UNIVERSITY OF MANITOBA

January 16, 2017
(3:30 pm – 6:30 pm)

FINAL EXAMINATION (+ formula sheet)
PAGE NO.: 1 of 7

DEPARTMENT & COURSE NO.: PHYS 1020 A02 & A03
EXAMINATION: General Physics 1

TIME: 3 hours
EXAMINERS: P. Basnet, J. English, 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 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

$G = 6.674\times10^{-11}\,\text{m}^3\text{kg}^{-1}\text{s}^{-2}$	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, $L_f = 3.35\times10^5$ 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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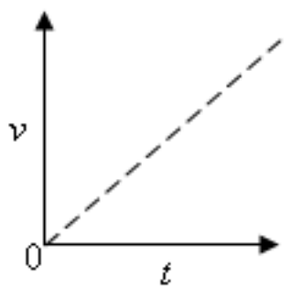
1. A bird flies 25.0 m in the direction 55° east of south from its nest on a cliff. The bird then flies 75.0 m in the direction 55° west of north to the top of a tree. What are the northward and westward components of the resultant displacement of the bird from its nest?

	Northward	*Westward*
(a)	81 m	57 m
(b)	35 m	35 m
(c)	57 m	81 m
(d)	41 m	29 m
(e)	29 m	41 m

2. The figure shows the speed as a function of time for an object in free fall near the surface of the earth.



The object was dropped from rest in a long evacuated cylinder. What does the slope of the line represent?

(a) displacement
(b) velocity
(c) speed
(d) acceleration
(e) none of these

3. A train with a constant speed of 16 m/s passes through a town. After leaving the town, the train accelerates at 0.33 m/s^2 until it reaches a speed of 35 m/s. How far did the train travel while it was accelerating?

(a) 0.029 km (b) 1.5 km (c) 2.3 km (d) 0.53 km (e) 3.0 km

4. A brass ball is shot vertically upward from the surface of an atmosphere-free planet with an initial speed of 20.0 m/s. One second later, the ball has an instantaneous velocity in the upward direction of 15.0 m/s. How high does the ball rise?

(a) 50.0 m (b) 40.0 m (c) 10.0 m (d) 20.0 m (e) 70.0 m

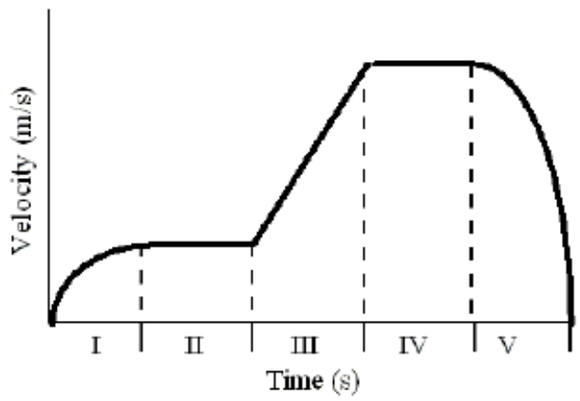
5. A projectile is fired at an angle of 55.0° above the horizontal with an initial speed of 35.0 m/s. What is the magnitude of the *horizontal* component of the projectile's displacement at the end of 2 s?

(a) 20 m (b) 10 m (c) 50 m (d) 30 m (e) 40 m

6. An airplane traveling north at 400 m/s is accelerated due east at a rate of 50 m/s^2 for 6 s. If the effects of air resistance *and* gravity are ignored, what is the final speed of the plane?

(a) 300 m/s (b) 400 m/s (c) 700 m/s (d) 800 m/s (e) 500 m/s

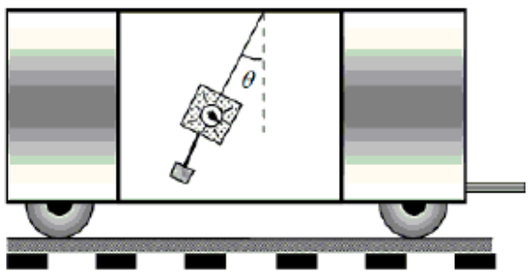
7. A 2.0-kg object moves in a straight line on a horizontal frictionless surface. The graph shows the velocity of the object as a function of time. The various equal time intervals are labeled using Roman numerals: I, II, III, IV, and V.



The net force on the object always acts along the line of motion of the object.
Which section of the graph corresponds to the application of the *largest constant* net force?

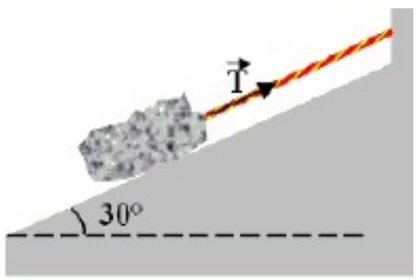
(a) I only (b) II (c) III (d) V (e) IV

8. A spring scale is fastened to the ceiling of a railway car, which is accelerating at 11.0 m/s^2 with respect to the ground. When a 3.0-kg block is hung from the scale, it is oriented as shown in the figure. What does the spring scale read?



(a) 44 N (b) 29 N (c) 3 N (d) 90 N
(e) It is impossible to calculate, θ has not been given

9. A rope holds a 15-kg rock at rest on a *frictionless* inclined plane as shown. Determine the tension in the rope.

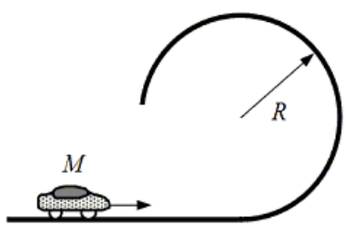


(a) 30 N (b) 14.7 N (c) 147 N
(d) 128 N (e) 74 N

10. A satellite is placed in a circular orbit to observe the surface of Mars from an altitude of 144 km. The equatorial radius of Mars is 3397 km. If the mass of Mars is 6.39×10^{23} kg, what is the speed of the satellite?

(a) 2380 m/s (b) 194 m/s (c) 5420 m/s (d) 36 500 m/s (e) 3470 m/s

11. A small car of mass *M* coasts along a straight, horizontal track without friction. As suggested in the figure, the track then bends into a vertical circle of radius *R*.



Which one of the following expressions determines the minimum speed that the car must have at the bottom of the track if it is to remain in contact with the track at the top?

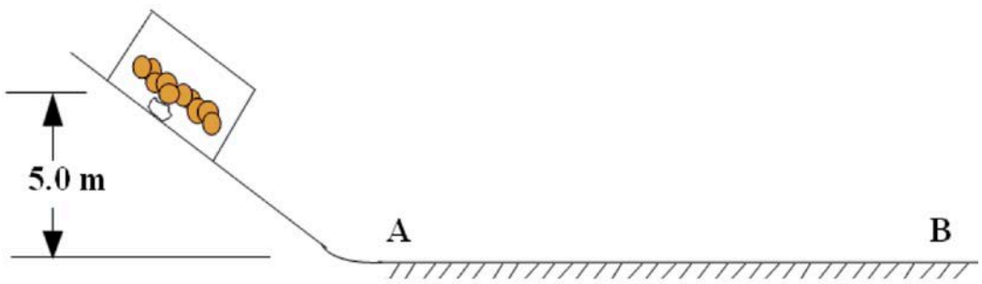
(a) $v = MgR$ (b) $v^2 = 2gR$ (c) $v^2 = 4gR$ (d) $v^2 = 5gR$ (e) $v = gR$

12. The kinetic energy of a car is 8×10^6 J as it travels along a horizontal road. How much work is required to stop the car in 10 s?

(a) zero joules (b) 8×10^4 J (c) 8×10^5 J (d) 8×10^6 J (e) 8×10^7 J

13. A 9.0-kg box of oranges slides from rest down a frictionless incline from a height of 5.0 m. A constant frictional force, introduced at point **A**, brings the block to rest at point **B**.

If the coefficient of kinetic friction is 0.26, what is the distance between A and B?



(a) 5.0 m (b) 7.0 m (c) 12 m (d) 15 m (e) 19 m

14. The amount of energy needed to power a 0.10-kW bulb for one minute would be just sufficient to lift a 1.0-kg object through a vertical distance of

(a) 12 m (b) 75 m (c) 100 m (d) 120 m (e) 610 m

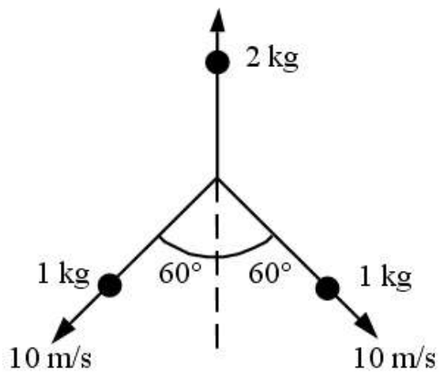
15. A machine gun fires 25-g bullets at a speed of 1000 m/s. If the average recoil force experienced by the machine gun is 100 N, at what rate do the bullets leave the gun?

(a) 1 bullet per second
(b) 2 bullets per second
(c) 3 bullets per second
(d) 4 bullets per second
(e) 5 bullets per second

16. 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 then continues along the original line of motion with the added load. How does the kinetic energy of the loaded sled 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.

17. A stationary 4-kg shell explodes into three pieces. Two of the fragments have a mass of 1 kg each and move along the paths shown with a speed of 10 m/s. The third fragment moves upward as shown.



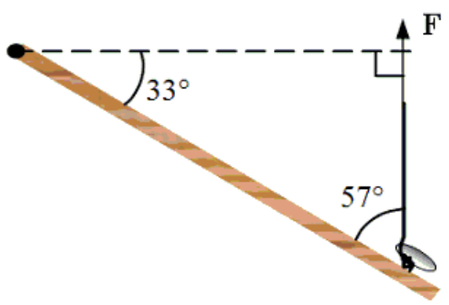
What is the speed of the center of mass of this system after the explosion?

(a) zero (b) 1 m/s (c) 3 m/s
(d) 5 m/s (e) 7 m/s

18. During the time a compact disc (CD) accelerates from rest to a constant rotational speed of 477 rev/min, it accelerates with an angular acceleration of 794 rad/s^2. What is the angular displacement of the CD?

(a) 5600 rad (b) π/2 rad (c) π rad (d) 3π/2 rad (e) 2π rad

19. A string is tied to a doorknob 0.72 m from the hinge as illustrated in the figure. At the instant shown, the force applied to the string is 5.0 N. What is the magnitude of the torque on the door?

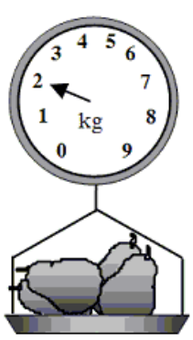


(a) 2.1 N • m
(b) 3.0 N • m
(c) 1.0 N • m
(d) 0.78 N • m
(e) 0.60 N • m

20. Consider the following four objects: a hoop, a flat disk, a solid sphere, and a hollow sphere. Each of the objects has mass *M* and radius *R*. The axis of rotation passes through the center of each object, and is perpendicular to the plane of the hoop and the plane of the flat disk. If the objects are all spinning with the same angular momentum, which requires the largest torque to stop it?

(a) the solid sphere (b) the hollow sphere (c) the hoop
(d) the flat disk (e) both the solid and the hollow spheres

21. In the produce section of a supermarket, five pears are placed on a spring scale. The placement of the pears stretches the spring and causes the dial to move from zero to a reading of 3.0 kg. If the spring constant is 450 N/m, what is the displacement of the spring due to the weight of the pears?



(a) 0.0044 m (b) 0.0088 m
(c) 0.018 m (d) 0.065 m
(e) 0.088 m

22. A 0.80 kg ball is hung from a vertical spring and oscillates in simple harmonic motion with a time period of 0.385 s and an amplitude of 0.075 m. What is the spring constant of the spring?

(a) 147 N/m (b) 3.8 N/m (c) 213 N/m (d) 529 N/m (e) 5.4 N/m

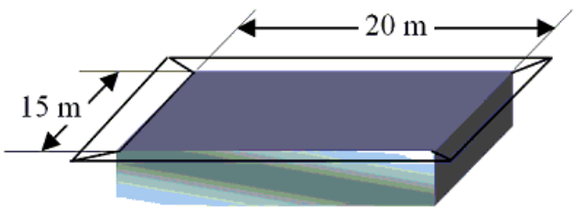
23. A simple pendulum on earth has a period of 6.0 s. What is the approximate period of this pendulum on the moon where the acceleration due to gravity is roughly 1/6 that of earth?

(a) 1.0 s (b) 2.4 s (c) 6.0 s (d) 15 s (e) 36 s

24. The density of gold is 19 300 kg/m^3. What is the mass of a gold sphere whose diameter is 0.35 m? The volume of a sphere is 4/3 πr^3.

(a) 87.5 kg (b) 433 kg (c) 947 kg (d) 1260 kg (e) 3790 kg

25. An in-ground swimming pool has the dimensions shown in the drawing. It is filled with water to a uniform depth of 6.00 m. What is the total force exerted on the 15-m side of the swimming pool? Include the effect of the atmosphere, and take the average pressure on the wall as the pressure at 3 m depth.



(a) 3.04×10^6 N (b) 5.63×10^6 N (c) 6.00×10^6 N
(d) 9.34×10^6 N (e) 1.17×10^7 N

26. In a very large closed tank, the absolute pressure of the air above the water is 5.01×10^5 Pa. The water leaves the bottom of the tank into atmospheric pressure through a nozzle that is directed horizontally. The opening of the nozzle is 5.00 m below the surface of the water. The speed at which water leaves the nozzle is

(a) 30 m/s (b) 38 m/s (c) 33 m/s (d) 25 m/s (e) 18 m/s

27. The coefficient of linear expansion of steel is 12×10^{-6}/C°. A railroad track is made of individual rails of steel 1.0 km in length. By what length would these rails change between a cold day when the temperature is -20 °C and a hot day at 40 °C?

(a) 0.62 cm (b) 24 cm (c) 72 cm (d) 480 cm (e) 620 cm

28. Ice with a mass of 0.30 kg at 0°C is placed in a Styrofoam cup containing 0.52 kg of lemonade. The specific heat capacity of lemonade is approximately the same as that of water. After the ice and lemonade reach an equilibrium temperature, 0.09 kg of ice still remains. What was the starting temperature of the lemonade? You can assume that the cup does not absorb heat.

(a) 8 ºC (b) 16 ºC (c) 24 ºC (d) 32 ºC (e) 40 ºC

29. Which one of the following statements concerning the *mole* is false?

(a) The mole is related to Avogadro's number.
(b) The mole is defined in terms of the carbon-12 isotope.
(c) The mole is the SI base unit for expressing the amount of a substance.
(d) One mole of a substance has the same mass as one mole of any other substance.
(e) One mole of a substance contains the same number of particles as one mole of any other substance.

30. On a cold day (- 3ºC), the gauge pressure on a tire reads 2.0 atm. If the tire is heated to 27 ºC, what will be the absolute pressure of the air inside the tire? Assume the volume of the tire does not change.

(a) 2.0 atm (b) 2.2 atm (c) 2.4 atm (d) 2.9 atm (e) 3.3 atm

THE END

Phys1020 (Fall 2016)
Final Exam (Jan 16, 2017) Answers

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