

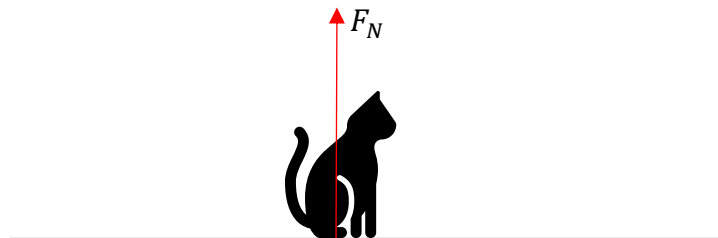
Unit 3 AOS 1 Diagnostic Quizzes

Quiz 1: Newton's Laws

Q1) Tara is standing in a lift moving vertically downwards at a constant speed of 4.0 m s^{-1} . Tara's mass is 70 kg . Which one of the following is closest to the magnitude of the normal force on Tara?

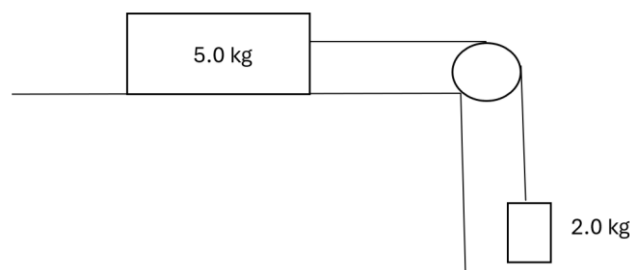
- A. 0 N
- B. 407 N
- C. 687 N
- D. 967 N

Q2) A cat is sitting on the ground as shown below. Identify the reaction force to the force labelled below.



- A. The force on the ground by the cat.
- B. The force on the cat by the ground.
- C. The force on the Earth by the cat.
- D. The force on the cat by the Earth.

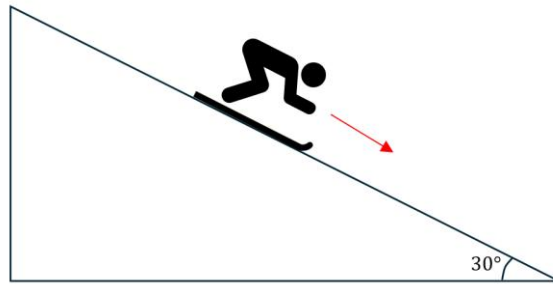
Q3) A block on a table is accelerated by a falling mass, as shown below. The block on the table experiences a frictional force of 6.0 N as it slides to the right.



Which one of the following is closest to the magnitude of the tension on the 2.0 kg block?

- A. 6.0 N
- B. 14 N
- C. 16 N
- D. 20 N

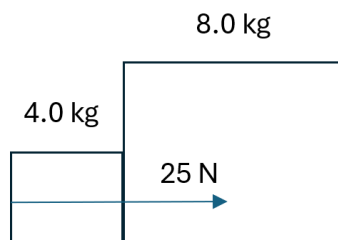
Q4) James is skiing down a slope angled at 30° to the horizontal. James' mass is 60 kg.



If the frictional force acting on James is 100 N, which of the following is closest to the magnitude of James' acceleration?

- A. 1.2 m s^{-2}
- B. 3.2 m s^{-2}
- C. 4.9 m s^{-2}
- D. 6.8 m s^{-2}

Q5) A 4.0 kg and an 8.0 kg mass are being pushed together as shown. The applied force is 25 N.

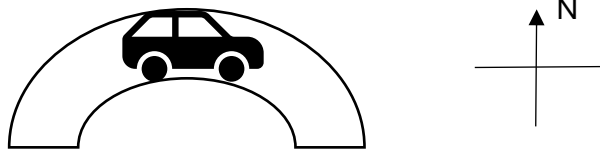


Which of the following is closest to the magnitude of the force on the 4.0 kg mass by the 8.0 kg mass?

- A. 6.3 N
- B. 17 N
- C. 19 N
- D. 25 N

Quiz 2: Circular motion

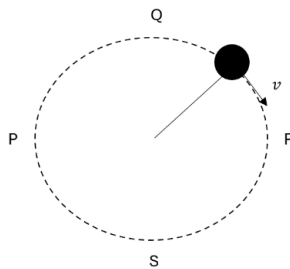
Q1) A 600 kg car is travelling around a roundabout at a constant speed of 30 km h^{-1} . The diagram below shows a top view of the roundabout. The radius of the roundabout is 8.0 m.



At the point shown in the diagram, which one of the following is closest to the net force on the car?

- A. 5.21 kN East
- B. 5.21 kN South
- C. 67.5 kN East
- D. 67.5 kN South

Q2) A 2.0 kg mass is being swung by a light rod in a vertical circle of radius 1.0 m at a constant speed of 7.0 m s^{-1} , as shown below.



Which one of the following is closest to the magnitude of the tension in the light rod at point S?

- A. 20 N
- B. 78 N
- C. 98 N
- D. 118 N

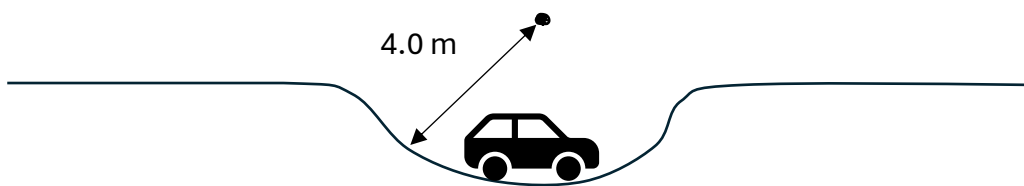
Q3) A cyclist is racing around a banked velodrome at a radius of 35 m. She is travelling at the constant speed equal to the design speed 50 km h^{-1} . Which one of the following is closest to the angle of bank of the track?

- A. 15°
- B. 22°
- C. 29°
- D. 34°

Q4) Tony is about to ride in a rollercoaster. The rollercoaster contains a vertical loop of diameter 20 m. Which one of the following is closest to the minimum speed that the cart must be travelling upside down at the top of the vertical loop to remain in contact with the track?

- A. 3.1 m s^{-1}
- B. 9.9 m s^{-1}
- C. 14 m s^{-1}
- D. 20 m s^{-1}

Q5) Alan is driving a car through a dip in the road. The dip can be modelled as a circular arc of radius 4.0 m.



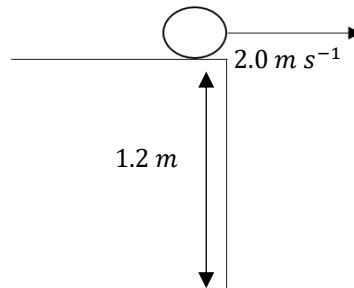
Which of the following is closest to the speed Alan must be travelling at the bottom of the dip if the normal force acting on the car is triple the gravitational force acting on Alan and the car?

- A. 3.6 m s^{-1}
- B. 6.3 m s^{-1}
- C. 8.9 m s^{-1}
- D. 11 m s^{-1}

Quiz 3: Projectile motion

Use the following information to answer Questions 1 and 2.

A ball travelling at 2.0 m s^{-1} slides off a table 1.2 m high, as shown.



Q1) Which one of the following is closest to the time taken for the ball to hit the ground (ignoring air resistance)?

- A. 0.33 s
- B. 0.49 s
- C. 0.60 s
- D. 0.74 s

Q2) Which one of the following is closest to the final speed of the ball as it hits the ground?

- A. 2.0 m s^{-1}
- B. 4.9 m s^{-1}
- C. 5.2 m s^{-1}
- D. 5.6 m s^{-1}

Use the following information to answer Questions 3 and 4.

Alex hits a golf ball at 20 m s^{-1} at an angle of 40° to the horizontal, as shown below. Ignore the effects of air resistance.



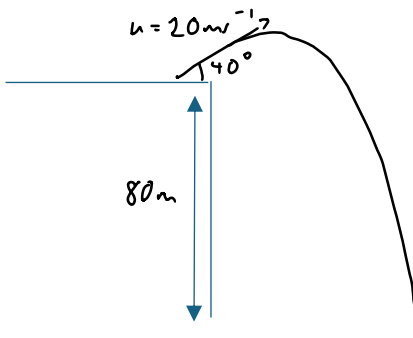
Q3) Which one of the following is closest to the maximum height reached by the ball during its flight?

- A. 8.4 m
- B. 9.8 m
- C. 12 m
- D. 20 m

Q4) Which one of the following is closest to the horizontal distance travelled by the ball once it hits the ground (assuming that the ground is level)?

- A. 20 m
- B. 26 m
- C. 40 m
- D. 82 m

Q5) A rock is thrown off an 80 m cliff. It has an initial velocity of 20 m s^{-1} , at an angle of 40° to the horizontal as shown below.



Which of the following is closest to the time taken for the rock to reach the bottom of the cliff?

- A. 5.2 s
- B. 5.6 s
- C. 5.9 s
- D. 6.2 s

Quiz 4: Momentum and impulse

Use the following information to answer Questions 1 and 2.

A 57 g tennis ball travelling at 15 m s^{-1} East is hit by a tennis racquet. It leaves the racquet at 25 m s^{-1} West.

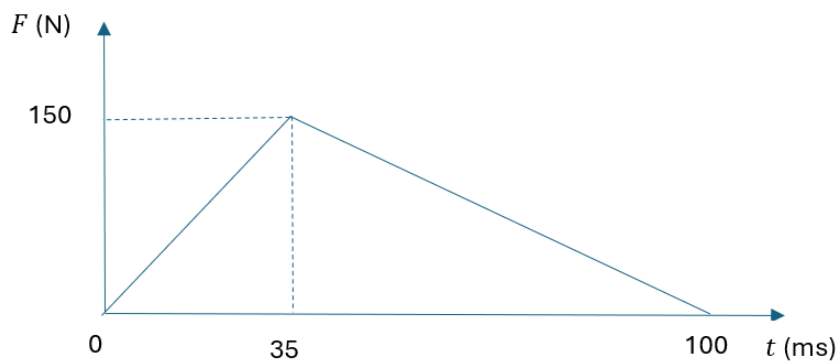
Q1) Which one of the following is closest to the impulse on the ball?

- A. 0.57 N s West
- B. 0.57 N s East
- C. 2.3 N s West
- D. 2.3 N s East

Q2) The ball was in contact with the racquet for 500 ms. Which of the following is closest to the average force exerted on the racquet by the ball?

- A. 1.1 N West
- B. 1.1 N East
- C. 4.6 N West
- D. 4.6 N East

Q3) The figure below shows an force-time graph for a 170 g baseball being caught by a fielder.



Which one of the following is closest to the magnitude of the impulse of the baseball?

- A. 2.63 N s
- B. 3.75 N s
- C. 5.25 N s
- D. 7.50 N s

Q4) A 300 kg dodgem car travelling at 6.0 m s^{-1} collides into a stationary dodgem car of mass 400 kg, before rebounding in the opposite direction at 4.0 m s^{-1} . Which one of the following is closest to the final speed of the 400 kg dodgem car?

- A. 0.67 m s^{-1}
- B. 1.5 m s^{-1}
- C. 7.5 m s^{-1}
- D. 11 m s^{-1}

Q5) A 500 g soccer ball, initially travelling at 10 m s^{-1} South, is kicked by a player with an average force of 70 N North. If the collision took 200 ms, which of the following is closest to the final velocity of the ball?

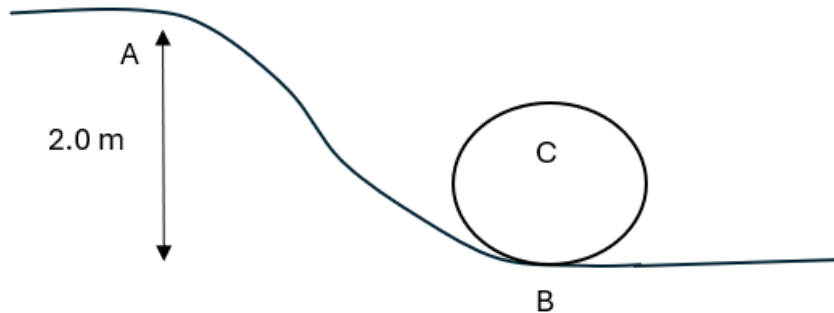
- A. 10 m s^{-1} North
- B. 18 m s^{-1} North
- C. 28 m s^{-1} North
- D. 38 m s^{-1} North

Quiz 5: Energy

Q1) A 500 kg railway carriage moving to the right at 5.0 m s^{-1} collides with a stationary 400 kg railway carriage. The two carriages couple together. Which one of the following options correctly states the combined final speed of the two carriages, as well as whether the collision is elastic or inelastic?

- A. 2.8 m s^{-1} , inelastic
- B. 2.8 m s^{-1} , elastic
- C. 6.3 m s^{-1} , inelastic
- D. 6.3 m s^{-1} , elastic

Q2) Sarah is designing a track for a model car with mass 0.50 kg , as shown below. The car is released from rest at point A, which is 2.0 m above the ground and travels through a vertical loop of radius 0.5 m .

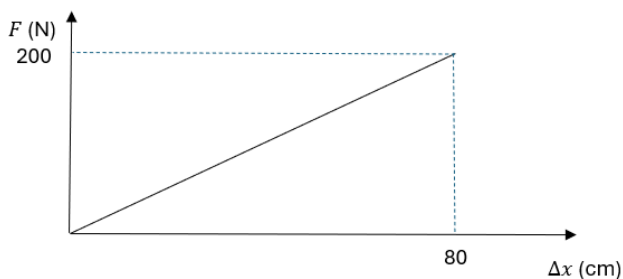


Assuming no friction, which one of the following is closest to the speed of the car at the top of the loop (point C)?

- A. 2.2 m s^{-1}
- B. 4.4 m s^{-1}
- C. 5.4 m s^{-1}
- D. 6.3 m s^{-1}

Use the following information to answer Questions 3 and 4.

The following figure is the force-extension graph of an ideal spring.



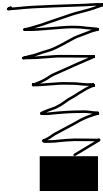
Q3) Which of the following is closest to the spring constant of the spring?

- A. 2.5 N m^{-1}
- B. 25 N m^{-1}
- C. 80 N m^{-1}
- D. 250 N m^{-1}

Q4) Which of the following is closest to the elastic potential energy stored in the spring at an extension of 60 cm ?

- A. 0.45 J
- B. 0.80 J
- C. 45 J
- D. 80 J

Q5) A vertical spring with spring constant $k = 30 \text{ N m}^{-1}$ is shown below. The spring is initially unstretched. A 0.90 kg mass is attached to the spring and is then released. Ignore the mass of the spring. Which of the following is closest to the extension of the spring at the lowest point of its oscillation?



- A. 0.29 m
- B. 0.39 m
- C. 0.49 m
- D. 0.59 m

Answers:

Quiz 1:

Question	Answer	Notes
1	C	The lift is travelling at a constant speed , so $F_{net} = 0$.
2	A	The force shown is the force on the cat by the ground (ie. normal force). Action-reaction forces, according to Newton's Third Law, must act on different objects. Therefore the reaction force would be the force on the ground by the cat. The common mistake is to say that the gravitational force (force on the cat by the Earth) is the reaction force, however this acts on the same object as the normal force, and is therefore not the reaction force.
3	C	Two steps: first find the acceleration of the entire system using Newton's second law. Then, isolate the 2.0 kg block and use Newton's second law to calculate the tension.
4	B	Use Newton's second law. The net force is the component of the weight force acting down the slope ($mg\sin\theta$), minus the frictional force.
5	B	Two steps: first find the acceleration of the entire system using Newton's second law. Then, isolate the 4.0 kg block and use Newton's second law to calculate the force on the 4.0 kg block by the 8.0 kg block.

Quiz 2:

Question	Answer	Notes
1	B	Convert $km\ h^{-1}$ to $m\ s^{-1}$ by dividing by 3.6. Also note that the direction of centripetal force is towards the centre of the circle.
2	D	At point S, $F_{net} = T - F_g$. Use this to calculate the tension.
3	C	Use the derived formula $\tan\theta = \frac{v^2}{rg}$.
4	B	Use the derived formula $v_{min} = \sqrt{rg}$. Remember to halve the diameter to get the radius.
5	C	$F_{net} = F_N - F_g$ $F_{net} = 3F_g - F_g = 2F_g$ $\frac{mv^2}{r} = 2mg$ Mass cancels out, solve for the speed.

Quiz 3:

Question	Answer	Notes
1	B	Use $s = ut + \frac{1}{2}at^2$ vertically. Remember to define a direction as positive.
2	C	Two methods: 1. Find the vertical component of the velocity using $v^2 = u^2 + 2as$. The horizontal velocity is constant. Use a vector triangle to find the magnitude of velocity (ie. speed) 2. Use conservation of energy.
3	A	Use $v^2 = u^2 + 2as$ vertically.
4	C	Use $v = u + at$ vertically to find the time to the max height, and double this (time for the whole journey). Then, use $s = ut$ horizontally to find the horizontal distance travelled.
5	B	Use $s = ut + \frac{1}{2}at^2$ vertically, taking upwards as positive (hence displacement and acceleration are negative). Remember to resolve the initial velocity into perpendicular components. Use the quadratic formula to solve for t. Alternatively, you can find v first using $v^2 = u^2 + 2as$ and then find t (avoids quadratic formula).

Quiz 4:

Question	Answer	Notes
1	C	Impulse is equal to the change in momentum. Be careful: momentum is a vector. Assign one direction as positive. If West is assigned as positive, the initial velocity is -15 m s^{-1} and the final velocity is 25 m s^{-1} . Thus the overall change in velocity is $25 - (-15) = 40 \text{ m s}^{-1}$, not 10 m s^{-1} .
2	D	Use $I = F_{av}t$. Be careful with the direction: The impulse in part (a) was 'on the ball by the racquet', which was West. However, this question asks for the average force 'on the racquet by the ball', so the direction is East.
3	D	Impulse = area under the force-time graph. Remember to convert ms to s for the time.
4	C	Use the law of conservation of momentum. Remember to assign one direction as positive (the other direction will be negative).
5	B	Firstly, assign one direction as positive (eg. North). Then, substitute the values into $m(v - u) = F_{av}t$, and solve for v.

Quiz 5:

Question	Answer	Notes
1	A	Use the law of conservation of momentum to calculate the final speed. Compare the total kinetic energy before and after the collision to determine whether the collision is elastic or inelastic. For elastic collisions, $\sum E_{k(i)} = \sum E_{k(f)}$, but for inelastic collisions, $\sum E_{k(i)} > \sum E_{k(f)}$.
2	B	Use the law of conservation of energy. Equate the total energy at A to the total energy at C.
3	D	Spring constant is the gradient of the F-x graph. Remember to convert cm to m.
4	C	Elastic potential energy is the area under the F-x graph. Note that the question asks for the elastic potential energy stored at an extension of 60 cm, not 80 cm.
5	D	At the very lowest point reached by the spring after the mass is released, the change in elastic potential energy is equal to the change in gravitational potential energy (kinetic energy is zero at the lowest point). Therefore, $\Delta E_g = \Delta E_s$ $mg\Delta x = \frac{1}{2}k(\Delta x)^2$ $\Delta x = \frac{2mg}{k}$