



Introductory Physics Examination Version 1994 R

Do Not Open This Booklet until You Are Told to Begin

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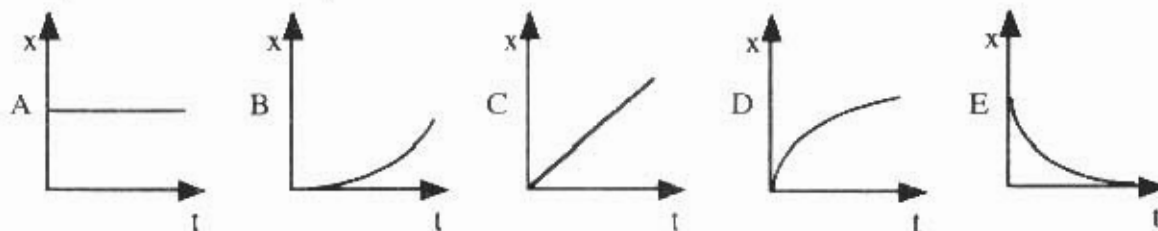
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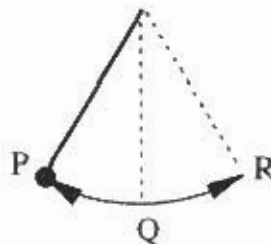
Part I - Section A - Mechanics

24 Questions - 25 minutes

1. A runner's velocity is doubled. The runner's momentum will be:
A. quadrupled B. doubled C. the same D. halved E. quartered
2. Acceleration is the time rate at which _____ changes.
A. displacement B. force C. mass D. position E. velocity
3. Which graph of position x versus time t best represents a moving object with positive velocity and positive acceleration, both in the x direction?



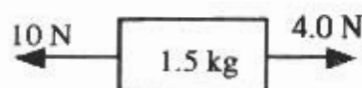
4. A ball is thrown vertically upward. At its highest point, its velocity is _____ and its acceleration is _____.
A. up, zero B. zero, zero C. zero, down D. down, zero E. down, down
5. A pendulum oscillates between points P and R , the points of maximum displacement. Point Q is its equilibrium position. If it takes 1.0 s to move from point Q to R , what is the period of the oscillation?
A. 0.25 s B. 0.50 s C. 1.0 s D. 2.0 s E. 4.0 s



6. Which of the following will decrease the period of a simple pendulum?
A. increasing the angular amplitude
B. decreasing its length
C. increasing the mass of the bob
D. decreasing the mass of the bob
E. moving it to the top of a mountain

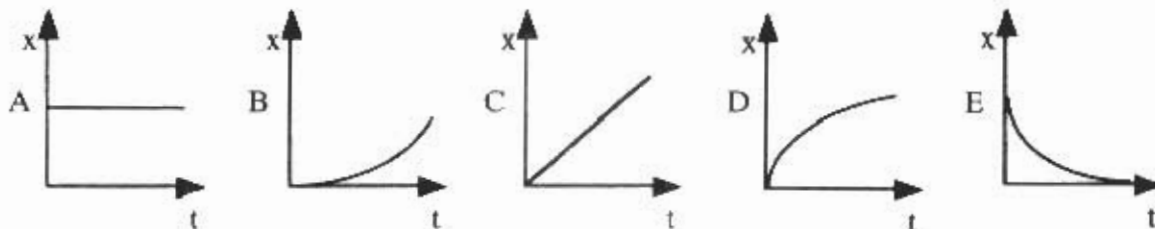


7. Two forces (see figure at right) act on a 1.5 kg block. What is the magnitude of the acceleration of the block?



- A. 4.0 m/s^2 B. 9.0 m/s^2 C. 9.3 m/s^2 D. 10 m/s^2 E. 21 m/s^2

8. Which graph of position x versus time t best represents a moving object with constant velocity in the x direction?



9. A ball is thrown upward (ignore air resistance). What force(s) act on the ball as it travels upward after leaving the thrower's hand?

- A. A constant upward force.
B. A decreasing upward force.
C. The downward gravitational force.
D. A constant upward force and the downward gravitational force.
E. A decreasing upward force and the downward gravitational force.

10. A mass at rest explodes, breaking into two pieces of unequal mass that move in opposite directions. Which of the following is correct?

- A. Both pieces have the same speed.
B. The more massive piece has the greater speed.
C. The momentum of the more massive piece has the greater magnitude.
D. Both pieces have the same magnitude of momentum.
E. The momentum of the less massive piece has the greater magnitude.

11. An automobile's velocity is doubled. The automobile's kinetic energy will be:

- A. quadrupled. B. doubled. C. the same. D. halved. E. quartered.

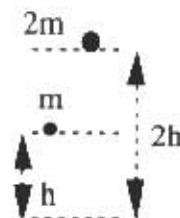
12. If the Earth had its present radius but twice as much mass, you would weigh _____ what you weigh now.

- A. one fourth B. one half C. the same as D. twice E. four times



13. An object with mass m is dropped from height h and attains a speed v at ground level. A second object with mass $2m$ is dropped from height $2h$. Ignoring air resistance, the speed attained by the second object at ground level is:

A. $0.5 v$ B. v C. $\sqrt{2} v$ D. $2 v$ E. $4 v$



14. A track star accelerates from rest and reaches a speed of 3.0 m/s in 4.0 s . The magnitude of his average acceleration is:

A. 0.38 m/s^2 B. 0.75 m/s^2 C. 1.3 m/s^2 D. 12 m/s^2 E. 24 m/s^2

15. A book rests on a horizontal table. The Newton's Third Law reaction force to the force that the table exerts on the book is:

A. the gravitational force that Earth exerts on the book.
B. the gravitational force that the book exerts on Earth.
C. the frictional force of the table on the book.
D. the force that the table exerts on the book.
E. the force that the book exerts on the table.

16. In the absence of air resistance, the horizontal component of the velocity of a projectile:

A. decreases with distance.
B. decreases with time.
C. increases with time.
D. is zero.
E. remains constant.

17. A physics instructor is standing on a scale in a moving elevator. Which of the following motions of the elevator would cause the reading to increase?

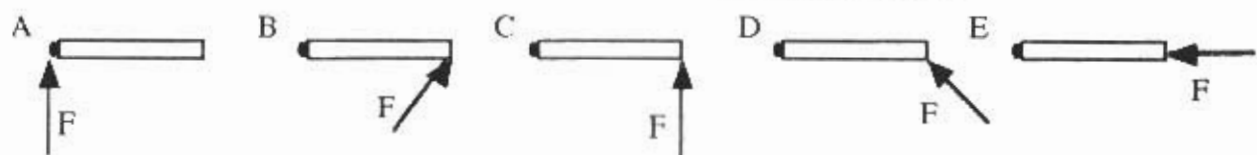
A. increasing its downward speed.
B. moving downward with constant speed.
C. moving upward with constant speed.
D. slowing to a stop while moving downward.
E. slowing to a stop while moving upward.



18. A twirling ice skater pulls in his arms. He spins faster because of:

- A. conservation of angular momentum.
- B. conservation of mechanical energy.
- C. an external torque.
- D. conservation of linear momentum.
- E. potential energy.

19. The door (seen from above in the figures below) has hinges on the left hand side. Which force produces the largest torque? The magnitudes of all forces are equal.



20. Which statement best describes motion in the solar system?

- A. The Earth makes one revolution around the sun each day.
- B. The Earth makes one revolution around the sun each year.
- C. The moon makes one revolution around the Earth each day.
- D. The sun makes one revolution around the Earth each day.
- E. The sun makes one revolution around the Earth each year.

21. An object from Earth is transported to the moon. On the moon the object's:

- A. weight and mass are less than on Earth.
- B. weight and mass are the same as on Earth.
- C. weight and mass are more than on Earth.
- D. weight is less but mass is more than on Earth.
- E. weight is less but mass is the same as on Earth.

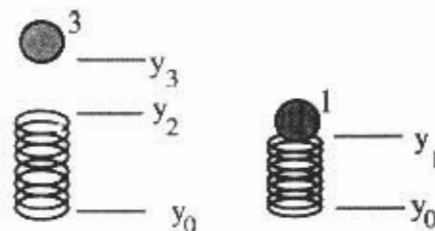
22. An object moving with constant speed in a circular path has a net force acting on it directed:

- A. inward toward the center of the circle.
- B. outward away from the center of the circle.
- C. tangent to the circle in the direction of the velocity.
- D. tangent to the circle in the direction opposite to the velocity.
- E. No net force acts on it.



23. A ball is dropped from rest at point 3 onto a massless coil spring with spring constant k . The spring compresses to point 1, where the ball is momentarily at rest again. Which equation best expresses the total energy of the system at point 3? Assume all variables are non-zero.

- A. $mg y_3$
- B. $mg y_3 + \frac{1}{2} m v^2$
- C. $mg y_3 + \frac{1}{2} k y_1^2$
- D. $mg y_3 + \frac{1}{2} k (y_2 - y_1)^2$
- E. $mg y_3 + \frac{1}{2} k y_1^2 + \frac{1}{2} m v^2$



24. For the ball and spring in the previous question #23, which equation best expresses the total energy of the system when the ball is at point 1?

- A. $mg y_1$
- B. $mg y_1 + \frac{1}{2} m v^2$
- C. $mg y_1 + \frac{1}{2} k y_1^2$
- D. $mg y_1 + \frac{1}{2} k (y_2 - y_1)^2$
- E. $mg y_1 + \frac{1}{2} k y_1^2 + \frac{1}{2} m v^2$

End of Section A - Mechanics

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Part I - Section B- Waves, Optics, and Sound

16 Questions - 20 minutes

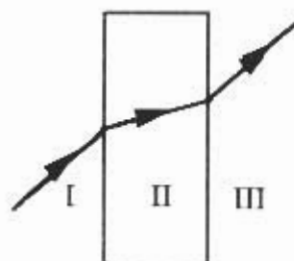
25. The distance between two adjacent crests of a periodic wave is the:
A. amplitude B. frequency C. period D. speed E. wavelength
26. In a vacuum all electromagnetic waves have the same:
A. amplitude B. frequency C. period D. speed E. wavelength
27. On which of the following conditions does the speed of light depend?
A. The material through which light travels.
B. The brightness of the light source.
C. The distance the light has traveled from the source.
D. The source of the light: sun, candle, light bulb, etc.
E. None of the above, the speed of light is always a constant.
28. Real images formed by a single lens or mirror are always:
A. erect.
B. inverted.
C. larger than the object.
D. the same size as the object.
E. smaller than the object.
29. Light from a laser strikes two slits and forms a sequence of bright bands. As the slit separation is increased:
A. the wavelength decreases.
B. the wavelength increases.
C. the distance between bright bands decreases.
D. the distance between bright bands is unchanged.
E. the distance between bright bands increases.
30. When a blue object is viewed in only red light, the object appears to be:
A. black B. blue C. green D. yellow E. white



31. A fire truck proceeding to a fire, approaches and passes a stationary observer. How does the pitch of the moving siren sound to the observer?

- A. The same as when the truck is at rest.
- B. Slightly higher, then much higher than that of the truck at rest.
- C. Slightly lower, then much lower than that of the truck at rest.
- D. First higher, then lower than when the truck is at rest.
- E. First lower, then higher than when the truck is at rest.

32. The diagram to the right shows light passing from material I into material II and out into material III. Ray I and ray III are parallel. Which of the following statements is true?



- A. The speed of light is the same in materials I, II, and III.
- B. The light slows down in material II and remains at that speed in III.
- C. The light slows down in material II and speeds up in III to the same speed it had in I.
- D. The light speeds up in material II and stays at the same speed in III.
- E. The light speeds up in material II and slows down in III to the same speed it had in I.

33. The inverse of the period is the:

- A. amplitude B. frequency C. period D. speed E. wavelength

34. At the point where the crest of one wave meets the trough of another wave with the same amplitude and frequency, the waves:

- A. constructively interfere with maximum amplitude.
- B. constructively interfere with zero amplitude.
- C. destructively interfere with zero amplitude.
- D. destructively interfere with maximum amplitude.
- E. will not interfere.

35. Sound waves in a gas are always ____ waves.

- A. longitudinal B. transverse C. resonant D. standing E. polarized

36. On a day when the speed of sound is 350 m/s, a clarinet sounds a note of frequency 275 Hz. The wavelength is about:

- A. 0.65 m B. 0.79 m C. 1.0 m D. 1.3 m E. 10 m



37. A guitar string has fundamental frequency f . If you press your finger down on the middle of the string, the new fundamental frequency will be:
- A. $\frac{1}{4} f$ B. $\frac{1}{2} f$ C. f D. $2 f$ E. $4 f$
38. In a vacuum green light always differs from red light in:
- A. amplitude. B. intensity. C. polarization. D. speed. E. frequency.
39. An example of the diffraction of light is the:
- A. bending of light when it enters a different material.
B. polarization of light passing through a Polaroid.
C. reflection of light from a spherical mirror.
D. separation of colors by a prism.
E. spreading of light passing through a hole or a slit.
40. A ruler partially immersed in water appears bent or broken because of the _____ of light.
- A. diffraction B. interference C. refraction D. reflection E. polarization

End of Section E – Waves, Optics, & Sound



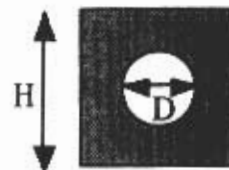
Part I - Section C - Heat and Kinetic Theory

8 Questions - 10 minutes

41. Heat always flows naturally from the _____ object to the _____ object.

- A. denser, less dense
- B. cooler, hotter
- C. hotter, cooler
- D. larger, smaller
- E. smaller, larger

42. A square metal plate (see figure to the right) is heated to a high temperature. Which one of the following statements best describes what happens to the dimensions of the plate?



- A. The height H of the plate decreases and the diameter D of the hole decreases.
- B. The height H of the plate decreases but the diameter D of the hole increases.
- C. The height H of the plate increases but the diameter D of the hole decreases.
- D. The height H of the plate increases but the diameter D of the hole stays the same.
- E. The height H of the plate increases and the diameter D of the hole increases.

43. The process by which energy from the sun passes through empty space and reaches Earth is called:

- A. radiation B. induction C. gravitation D. convection E. conduction

44. Which of the following will release the most energy when cooled from 30°C to 10°C ?

- A. 1 gram of lead
- B. 1 gram of water
- C. 10 grams of lead
- D. 10 grams of water
- E. Both substances would release the same amount of energy when cooled the same amount.

45. A gas in a sealed container has initial volume V and pressure P . It is compressed at constant temperature to volume $\frac{1}{2} V$. Its final pressure is :

- A. $\frac{1}{4} P$ B. $\frac{1}{2} P$ C. P D. $2 P$ E. $4 P$



46. The ideal gas law does *not* involve the _____ of the gas.
A. amount B. material C. pressure D. temperature E. volume
47. Increasing the temperature of a gas by 10°C requires more heat when the heat is added at constant pressure than when the heat is added at constant volume because:
A. work is done on the gas in expanding.
B. the gas does work in expanding its volume.
C. the gas does work in increasing its pressure.
D. its internal energy increases more.
E. its internal energy increases less.
48. Energy is added to water initially at 70°C . The pressure is kept at a constant one atmosphere. A possible final state is:
A. ice at 20°C .
B. water at 50°C .
C. steam at 90°C .
D. water at 110°C .
E. steam at 120°C .

End of Section C – Heat & Kinetic Theory



Part I - Section D - Electricity and Magnetism

20 Questions - 25 minutes

49. A neutral atom could be composed of:

- A. 4 electrons, 5 protons, 6 neutrons
- B. 5 electrons, 5 protons, 6 neutrons
- C. 6 electrons, 5 protons, 6 neutrons
- D. 0 electrons, 5 protons, 5 neutrons
- E. 5 electrons, 6 protons, 5 neutrons

50. An electric force F exists between two point charges. If both charges are doubled, the electric force between the two charges is:



- A. $\frac{1}{4} F$
- B. $\frac{1}{2} F$
- C. F
- D. $2 F$
- E. $4 F$

51. Two identical resistors connected in series have a combined resistance of 8.0 ohms. When connected in parallel, the resistance of the combination will be:

- A. 2.0 ohms
- B. 4.0 ohms
- C. 8.0 ohms
- D. 16 ohms
- E. 32 ohms

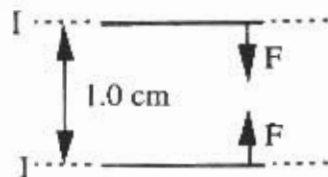
52. Which of the following is a unit of energy?

- A. ampere
- B. kilowatt•hour
- C. volt
- D. volt•ohm
- E. watt

53. The presence of a uniform magnetic field may be detected by using a(n):

- A. stationary charged object.
- B. small uncharged mass.
- C. ohmmeter.
- D. beam of neutrons.
- E. magnetic compass.

54. Two long straight parallel wires carry equal currents and are spaced 1.0 cm apart. If the current in each wire is doubled, the magnitude of the magnetic force F acting between the wires will be:

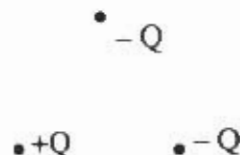


- A. $\frac{1}{4} F$
- B. $\frac{1}{2} F$
- C. F
- D. $2 F$
- E. $4 F$



55. Electromagnetic radiation is made up of
- A. Perpendicular transverse electric and magnetic fields.
 - B. Parallel transverse electric and magnetic fields.
 - C. Waves that travel at 345 m/s in air.
 - D. Waves that require a medium for transmission.
 - E. Longitudinal electric and magnetic fields.

56. One positive and two negative charges are placed at the corners of an equilateral triangle as shown to the right. All charges have the same magnitude. The direction of the net electric force on the negative charge at the top due to the other charges is:



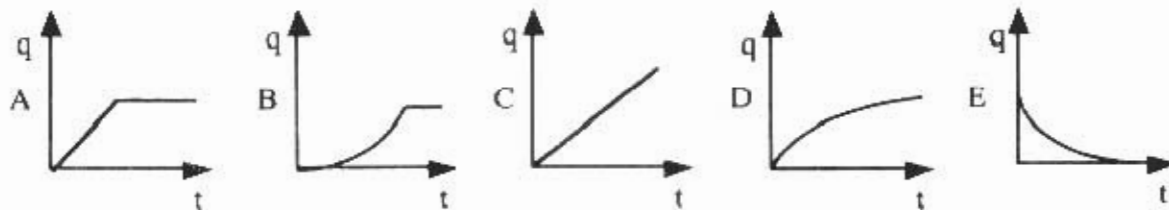
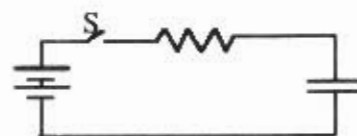
- A. undefined, since the force is zero
- B. towards the bottom of the page
- C. to the left
- D. to the right
- E. towards the top of the page

57. A proton moving to the right (see accompanying figure) enters a region of uniform magnetic field which is perpendicular to the page and into it. After the proton enters the field, the proton will:



- A. be unaffected and continue in a straight line.
- B. follow a straight line path perpendicular to the page.
- C. follow a clockwise circular path in the plane of the page.
- D. follow a counterclockwise circular path in the plane of the page.
- E. follow a circular path perpendicular to the page.

58. A set of parallel metallic plates, with no initial electric charge, is connected to a battery and resistor as shown to the right. The switch is then closed. Which graph best represents a plot of the charge q on one of the parallel plates versus time t ?





59. Two resistors in parallel are connected to a voltage source. One resistor has resistance R and dissipates power P . The second resistor has resistance $2R$ and dissipates power:

- A. $P/4$ B. $P/2$ C. P D. $2P$ E. $4P$

60. Object 1 has an initial charge of $+6.0 \mu\text{C}$. Object 2 is initially uncharged. They are brought into contact and then separated. After separation, object 1 has a charge of $+2.0 \mu\text{C}$. The charge on object 2 is:

- A. $+6.0 \mu\text{C}$ B. $+4.0 \mu\text{C}$ C. $+2.0 \mu\text{C}$ D. 0 E. $-2.0 \mu\text{C}$

61. Coulomb's Law is the expression for the:

- A. electric force between two point charges.
B. magnetic force between two moving point charges.
C. power delivered to a circuit.
D. strength of the electric current.
E. relation between voltage, resistance, and current in a circuit.

62. Metallic conductors always:

- A. have an excess of electrons.
B. repel electrons.
C. have electrons that can easily move within them.
D. have protons that can easily move within them.
E. have high resistance.

63. When a charged rod is brought close to the top of a neutral electroscope, the leaves of the electroscope:

- A. begin to spread apart before the rod touches the electroscope.
B. spread only after the rod touches the electroscope.
C. spread only after the rod is removed.
D. spread only if the rod is negatively charged.
E. spread only if the rod is positively charged.

64. Two light bulbs in parallel will always have the same:

- A. brightness. B. current in them C. power D. resistance E. voltage across them



65. A circuit has a total resistance of 12 ohms and uses a 9.0 volt battery. The circuit draws a current of _____ amperes.

- A. 0.75 B. 1.3 C. 6.8 D. 16 E. 108

66. Electrons, making up an electric current in a wire, travel at average velocities that are:

- A. infinite.
B. equal to the velocity of light.
C. equal to the velocity of sound.
D. very slow.
E. zero. Electrons never move in a wire.

67. The resistance of a wire depends:

- A. only on the wire's cross sectional area.
B. only on the wire's length.
C. only on the wire's substance.
D. only on the wire's temperature.
E. on the wire's cross-sectional area, length, substance, and temperature.

68. Magnet I is twice as strong as magnet II and at a certain distance pulls on magnet II with a force of magnitude 4.0 N. The magnitude of the force on magnet I is:

- A. 1.0 N B. 2.0 N C. 4.0 N D. 8.0 N E. 16 N

End of Section D – Electricity & Magnetism



Part I - Section E - Modern Physics

12 Questions - 15 minutes

69. If the half-life of radon is 2 days, what fraction of the original radon will remain after 8 days?

- A. $1/2$ B. $1/4$ C. $1/8$ D. $1/16$ E. $1/32$

70. An X-ray photon, scattering off an electron, transfers some of its energy to the electron. Which of the following statements is true?

- A. The scattered photon slows down.
B. The scattered photon speeds up.
C. The frequency of the scattered photon is greater.
D. The frequency of the scattered photon is smaller.
E. The wavelength of the scattered photon is smaller.

71. The energy levels for an electron in a hypothetical atom are shown to the right. The electron is initially in the $n=3$ state. The atom emits a photon. Which of the following is a possible energy for the emitted photon?

0	_____	$n=4$
-1 eV	_____	
-3 eV	_____	$n=3$
-7 eV	_____	$n=2$
-13 eV	_____	$n=1$

- A. 2 eV
B. 3 eV
C. 5 eV
D. 7 eV
E. 10 eV

72. Which of the following electromagnetic radiations has the quanta of greatest energy?

- A. gamma B. infrared C. light D. microwave E. radio

73. According to the current theory of elementary particles, a proton is composed of three:

- A. electrons B. neutrinos C. neutrons D. positrons E. quarks

74. An alpha particle is the same as a:

- A. electron B. photon C. helium nucleus D. hydrogen nucleus E. proton



75. Gamma rays may be emitted during:

- A. chemical reactions.
- B. nuclear decay.
- C. the photoelectric effect.
- D. transitions of an electron from a lower energy level to a higher energy level.
- E. vibrations of a large mass.

76. A spaceship traveling at a speed of $0.50c$ away from Earth sends a laser beam message back to Earth. The speed of the laser light beam as measured from Earth is:

- A. $0.50c$ B. $0.67c$ C. c D. $1.3c$ E. $1.5c$

77. In both nuclear fission and nuclear fusion:

- A. rest mass is converted to energy.
- B. the total rest mass remains unchanged.
- C. energy is converted to rest mass.
- D. the particles attain the velocity of light.
- E. two nuclei are formed.

78. The number of neutrons in an oxygen 17 atom ($^{17}_8\text{O}$) is:

- A. 8 B. 9 C. 17 D. 25 E. 0

79. A positron has positive charge and the same mass as a(n):

- A. electron B. helium nucleus C. neutron D. neutrino E. photon

80. The energy of a photon is directly proportional to its:

- A. amplitude B. frequency C. speed D. wavelength E. none of these

End of Section E – Modern Physics

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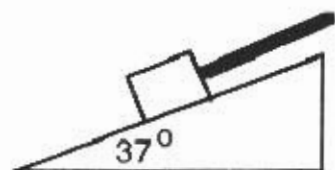
Part II - Section F - Mechanics
2 out of 3 Questions - 25 minutes

1. A 1825-kg car starts from rest and reaches a speed of 22 m/s in 10 s. The magnitude of the force (assumed constant) needed to overcome friction during this period is 8.0×10^2 N. Assume the acceleration is constant.

- What distance does the car travel during the 10 s period of acceleration?
- What is the magnitude of the acceleration of the car?
- What is the magnitude of the force due to the engine on the car?
- How much work does the engine do to accelerate the car?

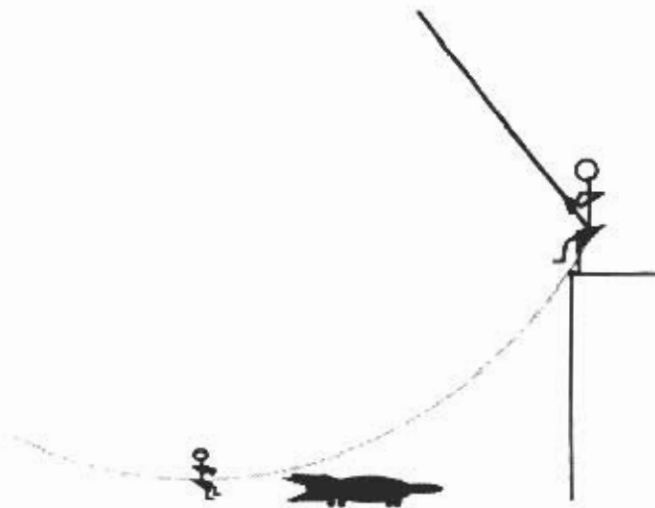
2. A 12-kg crate is being dragged up a rough inclined plane by means of an attached rope. The tension in the rope is 100 N and the coefficient of kinetic friction between the crate and the plane is 0.20.

- Draw a free body diagram showing all the forces acting on the crate.
- What is the normal force (normal component of the contact force) acting on the crate?
- What is the frictional force acting on the crate? Give both magnitude and direction.
- What is the acceleration of the crate?



3. Tarzan (mass 100 kg) stands at the top of a 5.0 m cliff and swings down to sweep Boy (mass 25 kg) from the jaws of a threatening crocodile. The vine Tarzan uses is 20 m long.

- What is his speed at the bottom of the swing just before he saves Boy from his terrible fate?
- What is the centripetal force acting on Tarzan at that time?
- What is Tarzan's and Boy's speed immediately after he saves him?
- How high do they go if all frictional forces are neglected?



End of Section F - Mechanics



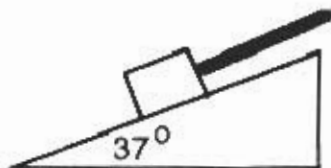
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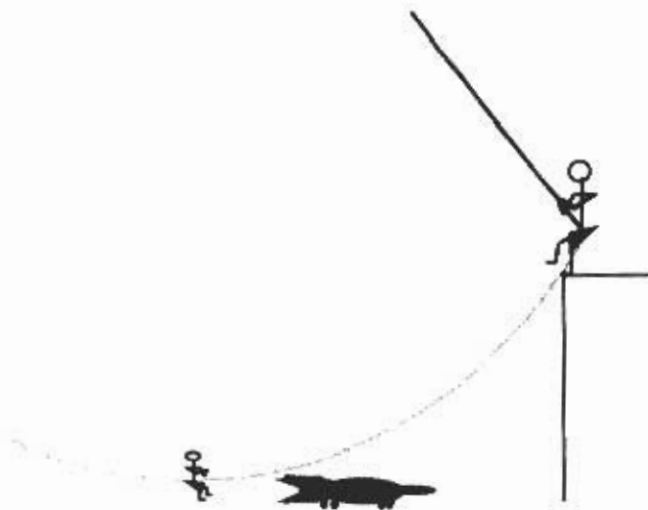
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- What is the frictional force acting on the crate? Give both magnitude and direction.
- What is the acceleration of the crate?



3. Tarzan (mass 100 kg) stands at the top of a 5.0 m cliff and swings down to sweep Boy (mass 25 kg) from the jaws of a threatening crocodile. The vine Tarzan uses is 20 m long.

- What is his speed at the bottom of the swing just before he saves Boy from his terrible fate?
- What is the centripetal force acting on Tarzan at that time?
- What is Tarzan's and Boy's speed immediately after he saves him?
- How high do they go if all frictional forces are neglected?



End of Section F - Mechanics

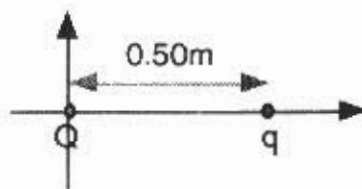
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Part II - Section G - Electricity and Magnetism

2 out of 3 Questions - 25 minutes

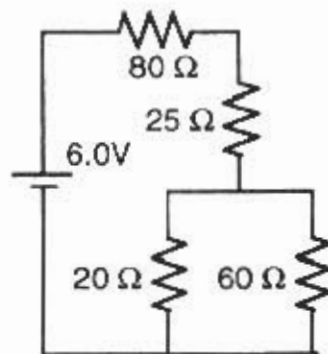
1. Two point charges $q = +2.0 \mu\text{C}$ and $Q = -3.0 \mu\text{C}$, are placed along the x-axis a distance 0.50 m apart. In the following, give magnitude and direction for all vector quantities.



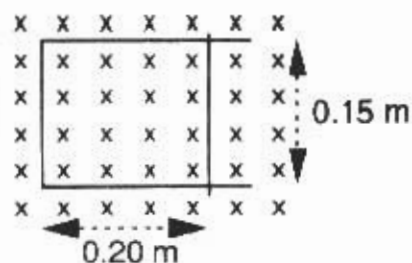
- What is the electric force on q ?
- What is the electric field at a point half-way between the two charges?
- What is the electric potential at a point half-way between the two charges?

2. In the figure to the right:

- What is the equivalent resistance of the circuit?
- What is the ratio of the current in the 60Ω resistor to that in the 20Ω resistor?
- What is the ratio of the voltage across the 80Ω resistor to that across the 25Ω resistor?
- What is the ratio of the power dissipated in the 25Ω resistor to that dissipated in the 60Ω resistor?



3. The circuit at the right is totally immersed in a uniform magnetic field of 2.0 T into the page and perpendicular to it. $1 \text{ T} = 1 \text{ N/A}\cdot\text{m}$. The total resistance is a constant 0.040Ω . The induced current in the wire is 0.30 A. The conventional current is clockwise. The electron flow is counterclockwise. The wire at the right of the circuit is moving with constant velocity.



- What is the magnetic force on the wire?
- What is the wire's velocity?
- If the current carrying wire were infinitely long, what would be the magnetic field due to the wire's current a distance 0.050 m to the right of the wire?

End of Section G - Electricity & Magnetism