EQ. C

SOLUTIONS

Physics 101
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Name

Equivalent Exam

Midterm Exam # 3

There are 30 questioons.

Use: $g = 10\ m/s^2$ $G = 7 \times 10^{-11}$

1. Mass is ....

(a) the resistance of an object to being accelerated.
b) the same as weight.
c) changed if the object is moved from one planet to another.
d) is equal to the force times the acceleration.

2. Which is the correct statement of Newton's First Law ?

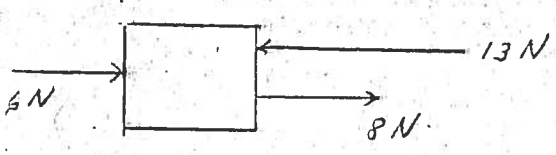
a) If the net force is zero, only the velocity direction is constant.
b) If there is a nonzero net force (like 50 N), the speed is always constant.
c) If there is a nonzero net force (like 50 N), the object has zero acceleration.
(d) If the net force is zero, then the velocity is constant.

3. Which is consistent with Newton's First Law ?

(a) A rock is thrown in deep outer space. After the throw, it moves with constant speed and constant direction.
b) A rock is thrown in deep outer space. It eventually slows down even though the net force is zero.
c) A jet plane is flying at a constant velocity. The net force is zero and there are no individual forces acting on the jet.
d) None of the above.

4. Three forces act on a block as shown. What is the net force on the block ?

a) 3 N to the right
b) 3 N to the left
(c) 1 N to the right
d) 1 N to the left



$F_{net} = 6N + 8N - 13N$
$= 1N$ (to right)

5. A car accelerating from rest has an acceleration of 3 m/s^2 . If the car has a net force of 5100 N acting on it, what is the mass of the car?

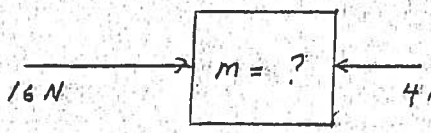
(a) 1700 kg
b) 1500
c) 1900
d) 1300

$a = \frac{F_{net}}{m}$ (N2) $\Rightarrow m = \frac{F_{net}}{a}$

$m = \frac{5100\,N}{3\,m/s^2} = 1700\,kg$

6. The block in the figure accelerates at 4 m/s^2. What is the mass of the block? Hint: Use Newton's 2nd Law.

a) 1 kg
b) 2
(c) 3
d) 4



$a = \frac{F_{net}}{m} \Rightarrow m = \frac{F_{net}}{a}$

$m = \frac{16\,N - 4\,N}{4\,m/s^2} = 3\,kg$

7. Which statement concerning the circular orbit of a satellite just above the Earth's atmosphere is INCORRECT ?

a) The orbital speed of a satellite 100 mi above the earth's surface is about 5 mi/sec.
(b) An engine force is required to keep the satellite moving in its orbit.
c) The orbit is a "sideways free-fall": the satellite tries to follow a path down toward the Earth's surface but the Earth's surface recedes below the orbit with the same curvature as the orbit, so that the satellite does not get any closer to the surface.
d) The orbit is located above the main part of the Earth's atmosphere to insure that air resistance does not slow the satellite appreciably.

8. An object is acted on by a centripetal force F_c . Which statement is TRUE ?

a) The object picks up speed and moves in a straight line.
b) The object moves in a circular path and has a constant direction of movement.
(c) The object moves in a circular path and has a constant speed.
d) The object moves in a straight line and has constant velocity.

9. Which statement concerning planetary motion is FALSE ?

(a) A planet moves in an elliptical orbit with the sun at the center point of the ellipse.
b) A planet "sweeps out" equal areas in equal times as it moves in its orbit around the sun.
c) The time to complete one orbit is longer for a larger orbit.
d) The speed of a planet varies as it moves in its elliptical orbit around the sun.

10. A ball is thrown horizontally to the right from a ledge and falls to the ground. What is the vertical velocity of the ball 3 s after the throw ? Hint: Does the ball accelerate, vertically speaking ? If so, with what acceleration value ?

a) 50 m/s
b) 40
c) 30
d) 20

$v = g\,t$

$v = 10\ \frac{m}{s^2} \cdot 3\ s = 30\ \frac{m}{s}$

11. The spacing of two object is reduced to 1/7 their original spacing. How does the gravitational force between the objects change ?

a) 7 times larger
b) 14 " "
c) 28 " "
d) 49 " "

$\frac{F_f}{F_i} = \left(\frac{d_i}{d_f}\right)^2$ $\qquad d_f = \frac{1}{7} d_i$

$\frac{F_f}{F_i} = \left(\frac{d_i}{\frac{1}{7} d_i}\right)^2 = 7^2 = 49 \Rightarrow F_f = 49\, F_i$

12. If for a fixed value of the net force, the mass decreases, the acceleration .....
(Hint: Recall Newton's 2nd Law.)

a) increases.
b) decreases.
c) does not change since the acceleration is determined entirely by the net force.
d) .... not enough information to tell.

$a = \frac{F_{net}}{m}$: N2 $\qquad m \downarrow \Rightarrow a \uparrow$ (inverse relationship

13. What is the gravitational force on a 4 kg mass from a 7 kg mass a distance of 3 m away ?

a) 2.18×10^{-10} N
b) 7.35×10^{-10}
c) 3.10×10^{-9}
d) 9.25×10^{-9}

$F = \frac{G m_1 m_2}{d^2}$

$F = \frac{7 \times 10^{-11} \cdot 4 \cdot 7}{3^2} \Rightarrow 2.18 \times 10^{-10}\ N$

14. Which statement concerning projectile motion near the Earth's surface is CORRECT ?

a) The horizontal part of the motion is at constant velocity; the vertical part of the motion is with constant acceleration g.
b) The horizontal part of the motion is at constant velocity; the vertical part of the motion is at constant velocity.
c) The horizontal part of the motion is with constant acceleration g ; the vertical part of the motion is at constant acceleration g .
d) The horizontal part of the motion is with constant acceleration g ; the vertical part of the motion is at constant velocity.

15. Which statement concerning an ellipse is TRUE ?

a) It has one focal point.
b) An ellipse is not a closed oval, but a "spiral".
c) An ellipse looks like a rectangle, but with slightly rounded corners.
d) An ellipse can be drawn using a certain pencil-and-string construction.

16. Which statement concerning dropping a ball <u>in the presence of air resistance</u> is TRUE ?

a) The ball continues to pick up speed (i.e., accelerate) until it hits the ground.
(b) The ball eventually reaches a constant speed (the "terminal" speed) and then continues falling to the ground; this is due to the fact that the air resistance force eventually builds up to equal the force of gravity, resulting in zero net force.
c) The eventual speed of the ball is constant, since the air resistance force is eventually zero.
d) There is never a cancellation between the air resistance force and the gravitational force.

17. Which is the correct statement of Newton's Third Law ?

(a) When one object exerts a force on a second object, the second object exerts a force back on the first object of the same strength and opposite direction.
b) For every action force on an object, there is an equal reaction force on the object in the <u>same</u> direction.
c) When one object exerts a force on a second object, the second object exerts no force back on the first object.
d) When an action force acts on an object, there is automatically a reaction force on the <u>same</u> object and so the net force on that object remains zero.

18. Which illustrates Newton's Third Law ?

a) A ball is rolled on a carpet: it slows down.
b) A ball is thrown in deep space: it eventually comes to rest.
(c) You push a wall: the wall simultaneously pushes back on you and you accelerate backwards.
d) A jet flying at a constant velocity has a <u>nonzero</u> NET force acting on it.

19. What is the momentum of a cart of mass 350 kg and rolling with a velocity of 12 m/s ?

a) 5400 kgm/s
(b) 4200
c) 3800
d) 2600

$$p = mv$$
$$p = 350\ kg \cdot 12\ m/s$$
$$p = 4200\ kg\frac{m}{s}$$

20. A ball of mass 1 kg is initially moving to the left with a velocity of - 10 m/s and is struck by a bat and then moves at a final velocity of + 20 m/s . If the time duration of the impact is 0.02 s , what was the net force from the bat on the ball ?

(a) 1500 N
b) 2000
c) 2500
d) 3000

$$\Delta p = F_{net}\,\Delta t$$
$$mv_f - mv_i = F_{net}\,\Delta t$$
$$1kg(20m/s) - 1kg(-10m/s) = F_{net}(0.02\,s)$$
$$30\ kgm/s = F_{net}(0.02s)$$
$$F_{net} = \frac{30\ kgm/s}{0.02s} = 1500\ N$$

21. An ice skater of mass 60 kg is at rest holding a ball of mass 2 kg. She then throws the ball to the right with a velocity of + 20 m/s. With what velocity does she move after the throw ?

a) - 5/6 m/s
b) - 4/5
c) - 3/4
(d) - 2/3

ice friction and air resistance negligible $\Rightarrow F_{ext} = 0$

$\Rightarrow p_i = p_f$; $(p = m_s v_s + m_b v_b)$

$p_i = p_f$

$60\,kg \cdot 0 + 2\,kg \cdot 0 = 60\,kg\, v_s + 2\,kg\,(20\,m/s)$

$0 = 60\,kg\, v_s + 40\,kg\,m/s \Rightarrow 60\,kg\, v_s = -40\,kg\,m/s$

$v_s = -\frac{40}{60}\frac{m}{s} = -\frac{2}{3}\frac{m}{s}$

22. What is the definition of the rotational mass (I) ?

a) It is the "regular" mass times the centripetal force.
b) It is the same as the "regular" mass – it just refers to when the "regular" mass is rotating.
(c) It is the resistance to rotational acceleration.
d) It is the "regular" mass divided by the rotational velocity.

23. Which statement concerning rotational mass (I) is TRUE ?

a) It is zero for a solid sphere.
(b) It depends on the mass, axis, and shape of the object.
c) It is larger for a barbell with the weights "in" than for a barbell with the weights "out".
d) It does <u>not</u> depend on the axis – it depends only on the shape of the object.

24. A force of 100 Newtons is approximately .....

(a) 25 pounds.
b) 20
c) 10
d) 250

$100\,N\left(\frac{\frac{1}{4}\,lb}{1\,N}\right) = \frac{100\,lb}{4} = 25\,lb$

25. Consider catching (stopping) a ball initially moving at 30 m/s with your hand:

a) If the object is slowed down to rest in a "large" time (like 1 s), the force of impact is "large".
(b) If the object is slowed down to rest in a "small" time (like 0.001 s), the force of impact is "large".
c) The force of impact is always the same, regardless of how long it takes to stop the ball.

26. Consider the following "sticking" collision (taking place in deep space): Object #1, of mass 1 kg, has an initial velocity of 10 m/s. Object #2, of mass 4 kg, is initially at rest. The objects collide and stick together on impact. What is the velocity of the resulting "clump" ?

a) 4 m/s
b) 3
c) 2
d) 1

Deep space $\Rightarrow F_{ext} = 0 \Rightarrow P_i = P_f$ (LCM)

$P = m_1 v_1 + m_2 v_2$

$P_i = P_f$

$1\,kg \cdot 10\,m/s + 4\,kg \cdot 0 = 1\,kg\, v_c + 4\,kg\, v_c$

$10\,kg\,m/s = 5\,kg\, v_c$

$\Rightarrow v_c = \frac{10\,m/s}{5} = 2\,m/s$

27. Which is the correct connection between net force and momentum ?

a) net force = (change in momentum) / (time interval)
b) net force = (change in momentum) x (time interval)
c) net force = (momentum) / (kinetic energy)
d) net force = (momentum) x (mass)

28. When the spacing between two masses increases, the gravity force between them.....

a) increases (like when stretching a rubber band).
b) decreases.
c) remains the same.
d) may increase or decrease, depending on how massive the objects are.

$F = \frac{G m_1 m_2}{d^2}$: $d \uparrow \Rightarrow F \downarrow$

inverse relationship

29. Whenever an object accelerates.....

a) there must be a net force acting on it.
b) there can be zero net force acting on it.
c) there are no individual forces acting on it.
d) ... none of the above.

30. An object moves in a circle at a constant rotational velocity of 60 deg/s. What is the angle that the object moves through in a time of 3.7 s ?

a) 222 deg
b) 254
c) 195
d) 280
e) 177

$\omega = \frac{\Delta\theta}{\Delta t}$

$\Rightarrow \Delta\theta = \omega \Delta t$

$\Delta\theta = 60 \frac{deg}{s} (3.7\,s)$

$\Delta\theta = 222\,deg$