

Use the following information to answer the next question.

A student was given the following situations:

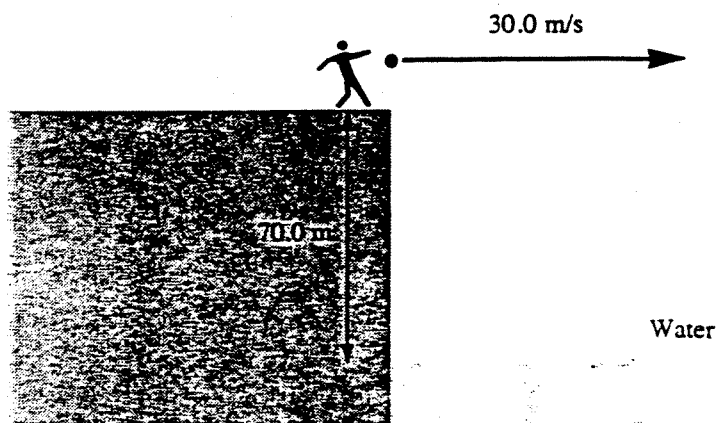
- 1 A cold air mass has a temperature of 5°C .
- 2 A car increases its velocity to $+90\text{ km/h}$.
- 3 An airplane changes its position to $\text{N } 52^{\circ}\text{ W}$.
- 4 A track contestant runs the 100 m dash in 9.89 s.
- 5 A submarine covers a displacement of 150 km, north.

1. Which situations are examples of scalar quantities?

- A. 1 and 3 only
- B. 1 and 4 only
- C. 2, 3, and 5 only
- D. 2, 4, and 5 only

Use the following information to answer the next two questions.

A boy stands on the edge of a sea cliff 70.0 m high and throws a rock horizontally, at a velocity of 30.0 m/s.



Numerical Response

- 1.** The time required for the rock to contact the water is _____ s.
(Round and record your answer to three digits.)

2. How far from the base of the cliff will the rock contact the water?
- A. 113 m
 - B. 132 m
 - C. 150 m
 - D. 183 m

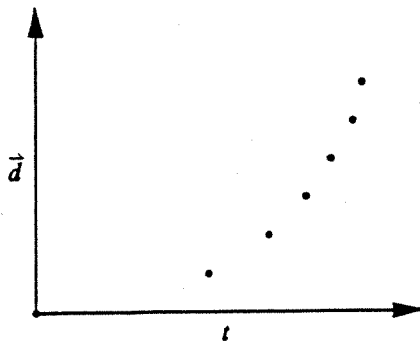
Use the following information to answer the next question.

Descriptions of Motion

- 1 An object is released from the top of a building and timed as it falls past each uniformly spaced floor.
- 2 A sports car starts from a stop sign and uniformly increases its speed to 100 km/h in 10 seconds.
- 3 A ball is rolled down a board inclined at 30° , and the time of travel is recorded for uniformly marked distances.
- 4 A tractor travels with uniform motion, and the time of travel is recorded for uniformly marked distances.

Numerical Response

This is a position–time graph related to moving objects:



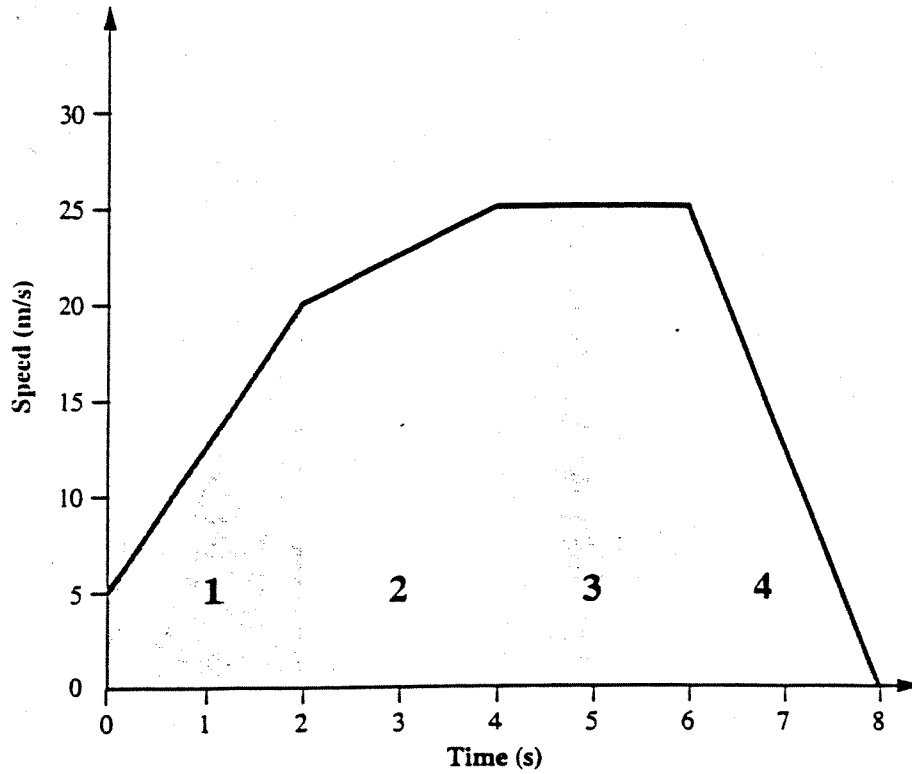
2. The statements that could be correctly represented by the position–time graph are, in any order, _____.

(Record your answer as .)

Use the following graph to answer the next two questions.

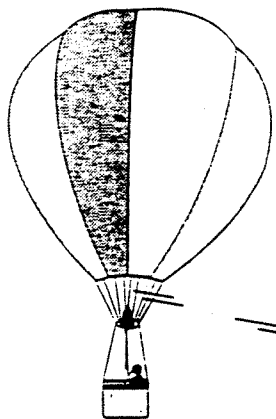
The following graph describes the motion of a truck over an 8 second time interval.

Speed vs Time



3. Which section of the graph indicates that a net force of zero was acting on the truck?
- A. 1
 - B. 2
 - C. 3
 - D. 4
4. Which section of the graph indicates the largest positive force acting on the truck?
- A. 1
 - B. 2
 - C. 3
 - D. 4

5. A balloon is rising vertically at a velocity of 4.0 m/s while a west wind is blowing at 10 m/s.



Balloon rising at 4.0 m/s



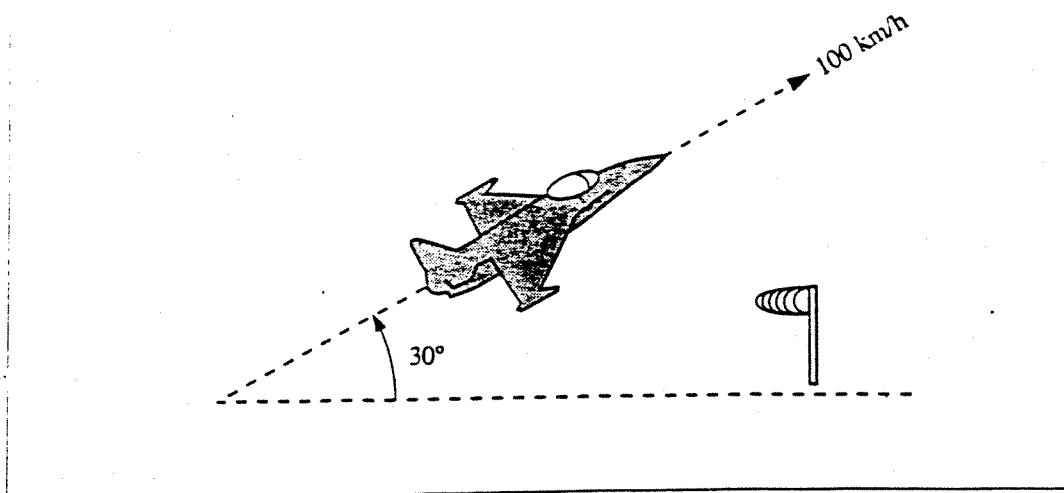
West wind of 10 m/s

Relative to the ground, the angle of ascent of the balloon is

- A. 21°
- B. 22°
- C. 69°
- D. 68°

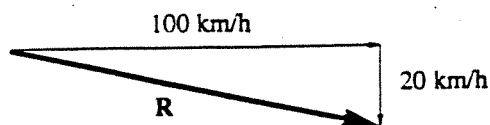
Use the following information to answer the next three questions.

An air force pilot takes off from a runway, heading due east at 100 km/h. The plane climbs at an angle of 30° from the ground. When it reaches altitude, it encounters a 20 km/h crosswind from the north.

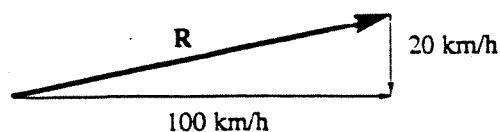


6. During the takeoff, the vertical and horizontal components of the plane's velocity, respectively, are
- A. 87 km/h, 50 km/h
 - B. 50 km/h, 87 km/h
 - C. 50 km/h, 50 km/h
 - D. 100 km/h, 100 km/h
7. The correct vector diagram, as viewed from above, to find the plane's velocity when it reaches altitude would be

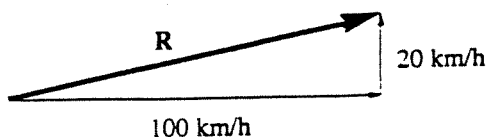
A.



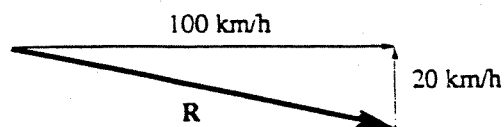
B.



C.

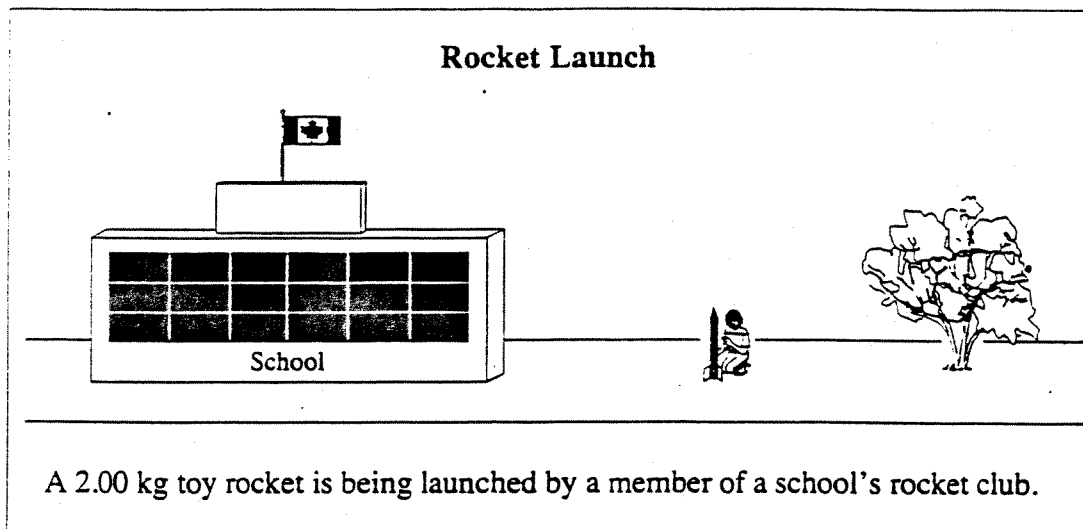


D.



8. The pilot is aware of the crosswind and aims his craft so that it will fly due east. In what direction does he point the nose of the plane?
- A. 11° N of E
 - B. 112° N of E
 - C. 79° N of E
 - D. 0° due east
-

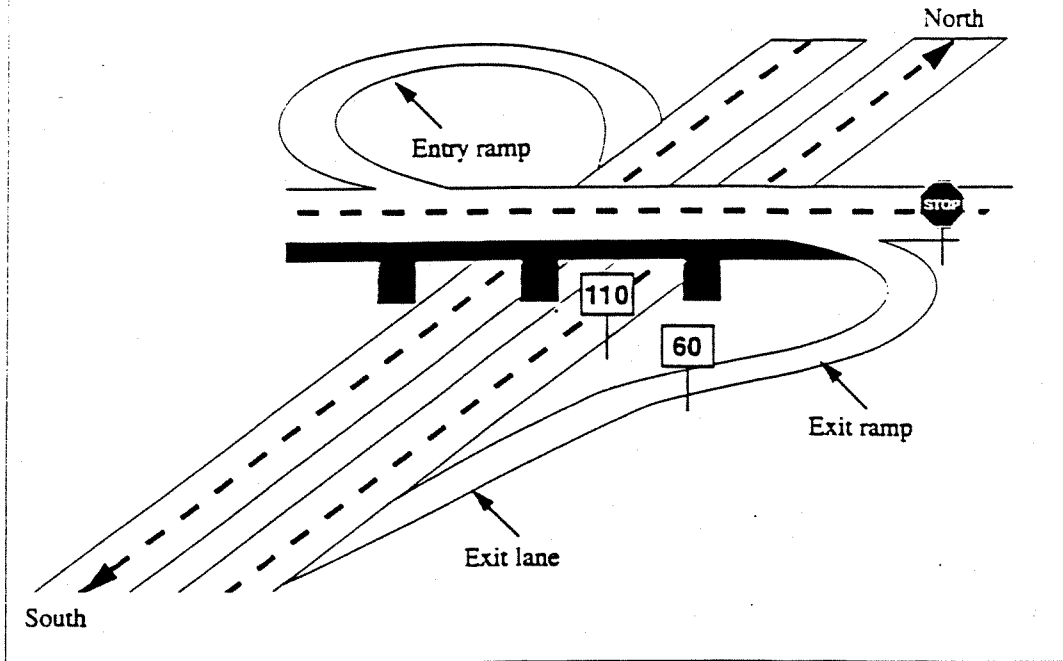
Use the following information to answer the next two questions.



9. The weight of the rocket is
- A. 2.00 N
 - B. 2.00 kg
 - C. 19.6 N
 - D. 19.6 kg
10. What is the initial exhaust force required to overcome gravity and then accelerate the rocket vertically at 5.80 m/s^2 ?
- A. 8.02 N
 - B. 11.6 N
 - C. 19.6 N
 - D. 31.2 N

Use the following information to answer the next question.

The design for an overpass on Highway 2 is shown. The roadway of the overpass is 6.5 m above the highway surface. The speed limit on the exit or entry ramp is 60 km/h (16.7 m/s) and on the highway is 110 km/h (30.6 m/s).



Numerical Response

3. On the 120 m-long ramp, the average force applied by the engine of a car is 3.0×10^3 N. If the engine power is rated at 71.0 kW, then the car accelerated for _____ seconds.
(Round and record your answer to two digits.)

Use the following information to answer the next two questions.

The speed of sound in a gas is given by the equation

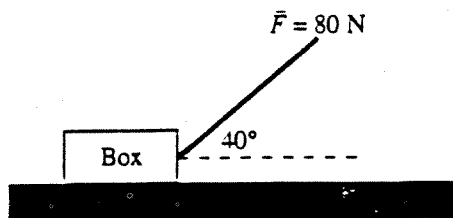
$$v = \sqrt{\frac{kP}{\rho}},$$

where v is the speed (m/s), k is a constant, P is the pressure (N/m^2), and ρ is the density (kg/m^3).

11. If the speed is 300 m/s, the pressure is 250 N/m^2 , and the density is $1.05 \times 10^{-6} \text{ kg/m}^3$, the numeric value of k is
- A. 3.78×10^{-4}
 - B. 1.39×10^{-3}
 - C. 1.93×10^{-6}
 - D. 3.73×10^{-2}
12. The SI unit for k is
- A. s/m
 - B. m/s
 - C. s^2/m^2
 - D. no units

Use the following information to answer the next question.

A force of 80 N is applied to a box by pulling on a rope at an angle of 40° to the horizontal as shown.



Numerical Response

4. The applied force can be broken into vertical and horizontal components. The vertical component of the force is ab N. The horizontal component of the force is cd N. The values of ab and cd are _____.
(Record your answer as .)

13. A pop can is dropped in a car that is travelling at 90 km/h. The horizontal velocity of the can, with respect to the roadway, is
- A. 0.0 km/h
 - B. 90 km/h forwards
 - C. 90 km/h backwards
 - D. 90 km/h downwards

Use the following information to answer the next two questions.

Road Safety

The speed limits on Alberta highways are 110 km/h (30.6 m/s) during the day, 100 km/h (27.8 m/s) at night, and 90 km/h (25 m/s) in the national parks.

14. The centripetal forces on a car's tires will
- A. increase with the size of the tire
 - B. be greatest in the parks
 - C. be greatest during the night
 - D. be greatest during the day
15. A car's engine heats up as it inefficiently converts chemical potential energy to mechanical kinetic energy. Car tires also heat up. This is because the tires are converting
- A. mechanical kinetic energy to heat
 - B. heat to mechanical kinetic energy
 - C. chemical potential energy to heat
 - D. gravitational potential energy to mechanical kinetic energy

Use the following information to answer the next question.

A student summarized some sixteenth- and seventeenth-century ideas about planetary motion.

- 1 The paths of the planets are ellipses, with the centre of the Sun at one focus.
- 2 The force between the Sun and a planet varies inversely with the square of its distance from the Sun.
- 3 An imaginary line from the Sun to a planet sweeps out equal areas in equal time intervals.
- 4 The ratio of the squares of the periods of any two planets revolving around the Sun is equal to the ratio of the cubes of their average distance from the Sun.

16. Which ideas form the basis of Kepler's laws regarding planetary motion?

- A. 1 and 2 only
- B. 2 and 4 only
- C. 1, 3, and 4 only
- D. 1, 2, 3, and 4

Numerical Response

5. A satellite is moving around Earth in a geosynchronous orbit. This means it is directly above one spot on Earth at all times. The period of this orbit in scientific notation is $b \times 10^w$ h. The value of b is _____.
- (Round and record your answer to two digits.)

Use the following information to answer the next question.

The length of a skid mark in a collision can be used to determine if a motorist has been speeding. The relationship between vehicle speed and skid mark length is given by

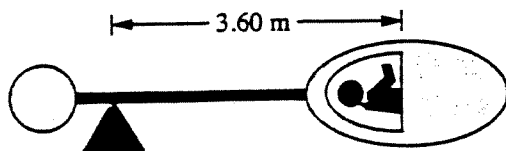
$$S = \frac{v^2}{2g\mu}$$

where v = vehicle speed (m/s)
 g = acceleration due to gravity
 μ = coefficient of friction (0.30 for asphalt)

17. The posted speed limit on a residential asphalt street is 50.0 km/h (13.9 m/s). After an accident, the skid mark is found to be 60.0 m long. How much longer is this skid mark than it would have been if the vehicle had been travelling at the posted speed limit?
- A. 27 m
B. 28 m
C. 29 m
D. 33 m

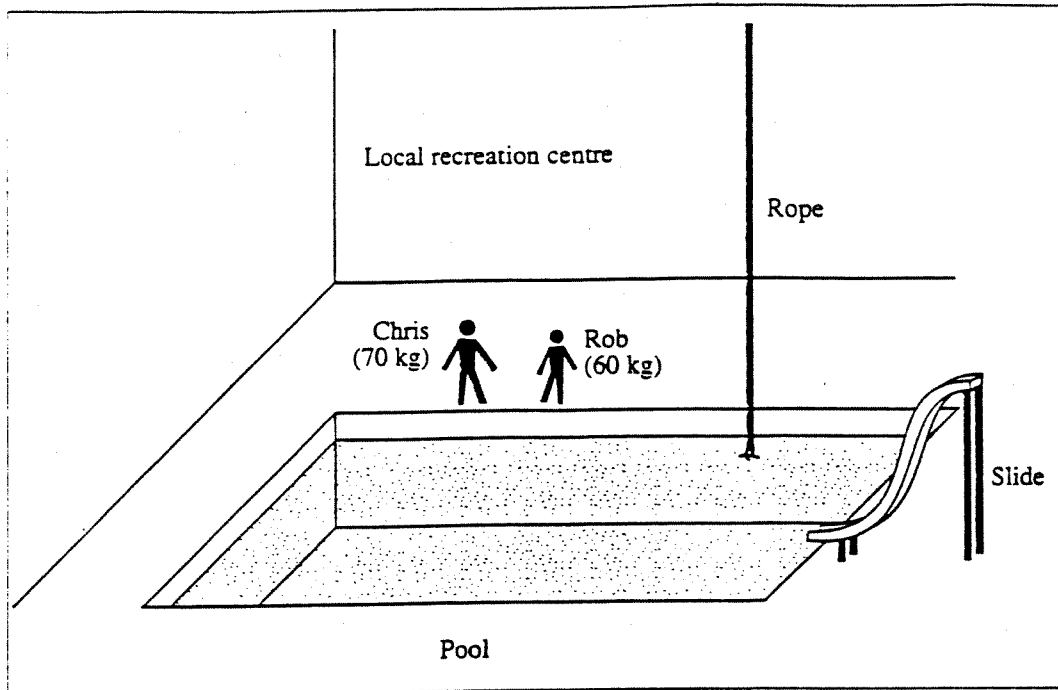
Use the following information to answer the next question.

Part of the training of astronauts involves simulating liftoff acceleration, in which the astronaut sits in a mock capsule that rotates in a horizontal plane around a fixed centre. Assume that the astronaut's centre of mass is 3.60 m from the centre of rotation.



18. If the capsule was spinning at 12.5 m/s, what horizontal force would the circular motion exert on a 70.0 kg astronaut?
- A. 777 kN
B. 3.04 kN
C. 2.35 kN
D. 0.243 kN

Use the following information to answer the next two questions.



19. The boys are trying to decide how long it will take Rob to make one complete swing on the rope, coming back to the pool deck rather than letting himself drop into the water. The rope is about 8 m long. The time Rob's complete swing takes is closest to
- A. 0.2 s
 - B. 5 s
 - C. 6 s
 - D. 17 s

Numerical Response

6. When the waves are turned on in the pool, the boys notice that a wave occurs every 3.0 seconds. Chris says that the frequency would be $a.b \times 10^{-c}$ Hz. The values of a , b , and c are _____.
- (Record your answer as .)

20. A 440 g mass is attached to a spring on a horizontal, frictionless surface. The mass is then pulled back 1.6 cm, where the force required to hold it is 4.4 N. If the mass is pulled back further to a displacement of 2.4 cm, then released, the instantaneous acceleration of the mass will be
- A. 2.9 m/s^2
 - B. 4.8 m/s^2
 - C. 15 m/s^2
 - D. 25 m/s^2

Numerical Response

7. Piano tuners often start with middle C. This frequency is 262 Hz. If the speed of sound is 330 m/s, the wavelength produced is _____ m.
(Round and record your answer to three digits.)

Use the information provided in Numerical Response 7 to solve Selected Response 21.

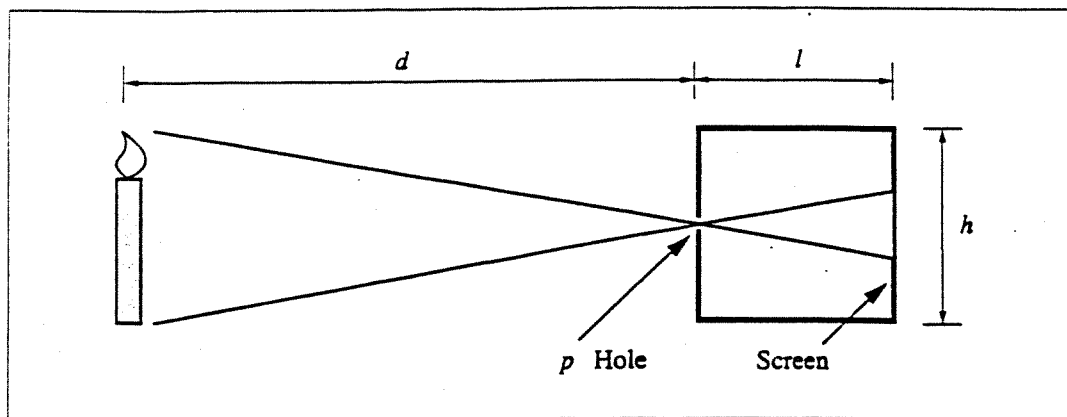
21. The piano tuner checks his work on middle C by using a fork pitched at 264 Hz. What will he hear?
- A. Uniform sound at 264 Hz and 261 Hz
 - B. Uniform sound at 525 Hz
 - C. Beats at 2 Hz
 - D. Beats at 525 Hz

Numerical Response

8. On the planet Garpion, a pendulum with a length of 1.50 m swings with a frequency of 0.575 Hz. The acceleration of gravity on this planet is $ab.c \text{ m/s}^2$. The values of a , b , and c are _____.

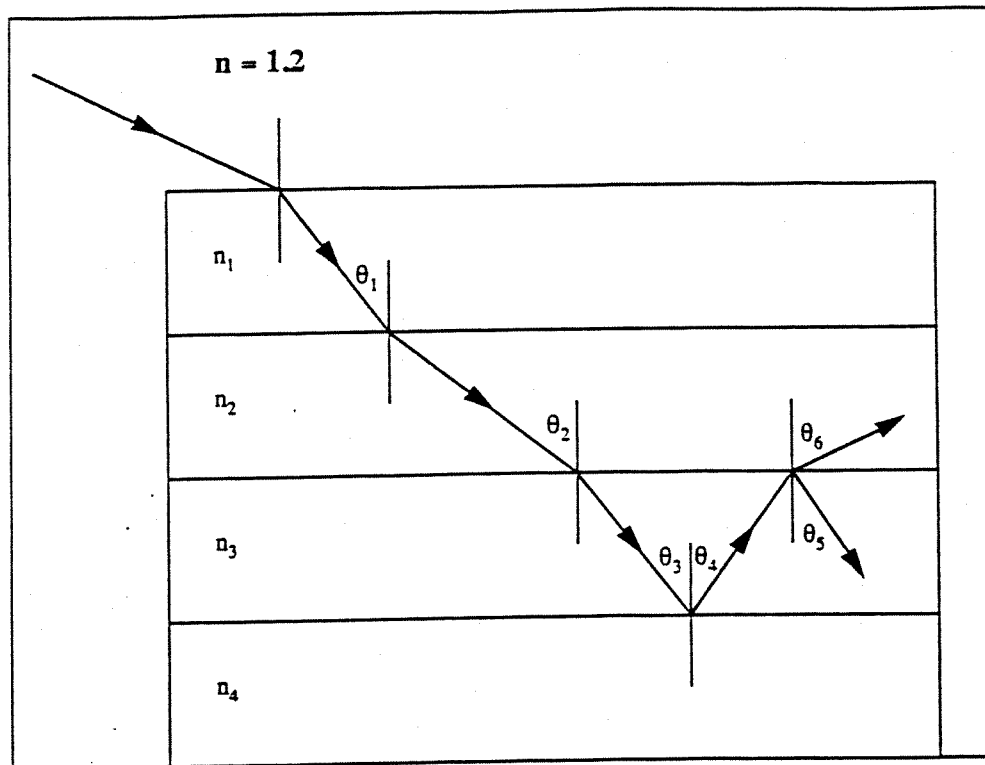
(Record your answer as $\boxed{a}\boxed{b}.\boxed{c}$.)

Use the following diagram to answer the next question.



25. A student who wanted to design a pinhole camera that would increase the size of the image on the screen would have to increase the
- A. distance, d
 - B. size of the hole, p
 - C. length of the camera, l
 - D. height of the camera, h

Use the following information to answer the next question.



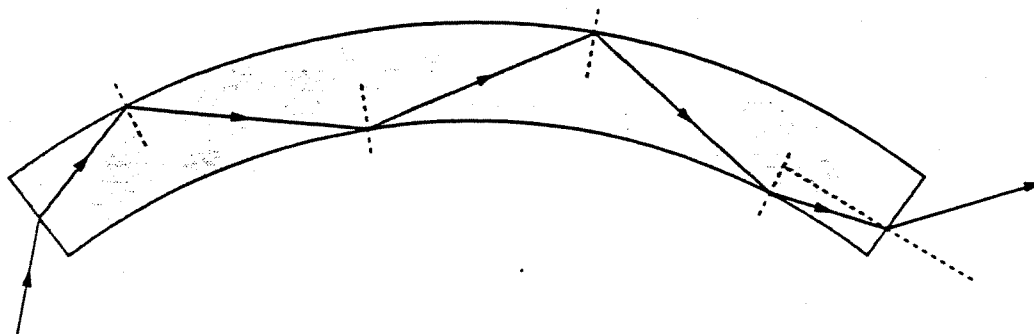
Four transparent blocks are stacked vertically, and the stack is placed in a liquid of refractive index 1.2. The indices of refraction for the blocks are n_1 , n_2 , n_3 , and n_4 . At the boundary between blocks 3 and 4, there is total internal reflection.

26. The angle of reflection θ_5 is equal to

- A. θ_1 and θ_2
- B. θ_2 and θ_3
- C. θ_2 and θ_4
- D. θ_3 and θ_4

Use the following information to answer the next four questions.

Total internal reflection finds important application in the field of fibre optics. An optical fibre is a long, narrow filament of glass or transparent plastic. Because it is narrow, light entering the fibre at one end strikes the inside wall of the fibre at an angle greater than the critical angle.



Since the light is totally reflected inside the fibre, it travels along the fibre, making hundreds of internal reflections without escaping.

27. What is the critical angle between glass ($n = 1.50$) and air ($n = 1.00$)?
- A. 33.7°
 - B. 41.8°
 - C. 48.2°
 - D. 56.3°

Use this additional information to answer the next three questions.

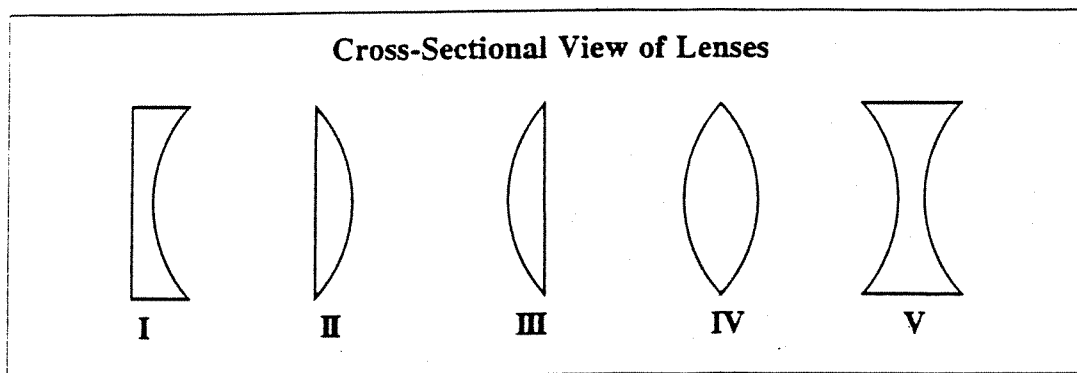
One of your close friends plays on the football team. During last week's game, he received an injury to his right knee. He has been informed that he is to undergo microsurgery that will involve light and fibre-optic technologies. He asks you to give him some background information about the physics involved in his surgery.

28. Your friend asks you about the speed of light that is used in the fibre-optic procedure he will be going through. You inform him that the speed of the light in the optical fibre will be
- A. 2.00×10^8 m/s
 - B. 3.00×10^8 m/s
 - C. 4.50×10^8 m/s
 - D. 2.40×10^8 m/s

29. Your friend was told that there was "full spectrum imaging." You explain that full spectrum includes light of 400 nm to 750 nm wavelengths. Your friend asks what the frequency of green light is. You answer

- A. 7.50×10^{14} Hz
- B. 5.45×10^{14} Hz
- C. 4.00×10^{14} Hz
- D. 1.65×10^2 Hz

Use this additional information to answer the next question.



30. As the light leaves the optical fibre, it spreads out and must be focused by a lens to a spot 5 mm in diameter. The lens or lenses that could concentrate the laser light is/are

- A. I, V
- B. II, III, IV
- C. IV
- D. V

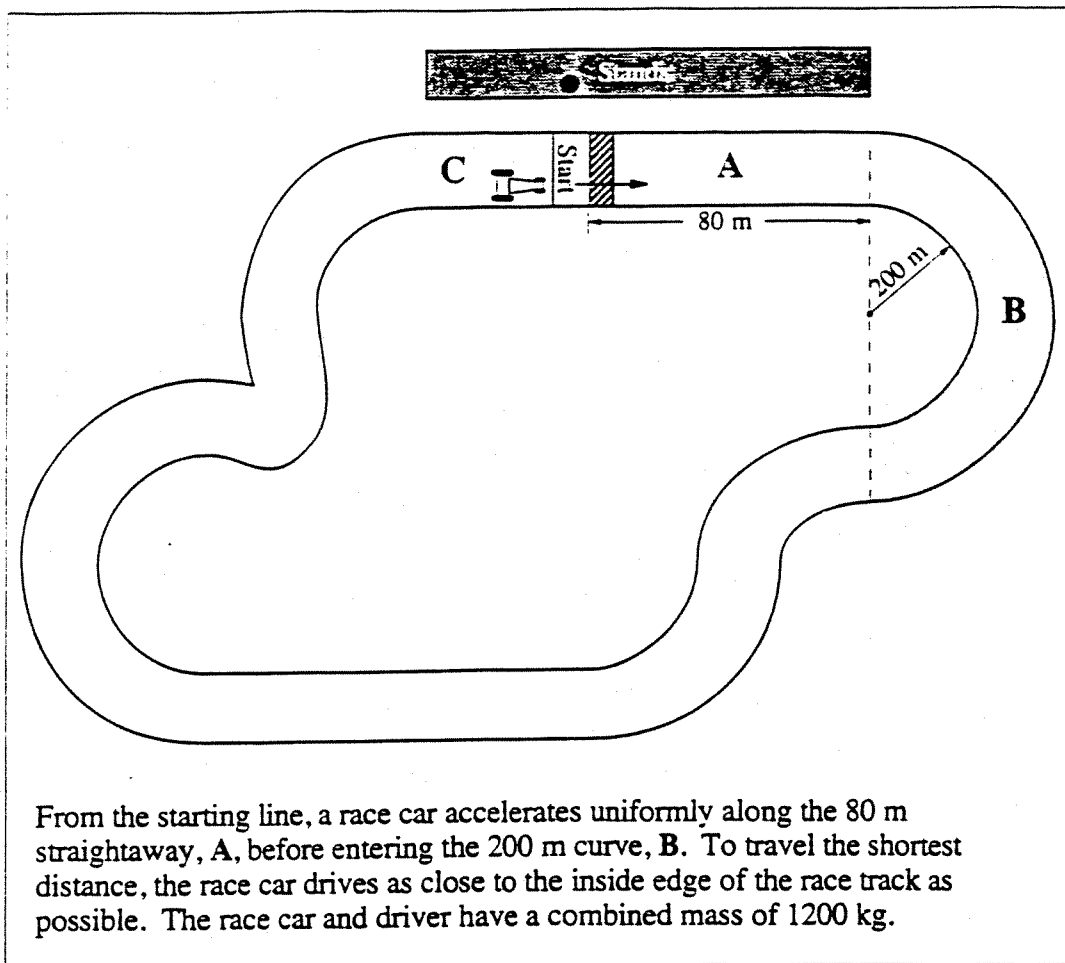
Use the following information to answer the next two questions.

A group of students set up a Young's double-slit experiment, using a sodium vapour lamp as a light source. They placed their diffraction grating 1.0 m from the screen and measured the angle of deviation to be 60° to the first maximum. A resource book listed the frequency of sodium light as 5.09×10^{14} Hz.

Numerical Response

9. The spacing of the openings on the diffraction grating is $b \times 10^{-w}$ m. The value of b is _____. (Round and record your answer to two digits.)
31. A diffraction grating can be used to measure the wavelength of the light from the sodium vapour lamp, because the light exhibits the phenomena of diffraction and
- A. refraction
 - B. dispersion
 - C. polarization
 - D. interference

Use the following information to answer the next question.



From the starting line, a race car accelerates uniformly along the 80 m straightaway, A, before entering the 200 m curve, B. To travel the shortest distance, the race car drives as close to the inside edge of the race track as possible. The race car and driver have a combined mass of 1200 kg.

Written Response — 10 marks

1. a. The race car starts from rest and accelerates uniformly at 2.4 m/s^2 along the straightaway. What is its speed when it enters the first turn?

- b. While going around the curve, **B**, the driver wants to go as fast as possible but does not want the car to skid. For the road conditions, the force of friction between the tires and the road is equivalent to 3.2 times the weight of the race car. What is the maximum speed the car can safely have? (**Note:** When $F_c > F_f$, the race car will skid.)
- c. A spectator in the stands near the start line observes that the loudness of the engines increases and then decreases as the race cars travel from **C** to **A**. This is not the only change that is observed as the race cars travel from **C** to **A**. Describe and explain what other change occurs, in terms of sound waves.