Name Answer Key

Date

Honors Physics

Period

Honors Midterm Review

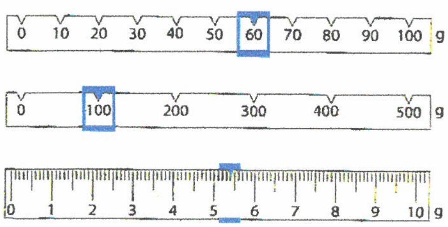
Mrs. Nadworny

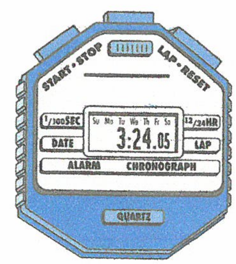
Honors Midterm Review

Directions: Each question below represents a typical problem from each chapter. Complete the problems on a separate sheet of paper, showing all work with the GUESS method and proper significant figures.

Measurements and Mathematics:

1. The first diagram shows an enlarged view of a triple beam balance, which measures in grams. Record the appropriate mass reading in kilograms, including proper uncertainty. The second diagram shows the cross section of a basketball. Measure and record the diameter of the ball, including proper uncertainty. The third diagram below shows a stopwatch used to record an event. Record the time in proper units, including proper uncertainty.





0.16540 kg ± 0.00002 kg   0.0339 m ± 0.0002 m   204.1 s ± 0.2 s

2. Using dimensional analysis, convert 35 miles/hour into meters/second. [1 mi = 1609 m]

$$\frac{35\text{ mi}}{\text{hr}}\left(\frac{1609\text{ m}}{1\text{ mi}}\right)\left(\frac{1\text{ hr}}{3600\text{ s}}\right) = 15.643\text{ m/s} = 16\text{ m/s}$$

Kinematics:

3. A man travels 4.6 meters east and 2.2 meters south. What is his displacement?

$$d = \sqrt{a^2 + b^2} = \sqrt{(4.6\text{ miles})^2 + (2.2\text{ miles})^2} = 5.1\text{ meters SouthEast}$$

4. How long does it take a skier to travel 595 meters, going 16.1 m/s?

$$t = \frac{d}{v} = \frac{595\text{ m}}{16.1\text{ m/s}} = 37.0\text{ s}$$

5. A Corvette can go from zero to 24 m/s in 2.15 seconds, calculate its rate of acceleration.

$$a = \frac{v_f - v_i}{t} = \frac{24\frac{m}{s} - 0\frac{m}{s}}{2.15\text{ s}} = 11\ \frac{m}{s^2}$$

6. A speedboat can accelerate at a rate of 1.06 m/s². How far does the boat travel if it accelerates from 4.91 m/s to 10.37 m/s?

$$d = \frac{v_f^2 - v_i^2}{2a} = \frac{(10.37\frac{m}{s})^2 - (4.91\frac{m}{s})^2}{2(1.06\frac{m}{s^2})} = 39.4\text{ m}$$

7. A stuntman jumps off a bridge into a canal. If his flight lasts 2.1 seconds what is his final velocity just before hitting the water?

$$v_f = v_i + at = (-9.81\,\tfrac{m}{s^2})(2.1\text{ s}) = 21\ \tfrac{m}{s}\text{ down}$$

8. You throw a baseball straight up and it returns to your hand in 1.46 seconds.
   a. Calculate the initial speed of the ball.

$$v_i = v_f - at = -(-9.81\tfrac{m}{s^2})(0.730s) = 7.16\tfrac{m}{s}$$

   b. Calculate the height that the ball reaches.

$$d = v_i t + \tfrac{1}{2}at^2 = (7.16\tfrac{m}{s})(.730s) + \tfrac{1}{2}(-9.81\tfrac{m}{s^2})(.730s)^2 = 2.61m$$

Vectors:

9. A tortoise swims West at 8.0 m/s across a river whose current is 5.0 m/s South. Determine the resultant velocity of the tortoise using the mathematical method.

$$\vec{v} = \sqrt{v_x^2 + v_y^2} = \sqrt{(8.0\text{ m/s})^2 + (5.0\text{ m/s})^2} = 9.4\text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{5.0\frac{m}{s}}{8.0\frac{m}{s}}\right) = 32°\text{ S of W}$$

10. A ball is kicked with an initial velocity of 24.5 m/s at an angle of 35.0°. Determine the vertical and horizontal components of the velocity using the mathematical method.

$$v_x = v\cdot\cos\theta = (24.5\tfrac{m}{s})(\cos 35.0°) = 20.1\tfrac{m}{s}\text{ forward}$$

$$v_y = v\cdot\sin\theta = (24.5\tfrac{m}{s})(\sin 35.0°) = 14.1\tfrac{m}{s}\text{ up}$$

Projectiles:

11. An object is projected horizontally off of a cliff 41 meters high with an initial speed of 26 m/s.
   a. Calculate how long it is in the air.

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(41\text{ m})}{9.81\frac{m}{s^2}}} = 2.9\text{ s}$$

   b. Calculate how far away it lands.

$$d_x = v_{ix}t = 26\tfrac{m}{s}(2.9\text{ s}) = 75\text{ m}$$

   c. Calculate how fast it was going vertically when it struck the ground.

$$v_{fy} = v_{iy} + at = (-9.81\tfrac{m}{s^2})(2.9\text{ s}) = 28\tfrac{m}{s}$$

   d. Calculate how fast it was going horizontally when it struck the ground.

$$v_{fx} = v_{ix} = 26\ \tfrac{m}{s}$$

	x	y
d	?	41m
t	?	?
a	0 m/s²	-9.81 m/s²
v_i	26m/s	0 m/s
v_f		

12. A rock is thrown into the air with an initial speed of 51.0 m/s at an angle of 62.0° with the horizontal.

	x	y
d		0 m
t		
a	0 m/s²	-9.81 m/s²
vᵢ		
v_f		0 m/s

a. Calculate the initial vertical speed of the rock.

$$v_{iy} = v_i \sin\theta = (51.0\tfrac{m}{s})(\sin 62.0°) = 45.0\tfrac{m}{s}$$

b. Calculate the initial horizontal speed of the rock.

$$v_{iy} = v_i \cos\theta = (51.0\tfrac{m}{s})(\cos 62.0°) = 23.9\tfrac{m}{s}$$

c. Calculate how long it was in the air.

$$t_{top} = \frac{\Delta v}{a} = \frac{0\tfrac{m}{s} - 45.0\tfrac{m}{s}}{-9.81\tfrac{m}{s^2}} = 4.59s$$

$$t_{total} = 2 \times t_{top} = 2(4.59s) = 9.18s$$

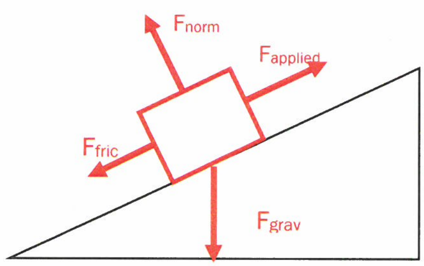
d. Calculate how far away it landed.

$$d_x = v_{ix}t = 23.9\tfrac{m}{s}(9.18s) = 219m$$

Forces:

13. A 39.4 kg wooden block is pushed up a wooden ramp inclined at 32.0° by applying a force of 231 newtons parallel to the incline. Draw a free body diagram of the situation. Calculate the acceleration of the block.

a. Draw and label an appropriate free body diagram.



b. Calculate the weight of the block.

$$F_{grav} = mg = 39.4kg(-9.81\tfrac{m}{s^2}) = {}^{-}387N = 387N \text{ down}$$

c. Calculate the normal force supporting the block.

$$F_{norm} = -F_{G\perp} = -F_{grav}\cos\theta = -(-387N)\cos(32.0°) = {}^{+}328N = 328N \text{ out of hill}$$

d. What is the coefficient of friction between the two surfaces?

μ= 0.30 (Found on reference tables)

e. Calculate the force due to friction acting on the block.

$$F_{fric} = \mu \bullet F_{norm} = (0.30)(328N) = 98N \text{ downhill}$$

f. Calculate the parallel component of the weight.

$$F_{G\parallel} = F_{grav}\sin\theta = -387N\sin(32.0°) = {}^{-}205N = 205N \text{ downhill}$$

g. Calculate the net force on the block.

$$F_{net} = F_{app} + F_{fric} + F_{G\|} = ({}^{+}231N) + ({}^{-}98N) + ({}^{-}205N) = {}^{-}72N = 72N \text{ downhill}$$

h. Calculate the acceleration of the block.

$$a = \frac{F_{net}}{m} = \frac{-72N}{39.4kg} = -1.8\tfrac{m}{s^2} = 1.8\tfrac{m}{s^2} \text{ downhill}$$

Universal Gravitation:

14. A star with a mass of 2.13×10^{17} kg and planet Blue, which has a mass of 4.13×10^{22} kg, are separated by a distance of 4.8×10^{11} m.

a. Calculate the gravitational attractive force between the star and Blue.

$$F_G = \frac{Gm_1m_2}{r^2} = \frac{(6.67\times10^{-11}\,\tfrac{N\cdot m^2}{kg^2})(2.13\times10^{17}\,kg)(4.13\times10^{22}\,kg)}{(4.8\times10^{11}\,m)^2} = 2.5\times10^{6}\,N \text{ toward}$$

b. Calculate the acceleration due to gravity on planet Blue if it has a radius of 3.26×10^6 meters.

$$g = \frac{Gm_1}{r^2} = \frac{(6.67\times10^{-11}\,\tfrac{N\cdot m^2}{kg^2})(4.13\times10^{22}\,kg)}{(3.26\times10^{6}\,m)^2} = 0.259\tfrac{m}{s^2} \text{ down}$$

Circular Motion:

15. A student whirls a 19.96 g rubber stopper above their head on a string with a radius of 0.318 meters. The stopper completes 10 revolutions in 4.89 seconds.

a. Calculate the Period of stopper.

$$T = \frac{time}{revolutions} = \frac{4.89s}{10} = 0.489s$$

b. Calculate the speed of the stopper.

$$v = \frac{2\pi r}{T} = \frac{2\pi(0.318m)}{0.489s} = 4.09\tfrac{m}{s}$$

c. Calculate the centripetal acceleration of the stopper.

$$a_c = \frac{v^2}{r} = \frac{(4.09\tfrac{m}{s})^2}{0.318m} = 52.6\tfrac{m}{s^2} \text{ inward}$$

d. Calculate the centripetal force acting on the stopper.

$$F_c = ma_c = 0.01996kg(52.6\tfrac{m}{s^2}) = 1.05N \text{ inward}$$

16. A worker tightening a bolt exerts a force of 6.5 newtons on the end of a 0.25 meter long wrench. Calculate the magnitude of the torque.

$$\tau = F \cdot r = (6.5N)(0.25m) = 1.6Nm$$

17. Two children sit on a see-saw that is 9.0 meters long and pivoted on an axis at its center. The first child has a mass of 20. kilograms and sits at the left end of the see-saw. The second child has a mass of 40. kilograms and sits somewhere on the see-saw to the right of the axis. At what distance from the axis should the second child sit to keep the see-saw horizontal?

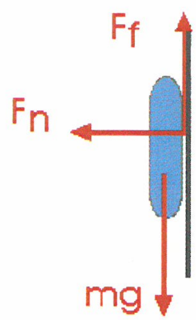
$$\tau_1 = \tau_2$$
$$F_1 \cdot r_1 = F_2 \cdot r_2$$
$$m_1 \not{g} \cdot r_1 = m_2 \not{g} \cdot r_2$$
$$r_1 = \frac{m_2 r_2}{m_1} = \frac{(20.kg)(4.5m)}{40.kg} = 2.3m$$

18. A 2500. kg car attempts to turn a corner going at a speed of 18 m/s. The radius of the turn is 20. meters. How much friction is needed to negotiate this turn successfully?

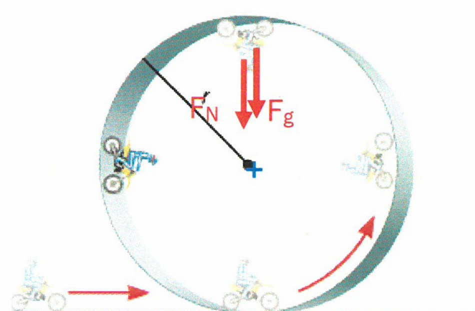
$$F_c = F_f$$
$$F_f = \frac{mv^2}{r}$$
$$F_f = \frac{(2500.\ kg)(18\ m/s)^2}{20.\ m}$$
$$F_f = 4.1 \times 10^4\ N$$

19. At amusement parks, there is a popular ride where the floor of a rotating cylindrical room falls away, leaving the backs of the riders "plastered" against the wall. The ride has a diameter of 9.0 meters and rotates with a maximum speed of 8.5 meters per second. Calculate the coefficient of friction between the rider's back and the wall.

$$F_{FY} = F_g \quad \text{AND} \quad F_{cx} = F_N$$
$$F_{FY} = mg \quad \text{AND} \quad F_N = \frac{mv^2}{r}$$
$$\mu F_N = mg$$
$$\mu\left(\frac{mv^2}{r}\right) = mg$$
$$\mu = \frac{mgr}{mv^2}$$
$$\mu = \frac{rg}{v^2} = \frac{(4.5m)(9.81\frac{m}{s^2})}{(8.5\frac{m}{s})^2} = 0.61$$



20. A 95 kilogram stunt motorcyclist on a 255 kilogram bike rounds a 14.0 meter diameter loop-the-loop. What force does the track exert on the bike at the top of the loop where the speed of the bike is 28 meters per second?



$$F_{net} = F_c = \frac{mv^2}{r}$$
$$F_N + F_g = \frac{mv^2}{r}$$
$$F_N = \frac{mv^2}{r} - mg$$
$$F_N = \frac{(95\ kg + 255\ kg)(28\ m/s)^2}{7.0\ m} - (350.\ kg)(9.81\ m/s^2)$$
$$F_T = 35767\ N = 3.6 \times 10^4\ N$$

Momentum:

21. A mass moving with a momentum of 43.9 kg·m/s receives an impulse of 21.3 N·s in the direction of motion. Calculate the final momentum of the mass.

$$J = p_f - p_i$$

$$p_f = J + p_i = (21.3N\cdot s) + (43.9\tfrac{kg\cdot m}{s}) = 65.2\tfrac{kg\cdot m}{s} \text{ forward}$$

22. A 6.7 kg object has a momentum of 31.1 kg·m/s. What is the object's speed?

$$v = \frac{p}{m} = \frac{31.1\frac{kg\cdot m}{s}}{6.7kg} = 4.6\tfrac{m}{s}$$

23. During the Collisions and Explosions lab, the red car (of mass 2.0 kg) is traveling at 3.0 m/s south. The blue car is traveling north at 1.5 m/s and has a momentum of 6.0 kg-m/s. When the cars collide their Velcro locks them together. What is the speed of the two cars after the collision?

Before	After
P_{before} =	P_{after}
$m_1v_1 + m_2v_2$ =	$(m_1 + m_2)\,v_f$
(2.0 kg)(-3.0m/s) + (+6.0 kg•m/s) =	(2.0 kg + 4.0 kg)(v_f)
0 kg•m/s =	(6.0 kg) v_f
0 m/s =	v_f

24. Later, during the Collisions and Explosions lab, the cars are placed together in the center of the track. The compressed spring is released, sending the red car (of mass 0.85 kg) to the West with a velocity 1.6 m/s. What is the velocity of the blue car (of mass 3.17 kg) after the explosion?

P_{before} =	P_{after}
P_{before} =	$m_1v_1 + m_2v_2$
0 kg-m/s =	(0.85 kg)(-1.6 m/s) + (3.17 kg)(v_2)
1.36 kg-m/s =	(3.17 kg)(v_2)
0.43 m/s East =	v_2

25. Even later, during the Collisions and Explosions lab, the red car (of mass 0.85 kg) is traveling to the right with a speed of 1.28 m/s. It is hit from behind by the blue car (of mass 3.17 kg), which is also moving to the right with a speed of 3.92 m/s. After they collide the red car continues to move to the right, but now at 4.18 m/s. What is the velocity with which the blue car continues to move after the collision?

P_{before} =	P_{after}
$m_1v_1 + m_2v_2$ =	$m_1v_1 + m_2v_2$
(0.85 kg)(+1.28 m/s) + (3.17 kg)(+3.92 m/s)	(0.85 kg)(+4.18 m/s) + (3.17 kg)(v_2)
+13.5144 kg•m/s =	+3.553 kg•m/s + (3.17 kg)(v_2)
3.1 m/s right =	v_2

26. A [...] one traveling at a speed of 3,450 meters per second. At another point it is half the distance, 1.68 x 10^7 meters, away. Calculate the speed of the satellite at the second location.

$$L_b = L_a$$

$$\cancel{m}vr = \cancel{m}vr$$

$$v_a = \frac{v_b r_b}{r_a} = \frac{(3450\frac{m}{s})(3.35\times10^7 m)}{(1.68\times10^7 m)} = 6880\tfrac{m}{s}$$

Energy:

27. A 14.5 kilogram box is pushed up a 2.54 meters frictionless ramp, inclined at 29.0°, at constant speed, into the back of a truck.

 a. Calculate the amount of work done.

Constant speed – forces balance

$F_{applied} = -F_{g\ parallel}$

$$W = F_{g\parallel}d = (F_g \sin\theta)d = (mg\sin\theta)d$$
$$= (14.5kg)(9.81\tfrac{m}{s^2})(\sin 29.0°)(2.54m)$$
$$= {}^{+}175J$$

 b. Calculate the amount of power developed.

$$P = \frac{W}{t} = \frac{175J}{55s} = 3.2W$$

28. A 60.0 kilogram runner has 2170 joules of kinetic energy. Calculate the speed of the runner.

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(2170J)}{60.0kg}} = 8.50\tfrac{m}{s}$$

29. A person who weighs 645 newtons rides an elevator upward at a constant speed of 3.0 meters per second for 5.0 second. Calculate the change in the person's gravitational potential energy.

$$h = vt = (3.0\tfrac{m}{s})(5.0s) = 15m$$
$$PE = mgh = (645N)(15m) = 9700J$$

30. A block is pushed across a smooth table top so that it is traveling with 175 joules of kinetic energy. It encounters a rough patch where friction does 92 joules of work on the block. Calculate the kinetic energy of block after traveling over the rough patch.

$$W = \Delta E_T = KE_f - KE_i$$
$$KE_f = W + KE_i = (-92J) + 175J = 83J$$

31. A pendulum is swinging back and forth with a period of 0.75 second. Calculate the length of the pendulum.

$$T = 2\pi\sqrt{\frac{L}{g}} \quad \text{so} \quad L = \left(\frac{T}{2\pi}\right)^2 g = \left(\frac{0.75s}{2\pi}\right)^2 9.81\tfrac{m}{s^2} = 0.14m$$

32. It takes a force of 24.7 N to hold a spring stretch a distance of 41.9 cm. What is the elastic potential energy of the spring in this position? [Hint: Watch your units!]

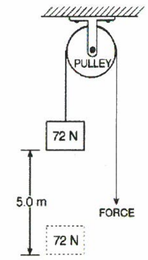
$$k = \frac{F}{x} = \frac{24.7N}{0.419m} = 58.9\,N/m$$

$$PE_{elastic} = \frac{1}{2}kx^2 = \frac{1}{2}(58.9\,N/m)(0.419m)^2 = 5.17J$$

33. A worker does 4260 joules of work pulling a rope through a pulley to lift a carton which gains 3880 joules of potential energy. What is the efficiency of the pulley system?

$$Eff\ (\%) = \frac{W_o}{W_i} \times 100 = \frac{3880\ J}{4260} \times 100 = 91.1\%$$

34. In the diagram, 400. J of work is done raising a 72 N weight a vertical distance of 5.0 m. Calculate how much work was done against friction as the weight was lifted.



$$W_{tot} = W_f + W_{lift}$$
$$W_f = W_{tot} - W_{lift} = W_{tot} - mgh$$
$$= 400.J - (72N)(5.0m) = {}^{+}40J$$

35. A 0.250 kg mass is attached to a spring which has a spring constant of 35 N/m, as shown. It is pulled down and released so that it bobs up and down. Calculate the period of the spring

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.350kg}{45}} = 0.55s$$

Answers in size order: 0, 0.0339, 0.14, 0.16540, 0.259, 0.30, 0.43, 0.489, 0.55, 0.61, 1.05, 1.6, 1.8, 2.3, 2.61, 2.9, 3.1, 3.2, 4.09, 4.59, 4.6, 5.1, 5.17, 7.16, 8.50, 9.18, 9.4, 11, 14.1, 16, 20.1, 23.9, 21, 26, 28, 32, 37.0, 39.4, 40, 45.0, 52.6, 65.2, 72, 75, 83, 91.1, 98, 175, 204.1, 205, 219, 328, 387, 6880, 9700, 3.6×10^4, 4.1×10^4, 2.5×10^6

College Level Review: Midterm

Directions: *Unless otherwise noted, use g = 10 m/s² and neglect air resistance for all questions.*

Unit 1 – Measurements & Mathematics

1 Km $\left(\frac{10^3 m}{1 km}\right)\left(\frac{10^9 nm}{1 m}\right) = 10^{12}$

1. How many nanometers are in a kilometer?

   (A) 10^{-9} (B) 10^{9} (C) 10^{-12} (D) 10^{12} (E) 10^{27}

2. Which of the following is the largest quantity?

   (A) 0.27 m (B) 27 x 10^{-3} m (C) 2.7 x 10^{-6} m (D) 0.000027 x 10^{2} m (E) 0.0000027 x 10^{3} m

   .027 .0000027 .0027 .0027

3. Which of the following represents a derived unit?

   I. Joules Nm II. Kilogram III. Ampere IV. Watt J/s = Nm/s

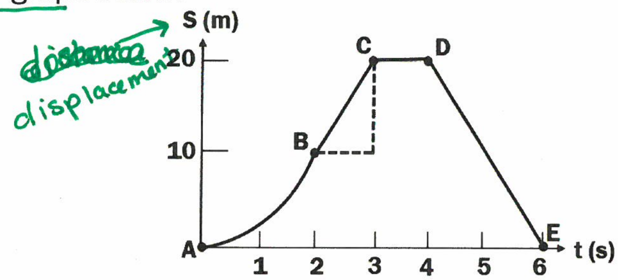
   (A) I only (B) I and IV only (C) I, III and IV only (D) all of the above (E) none of the above

Unit 2 – Kinematics

4. Which of the following is NOT an example of a vector?

   (A) force (B) velocity (C) mass (D) displacement (E) momentum

A football player catches a ball at his goal line (*x* = 0) at *t* = 0, and his motion is then graphed on the displacement vs. time graph below.



slope = velocity

5. During which interval is the player accelerating away from his goal line

   ↳ slope increases

   (A) AB (B) BC (C) CD (D) DE (E) none of the above

6. What is the player's speed between points B and C?

   (A) 20 m/s (B) 10 m/s (C) 7 m/s (D) 5 m/s (E) 0 m/s $V = \frac{d}{t} = \frac{10m}{1s} = 10 m/s$

7. Between points C and D, the player's motion can best be described as

   ↳ no slope

   (A) accelerating. (B) constant speed. (C) at rest. (D) backwards. (E) decelerating.

8. What is the player's velocity during the interval of 4 s to 6 s?

   backwards

   (A) 10 m/s (B) 5 m/s (C) 0 m/s (D) – 5 m/s (E) – 10 m/s $\vec{v} = \frac{\vec{d}}{t} = \frac{-20m}{2s}$

9. What is the player's total displacement at the end of his motion?

   (A) 20 m (B) 10 m (C) 0 m (D) – 10 m (E) – 20 m

   returns to start

Questions 10 - 11 refer to the following

A child on a skateboard crosses a line on the sidewalk traveling with a speed of 2 m/s when he begins to accelerate at a constant rate of 2 m/s². (v_i)

10. What will be the child's speed after 3 s? (a, t) $v_f = v_i + at = 2\text{ m/s} + (2\text{ m/s}^2)(3\text{ s})$

(A) 8 m/s (B) 9 m/s (C) 12 m/s (D) 15 m/s (E) 18 m/s

11. How far past the line on the sidewalk will the child be after 3 s? $d = v_i t + \frac{1}{2}at^2$ $(2\text{ m/s})(3\text{ s}) + \frac{1}{2}(2\text{ m/s}^2)(3\text{ s})^2$

(A) 8 m (B) 9 m (C) 12 m (D) 15 m (E) 18 m

12. A brick is dropped from a high scaffold and strikes the ground 4.0 seconds later. How high is the scaffold?

$d = \frac{1}{2}at^2$ $\frac{1}{2}(-10\text{ m/s}^2)(4\text{ s})^2$ $v_i = 0\text{ m/s}$, $a = -10\text{ m/s}^2$, $t = 4\text{ s}$, $d = ?$

(A) 20 m (B) 40 m (C) 60 m (D) 80 m (E) 100 m

Unit 3 – Vectors & Projectiles

13. When the tail of vector *A* is set at the origin of the *xy*-axis, the tip of *A* reaches (3,6). When the tail of vector *B* is set at the origin of the *xy*-axis, the tip of *B* reaches (−1,5). If the tail of vector *A* − *B* were set at the origin of the *xy*-axis, what point would its tip touch?

x: 3 − −1 = 4
y: 6 − 5 = 1
(4,1)

(A) (2,11) (B) (2,1) (C) (-2,7) (D) (4,1) (E) (4,11)

14. Vector *A* is positioned concurrently from vector *B* by angle θ. Which of the following measures could be taken to maximize the resultant of *A* and *B*?

I. Minimize the magnitude of A.
II. Maximize the magnitude of A.
III. Maximize the magnitude of B.
IV. Set θ to 90°. max at θ = 0°

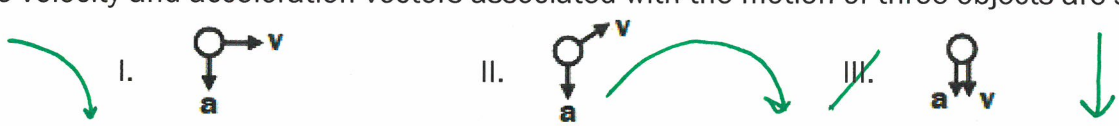
(A) I only (B) II & III only (C) I, II, III & IV (D) I & IV only (E) None of the above

15. A projectile is launched from level ground with a velocity of 40 m/s at an angle of 30° from the ground. What will be the vertical component of the projectile's velocity just before it strikes the ground? (sin 30° = 0.5, co 30° = 0.87)

symmetric $v_{fy} = v_{iy}$ $v_{iy} = v_i \sin\theta = 40\text{ m/s} \sin 30°$

(A) 10 m/s (B) 20 m/s (C) 30 m/s (D) 35 m/s (E) 40 m/s

The velocity and acceleration vectors associated with the motion of three objects are shown below.



16. Which of the above could represent the velocity and acceleration vectors for a projectile following a parabolic path? (curved)

(A) I only (B) II only (C) III only (D) I and II only (E) II and III only

17. A ball dropped from a tower will strike the ground below in 3.0 s. If the ball is launched horizontally from the tower at a speed of 10. m/s, how far horizontally from the base of the tower will the ball land on the level ground?

(A) 100 m (B) 45 m (C) 30 m (D) 10 m (E) 3.3 m

• Time to fall & time to land horizontally are the same

$d_x = v_x t = (10\text{ m/s})(3\text{ s})$

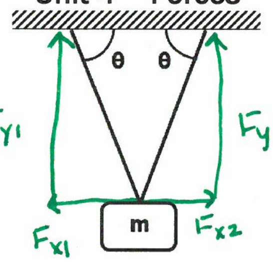
18. A steel sphere is launched horizontally with a speed v from the edge of a table of height h above a level floor. At the same instant, another steel sphere is dropped from the edge of the same table. Air resistance may be neglected. Which of the following statements is true?

(A) The two spheres will strike the floor at the same time.
~~(B)~~ The sphere that is dropped will strike the floor first.
~~(C)~~ The sphere that is launched horizontally will strike the floor first.
(D) The acceleration of the sphere that is dropped is greater than the acceleration of the other sphere after it is launched.
(E) The acceleration of the sphere after it is launched is greater than the acceleration of the sphere that is dropped.

Gravity is vertical - doesn't "care" about horizontal v

$a_y = -10 \text{ m/s}^2$
$a_x = 0 \text{ m/s}^2$
for both

Unit 4 – Forces



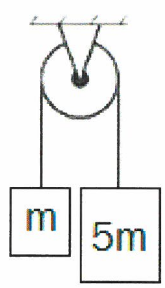
$F_{net\,x} = 0N$
$F_{x2} - F_{x1} = 0N$
$F_{x1} = F_{x2}$

$F_{net\,y} = 0N$
$F_{y1} + F_{y2} - F_g = 0N$
$F\sin\theta + F\sin\theta - F_g = 0N$
$2F\sin\theta - mg = 0N$
$F = \frac{mg}{2\sin\theta}$

19. A mass *m* is hung from two light strings as shown above. The tension in each string is

(A) mg cos θ (B) 2 mg cos θ (C) mg sin θ (D) ½ mg sin θ (E) $\frac{mg}{2\sin\theta}$

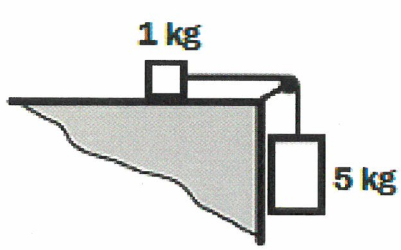
20. Two blocks of mass *m* and *5m* are connected by a light string that passes over a pulley of negligible mass and friction. What is the acceleration of the masses in terms of the acceleration due to gravity, *g*?



$a = \frac{F_{net}}{m_{net}} = \frac{F_{g2} - F_{g1}}{m_1 + m_2}$
$= \frac{5mg - 1mg}{5m + 1m} = \frac{4mg}{6m}$
$= \frac{2}{3}g$

(A) 4g (B) 5g (C) 6g (D) $\frac{4}{5}g$ (E) $\frac{2}{3}g$

21. A 1 kg block rests on a frictionless table and is connected by a light string to another block of mass 5 kg. The string is passed over a pulley of negligible mass and friction. What is the acceleration of the masses?

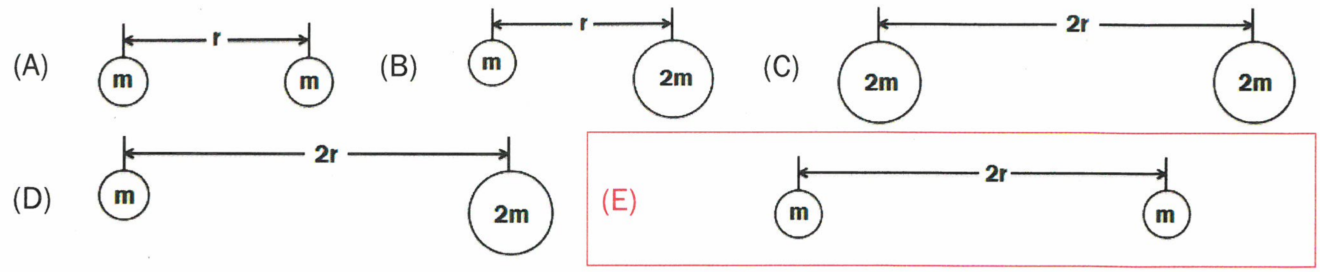


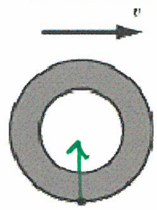
$a = \frac{F_{net}}{m_{net}} = \frac{F_{g\,hang}}{m_1 + m_2}$
$= \frac{5kg(g)}{5kg + 1kg}$
$= \frac{5}{6}g$
$= \frac{5}{6}(10 \text{ m/s}^2)$

(A) 6.6 m/s² (B) 8.3 m/s² (C) 10 m/s² (D) 20 m/s² (E) 50 m/s²

$F_g = \frac{Gmm}{r^2}$ ↓F ↓m ↓F ↑r

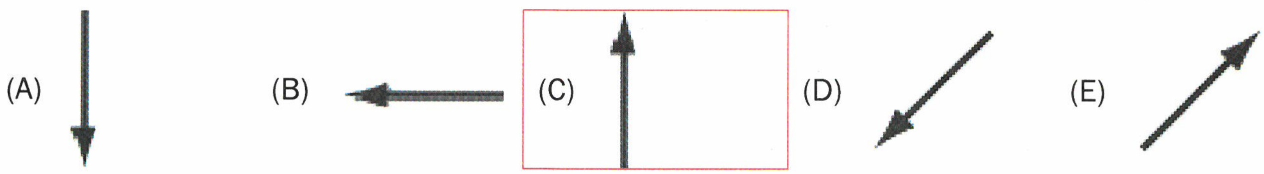
22. Which of the following diagrams of two planets would represent the smallest gravitational force between the masses?



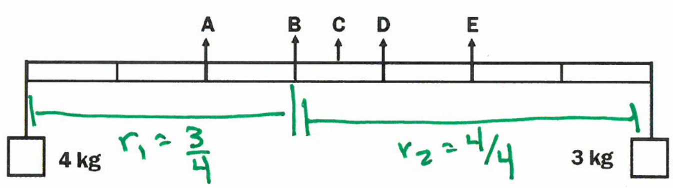


acceleration is always IN for circles

23. A car wheel drives over a pebble, which then sticks to the wheel momentarily as the wheel displaces it. What is the direction of the initial acceleration of the pebble?



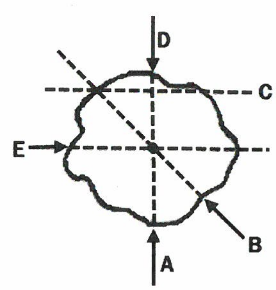
24. Two blocks of mass 3 kg and 4 kg hang from the ends of a rod of negligible mass marked in seven equal parts.



$\tau_1 = \tau_2$
$m_1 g r_1 = m_2 g r_2$
$r_1 = \frac{m_2}{m_1} r_2 = \frac{3}{4} r_2$

At which of the points indicated should a string be attached if the rod is to remain horizontal when suspended from the string?

(A) A (B) B (C) C (D) D (E) E



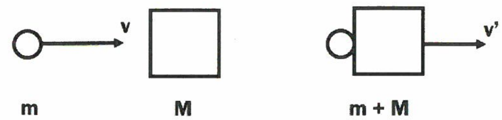
not through middle so causes rotation

25. The figure above relates to a flat object lying on a table of negligible friction. Five forces are separately applied to the object as shown. The line of action of each force is shown by a dashed line. Which of the five forces will cause the object to rotate about point O?

(A) A (B) B (C) C (D) D (E) E

26. A toy railroad car of mass 3 kg moving east collides with a 6 kg railroad car at rest, and the two cars lock together on impact and move away together toward the east at 2m/s. The speed of the first car before the collision is

(A) 2 m/s. (B) 3 m/s. (C) 4 m/s. (D) 6 m/s. (E) 9 m/s.



27. An object of mass m moving with a velocity v collides with another object of mass M. If the two objects stick together, what is their velocity?

(A) $\left(\frac{M}{m+M}\right)v$ (B) $\left(\frac{m}{M+m}\right)v$ (C) $\left(\frac{M+m}{m}\right)v$ (D) $\left(\frac{m+M}{M}\right)v$ (E) Zero

28. A 60 kg man holding a 20 kg box rides on a skateboard at a speed of 7 m/s. He throws the box behind him, giving it a velocity of 5 m/s. with respect to the ground. What is his velocity after throwing the object?

(A) 8 m/s (B) 9 m/s (C) 10 m/s (D) 11 m/s (E) 12 m/s

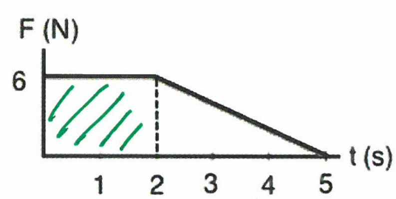
29. As a satellite orbits the earth, it passes points A and B. The satellite is traveling faster at point A than at point B. Consider the following statements:

I. The gravitational force is less at B than at A.
II. The speed is greater at A than at B.
III. The linear momentum is greater at A than at B.
IV. The angular momentum is greater at A than at B.

Which of the above statements are true?

(A) I and II only (B) I only (C) II only (D) I, II, and III only (E) I, II, III, IV

30. A force acts on a 3.0 kilogram mass initially at rest as shown in the force vs. time graph.

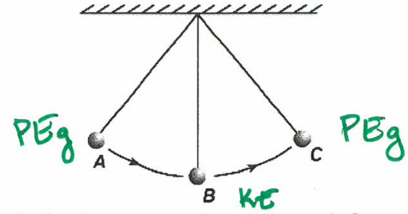


The change in momentum of the mass between 0 s and 2 s is

(A) 18 kg • m/s (B) 12 kg • m/s (C) 6 kg • m/s (D) 3 kg • m/s (E) 0 kg • m/s

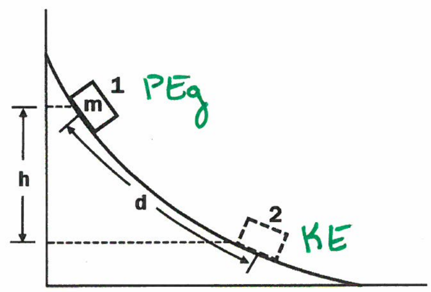
What is the velocity of the mass at 2 seconds?

(A) 12 m/s (B) 6 m/s (C) 4 m/s (D) 2 m/s (E) 0 m/s



31. A pendulum swings back and forth between points A and C as shown below. Which of the following statement(s) are true?

(A) The potential energy at A is equal to the kinetic energy at C.
(B) The kinetic energy at B is equal to the total energy of the pendulum.
(C) The pendulum has both kinetic energy and potential energy at point A.
(D) The potential energy is maximum at points A and C.
(E) The kinetic energy is maximum at point B.

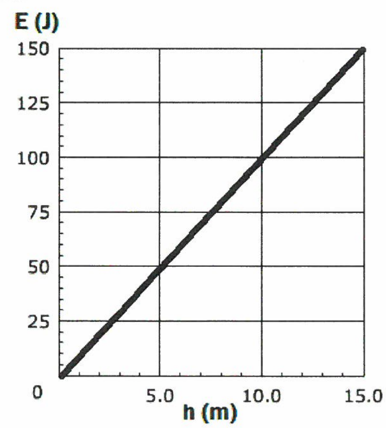


$E_i = E_f$
$PE_g = KE$
$mgh = \frac{1}{2}mv^2$

32. A box of mass *m* is released from rest at position 1 on the frictionless curved track shown above. It slides a distance *d* along the track in time *t* to reach position 2, dropping a vertical distance *h*. Let *v* and *a* be the instantaneous speed and instantaneous acceleration, respectively, of the box at position 2. Which of the following equations is valid for this situation?

(A) $h = vt$ (B) $h = \frac{1}{2}gt^2$ (C) $d = \frac{1}{2}at^2$ (D) $v^2 = 2ad$ (E) $mgh = \frac{1}{2}mv^2$

Questions 33 – 34 refer to the following graph that represents the gravitational potential energy of an object as it is raised a given height.



$PE_g = mgh$

$m = \frac{\Delta y}{\Delta x} = \frac{PE_g}{h} = mg = \text{weight}$

33. What is the physical significance of the slope?

(A) weight (B) mass (C) work (D) gravity (E) total energy

34. Determine the mass of the object.

(A) 500 kg (B) 10 kg (C) 5 kg (D) 1 kg (E) 0.50 kg

$m = \frac{PE_g}{gh} = \frac{150\text{ J}}{(10\text{ m/s}^2)(15\text{ m})} = 1\text{ kg}$