October 25, 2018 (5:30 p.m. – 7:30 p.m.)

PAPER A

COURSE NO.: PHYS 1020 General Physics

MIDTERM EXAMINATION
PAGE NO.: Page 1 of 5
Plus formula Sheet

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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 one 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 should have limited memory capacity and should not be capable of remote communication. No phones or handheld computers (PDAs) or notes are permitted.

Unless the question specifically asks about significant figures, 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 7-digit student number are printed on the score sheet and your student number is correctly coded in the box at the top right-hand side of the sheet.

This is paper A. Questions are numbered 1 to 20. Mark the correct answers in the first column of the accompanying IBM sheet in pencil. Also write "Paper A" next to your name on the IBM sheet.

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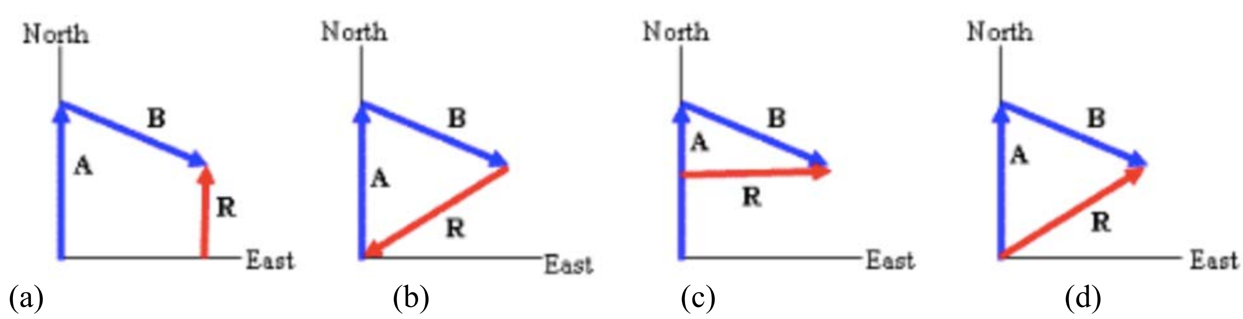
1. During a relay race, runner A runs a certain distance due north and then hands off the baton to runner B, who runs for the same distance in a direction south of east. The two displacement vectors **A** and **B** can be added together to give the resultant vector **R**. Which drawing correctly shows the resultant vector?



(e) none of the drawings is correct.

2. A vector $\mathbf{F_1}$ has a magnitude of 40.0 units and points 35.0º above the positive *x*-axis. A second vector $\mathbf{F_2}$ has a magnitude of 65.0 units and points in the negative *x* direction. Find the magnitude and direction of the resultant vector $\mathbf{F} = \mathbf{F_1} + \mathbf{F_2}$.

(a) 39.6 units, 54.6º relative to the +*x* axis
(b) 53.3 units, 52.1º relative to the +*x* axis
(c) 46.2 units, 136.0º relative to the +*x* axis
(d) 53.3 units, 141.8º relative to the +*x* axis
(e) 39.6 units, 144.6º relative to the +*x* axis

3. During the first 18 minutes of a 1.0-hour trip, a car has an average speed of 11 m/s. What must the average speed of the car be during the last 42 minutes of the trip be if the car is to have an average speed of 21 m/s for the entire trip?

(a) 21 m/s (b) 23 m/s (c) 25 m/s (d) 27 m/s (e) 29 m/s

4. A pitcher delivers a fast ball with a velocity of 43 m/s to the south. The batter hits the ball and gives it a velocity of 51 m/s to the north. What was the average acceleration of the ball during the 1.0 ms when it was in contact with the bat?

(a) 4.3×10^4 m/s^2, south (b) 5.1×10^4 m/s^2, north (c) 9.4×10^4 m/s^2, north
(d) 2.2×10^3 m/s^2, south (e) 7.0×10^3 m/s^2, north

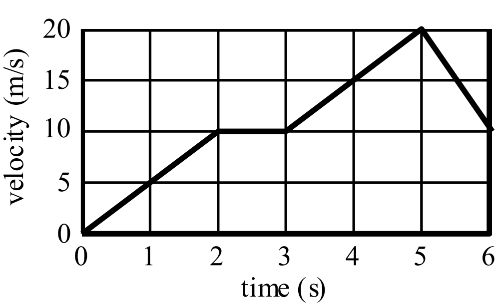
5. A cyclist is travelling at 15 km/h and accelerating at 0.10 m/s^2 when he passes another cyclist at rest. How long will it take the second cyclist to catch the first if she begins to accelerate (in the same direction) at 0.30 m/s^2 at the moment the first cyclist passes?

(a) 5.6 s (b) 14 s (c) 28 s (d) 42 s (e) 53 s

6. A hit baseball travels along a parabolic arc before it strikes the ground. If air resistance is ignored, which one of the following statements is necessarily true?

(a) The acceleration of the ball decreases as the ball moves upward.
(b) The velocity of the ball is zero when the ball is at the highest point in the arc.
(c) The acceleration of the ball is zero when the ball is at the highest point in the arc.
(d) The horizontal component of the velocity of the ball is the same throughout the ball's flight.
(e) The velocity of the ball is a maximum when the ball is at the highest point in the arc.

7. An object is moving along a straight line. The graph shows the object's velocity as a function of time.

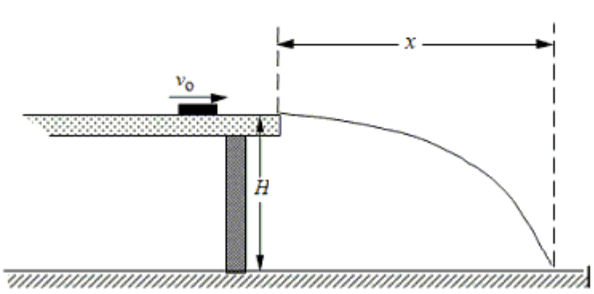


During which interval(s) of the graph does the object travel *equal distances* in *equal times*?

(a) 0 s to 2 s (b) 2 s to 3 s (c) 3 s to 5 s
(d) 0 s to 2 s and 3 s to 5 s (e) 0 s to 2 s, 3 to 5 s, and 5 to 6 s

8. A puck slides across a smooth, level tabletop at height H at a constant speed v_o. It slides off the edge of the table and hits the floor a distance x away as shown in the figure.

What is the relationship between the distances x and H?

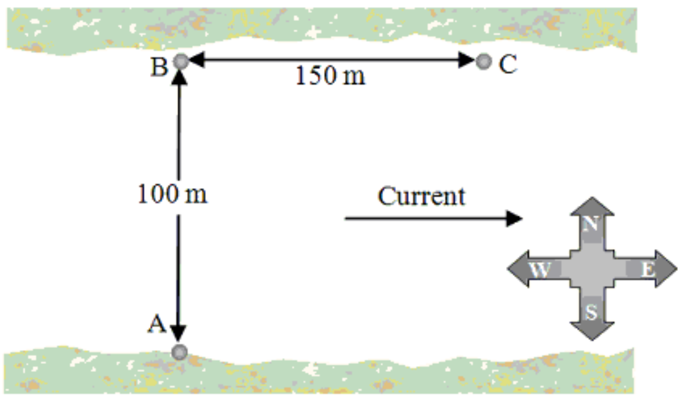


(a) $x = v_0\sqrt{\frac{2H}{g}}$ (b) $x = \frac{{v_0}^2}{2gH}$ (c) $x = \frac{{v_0}^2}{gH}$

(d) $H = v_0\sqrt{\frac{2x}{g}}$ (e) $x = v_0\frac{H}{g}$

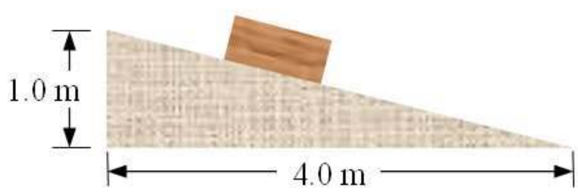
9. A man at point A directs his rowboat due north toward point B, straight across a river of width 100 m. The river current is due east. The man starts across, rowing steadily at 0.75 m/s and reaches the other side of the river at point C, 150 m downstream from his starting point.

What is the man's velocity relative to the shore during the crossing?



(a) 1.35 m/s, 34° north of east
(b) 2.00 m/s, 56° north of east
(c) 1.74 m/s, 34° north of east
(d) 2.11 m/s, 34° north of east
(e) 2.50 m/s, 42° north of east

10. In an experiment with a block of wood on an inclined plane, with dimensions shown in the figure, the following observations are made:

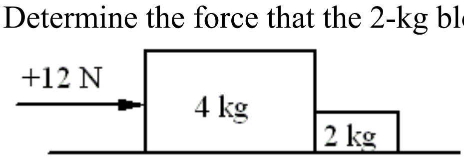


(1) If the block is placed on the inclined plane, it remains there at rest.
(2) If the block is given a small push, it will accelerate toward the bottom of the incline without any further pushing.

Which one of the following statements is the *best* conclusion that can be drawn from these observations?

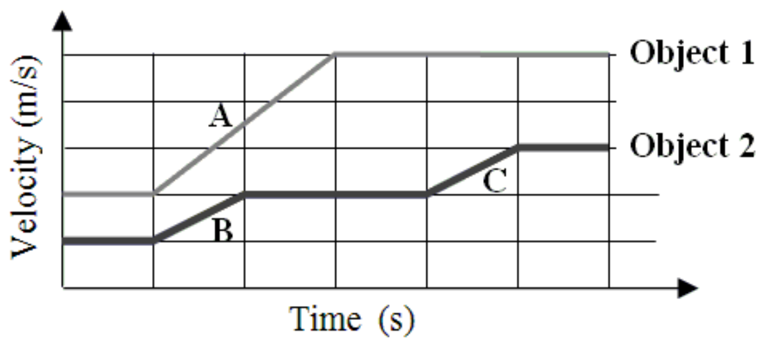
(a) The coefficient of kinetic friction must be negative.
(b) Both coefficients of friction must be less than 0.25.
(c) Both coefficients of friction must be greater than 0.25.
(d) The coefficient of static friction must be less than the coefficient of kinetic friction.
(e) The coefficient of static friction is greater than 0.25 while the coefficient of kinetic friction is less than 0.25.

11. A 4-kg block and a 2-kg block can move on a horizontal frictionless surface. The blocks are accelerated by a 12-N force to the right that pushes the larger block against the smaller one. Determine the force that the 2-kg block exerts on the 4-kg block.



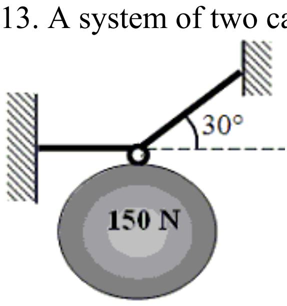
(a) 4 N to the left (b) 12 N to the left (c) 0 N (d) 4 N to the right
(e) 8 N to the right

12. The graph shows the velocities of two objects of equal mass as a function of time. Net forces $\mathbf{F}_A$, $\mathbf{F}_B$, and $\mathbf{F}_C$ acted on the objects during intervals A, B, and C, respectively. Which one of the following choices is the correct relationship between the magnitudes of the net forces?



(a) $F_B = F_C > F_A$
(b) $F_C > F_B > F_A$
(c) $F_A > F_B = F_C$
(d) $F_A = F_B = F_C$
(e) $F_A > F_B > F_C$

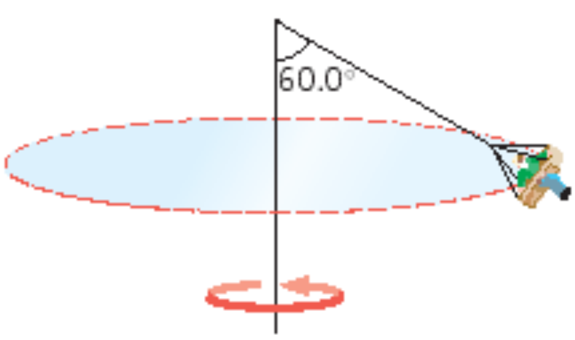
13. A system of two cables supports a 150-N ball as shown.



What is the tension in the horizontal cable?

(a) 87 N (b) 150 N (c) 170 N (d) 260 N (e) 300 N

14. A "swing" ride at a carnival consists of chairs that are swung in a circle by 10.2 m cables attached to a vertical rotating pole, as the drawing shows. Suppose the total mass of a chair and its occupant is 214 kg, and the cable makes an angle of 60º to the vertical. Find the speed of the chair.

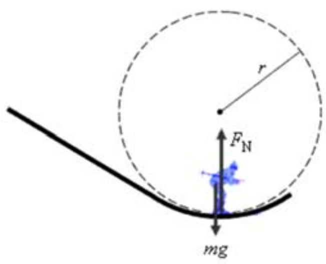


(a) 150 m/s.
(b) 9.3 m/s
(c) 12.2 m/s
(d) 13.2 m/s
(e) 10.1 m/s

15. A satellite has a mass of 6193 kg and is in a circular orbit 4.33×10^5 m above the surface of a planet. The period of the orbit is 1.9 hours. The radius of the planet is 4.90×10^6 m. What would be the true weight of the satellite if it were at rest on the planet's surface?

(a) 3.30×10^4 N (b) 8.19×10^6 N (c) 10.60×10^3 N (d) 2.26×10^8 N
(e) 7.50×10^3 N

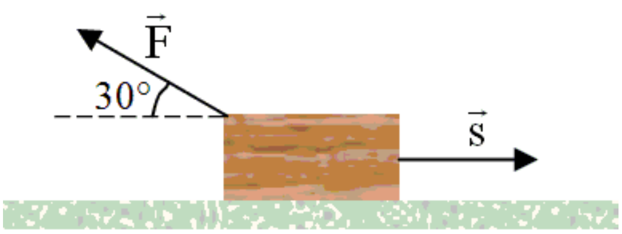
16. The drawing shows an extreme skier at bottom of a ski jump. At this point the track is circular with a radius *r*. Two forces act on the skier, her weight *mg* and the normal force F_N. Which relation describes how the net force acting on her is related to her mass *m* and speed *v* and to the radius *r*? Assume that "up" is the positive direction.



(a) $F_N - mg = \frac{mv^2}{r}$ (b) $F_N = \frac{mv^2}{r}$ (c) $-mg = \frac{mv^2}{r}$

(d) $F_N + mg = \frac{mv^2}{r}$ (e) $F_N - mg = \frac{\frac{1}{2}mv^2}{r}$

17. A constant force of 25 N is applied as shown to a block which undergoes a displacement of 7.5 m to the right along a frictionless surface while the force acts. What is the work done by the force?



(a) zero joules
(b) +94 J
(c) –94 J
(d) +162 J
(e) –162 J

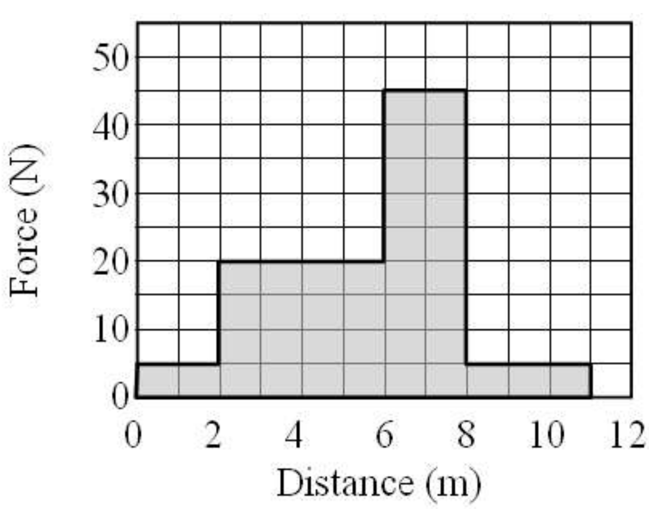
18. A skier leaves the top of a frictionless slope with an initial speed of 5.0 m/s. Her speed at the bottom of the slope is 13 m/s. What is the height of the slope?

(a) 1.1 m (b) 4.6 m (c) 6.4 m (d) 7.3 m (e) 11 m

19. A warehouse worker uses a forklift to raise a crate of pickles on a platform to a height 2.75 m above the floor. The combined mass of the platform and the crate is 207 kg. If the power expended by the forklift is 1440 W, how long does it take to lift the crate?

(a) 37.2 s (b) 5.81 s (c) 3.87 s (d) 18.6 s (e) 1.86 s

20. 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

THE END

PHYS 1020 General Physics 1 — Formula Sheet for Mid-Term Test

Mathematics

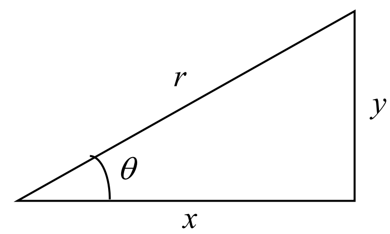
Quadratic equation:

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Trigonometry:

$$r^2 = x^2 + y^2$$
$$\sin\theta = y/r$$
$$\cos\theta = x/r$$
$$\tan\theta = y/x$$



Kinematics (for constant acceleration)**:**

$$v = v_0 + at$$

$$x = v_0 t + \tfrac{1}{2}at^2$$

$$x = \tfrac{1}{2}(v_0 + v)t$$

$$v^2 = v_0^2 + 2ax$$

$$x = vt - \tfrac{1}{2}at^2$$

Forces:

Newton's second law: $\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}$

First condition for equilibrium: $\sum \vec{\mathbf{F}} = 0$

Gravity:

Gravitational force near the earth: $F = mg$

Newton's law of universal gravitation: $F = G\dfrac{m_1 m_2}{r^2}$

$g = 9.80\ \text{m/s}^2$ $\quad G = 6.67\times10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2$

Friction:

Static: $0 \le f_s \le \mu_s F_N$ direction is always opposite to motion (or tendency to motion)

Kinetic: $f_k = \mu_k F_N$

Uniform Circular Motion

Period: $T = \dfrac{2\pi r}{v}$, where v is the speed of the object and r is the radius of the circle

Frequency: $f = \dfrac{1}{T}$ $\qquad \theta \text{ (in radians)} = \dfrac{\text{Arc length}}{\text{radius}}$

Centripetal Acceleration: $a_c = \dfrac{v^2}{r}$

Centripetal Force: $F_c = \dfrac{mv^2}{r}$ (directed towards the centre)

Work, Energy, and Power:

Work: $W = (F\ \cos\theta)\ s$

Kinetic energy: $\text{KE} = \tfrac{1}{2}mv^2$

Potential energy:

Gravitational (near Earth): $\text{PE} = mgh$

Work-energy theorem: $W_{\text{nc}} = \Delta\text{KE} + \Delta\text{PE} = E_f - E_i$

Total mechanical energy: $E = \text{KE} + \text{PE}$

Conservation of mechanical energy: $E = \text{KE} + \text{PE} = \text{constant};\ E_f = E_i$

Power (rate of doing work): $\overline{P} = \dfrac{W}{t}$

Answers

1. D
2. E
3. C
4. C
5. D
6. D
7. B
8. A
9. A
10. E
11. A
12. C
13. D
14. C
15. A
16. A
17. E
18. D
19. C
20. B