23.0×10^{-6}/Cº. After the tank and its contents reach thermal equilibrium with the interior of the chamber at 70 ºC, how much mercury has spilled? Ignore surface tension.

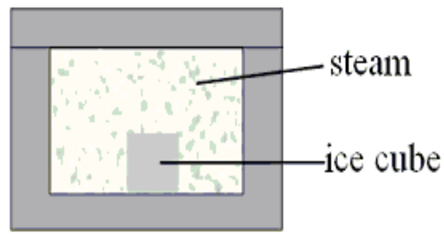
(a) 2.52×10^{-5} m^3 (b) 6.60×10^{-5} m^3 (c) 1.69×10^{-4} m^3
(d) 1.92×10^{-4} m^3 (e) 2.00×10^{-4} m^3

26. After working a 0.55-kg iron horseshoe with a temperature of 460 ºC on an anvil, a ferrier drops it into a bucket that contains 11 kg of water with an initial temperature of 24 ºC. Assuming no heat is transferred to the environment, determine the final temperature of the horseshoe in the bucket of water when thermal equilibrium is achieved. The specific heat capacity of iron is 452 J/ (kg Cº).

(a) 26 ºC (b) 34 ºC (c) 41 ºC (d) 49 ºC (e) 52 ºC

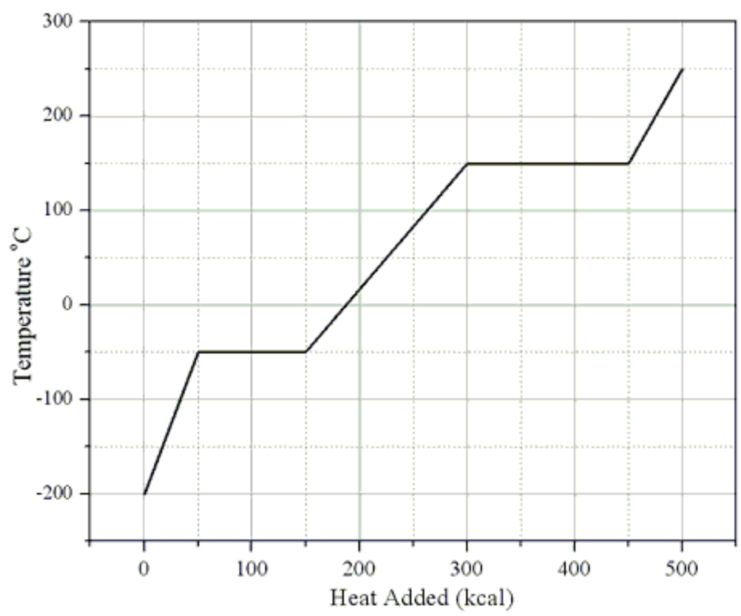
27. A 0.040-kg ice cube at 0 ºC is placed in an insulated box that contains 0.0075 kg of steam at 100 ºC. What is the equilibrium temperature reached by this closed system? **Note**: Assume that all of the ice melts and all of the steam condenses.

(a) 22.7 ºC (b) 33.6 ºC (c) 44.9 ºC
(d) 50.7 ºC (e) 66.4 ºC



28. Heat is added to a 1.0-kg solid sample of a material at -200 ºC. The figure shows the temperature of the material as a function of the heat added. What is the latent heat of fusion of this material?

(a) 50 cal/g (b) 100 cal/g
(c) 150 cal/g (d) 300 cal/g
(e) 450 cal/g



29. Two pure samples of atoms, labeled A and B, contain titanium (Ti) atoms and carbon (C) atoms, respectively. Each sample contains the same number of atoms. What is the ratio of the mass of sample B to that of sample A, m_B/m_A? The atomic masses for C and Ti are 12 u and 48 u respectively.

(a) 1.0 (b) 0.25 (c) 2.0 (d) 0.50 (e) 4.0

30. The temperature of a monatomic ideal gas with a mass per mole of 0.00750 kg/mol is 298 K. The absolute pressure of the gas is 1.65×10^5 Pa when its volume is 1.21×10^{-3} m^3. What is the mass of the gas?

(a) 9.11×10^{-5} kg (b) 2.18×10^{-4} kg (c) 4.22×10^{-4} kg
(d) 6.04×10^{-4} kg (e) 2.27×10^{-3} kg

THE END

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FINAL EXAMINATION

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PHYS 1020 A01, A02, A03

TIME: 3 hours

EXAMINATION: General Physics 1

EXAMINERS: P. Basnet, R.M Guillermic, W. Ens

ANSWERS

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