HKDSE Essentials

Third Edition

Pearson Longman

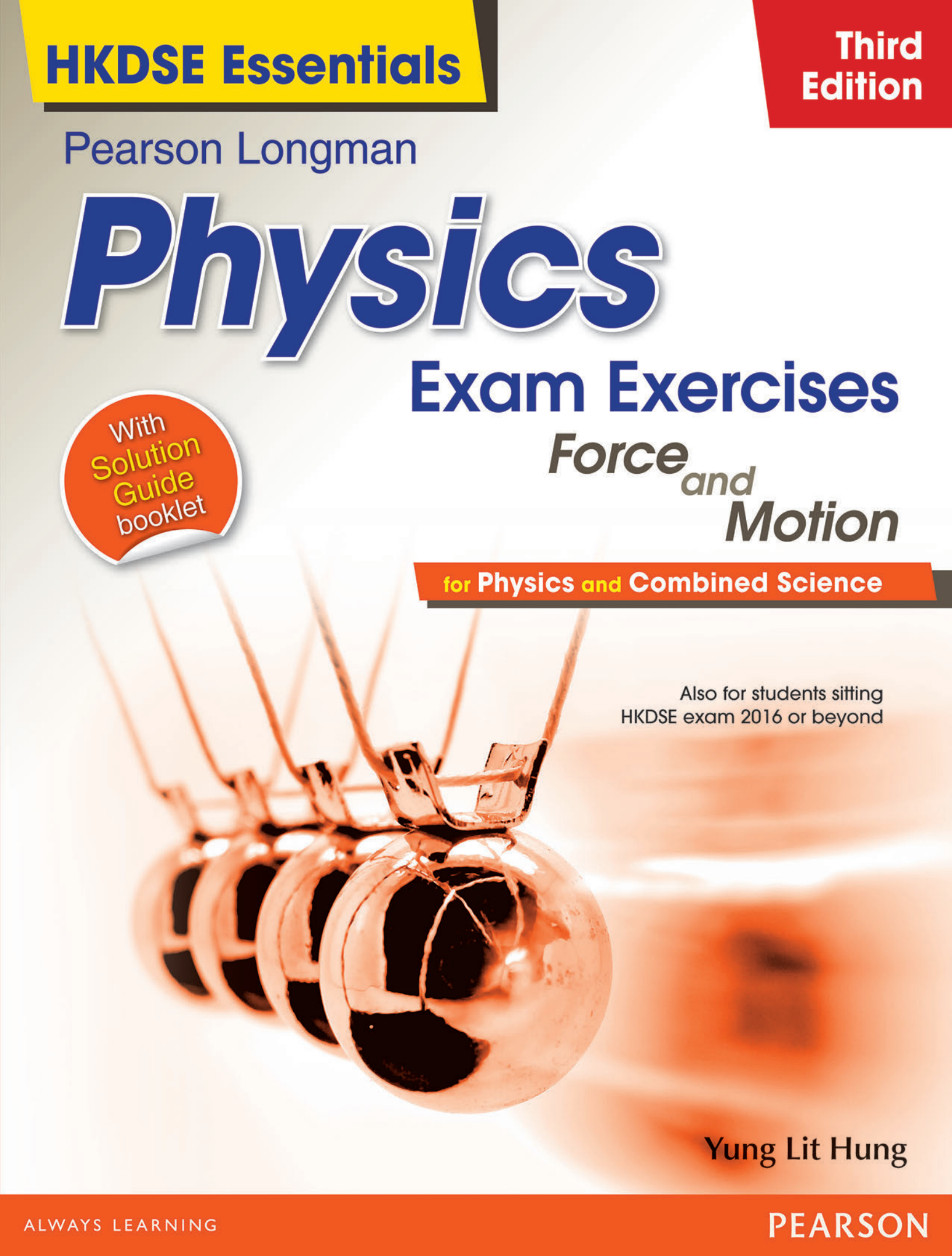
Physics

Exam Exercises

Force and Motion

With Solution Guide booklet

for Physics and Combined Science



Also for students sitting HKDSE exam 2016 or beyond

Yung Lit Hung

ALWAYS LEARNING

PEARSON

Contents

Up-to-date information:
http://physics.ilongman.com

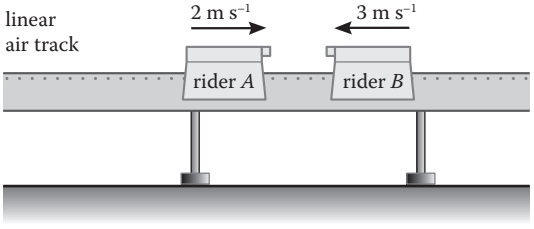
Questions with this icon are more difficult.

14/15 Questions with this icon are for students taking exam in 2014 or 2015 only.

Why my answer looks so strange?

Before practising

The riders collide and then rider A travels to the left at a speed of 2 m s^{-1}. What is the velocity of rider B after the collision?



Answer:

The speed of rider B is given by

$m_A u_A + m_B u_B = m_A v_A + m_B v_B$

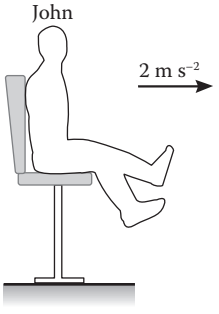
$2 + 3 = 2 + v_B$

$v_B = 3$ m s^{-1}

+/– ?

John of mass 70 kg is sitting in a car which is accelerating at 2 m s^{-2} horizontally.

Find the force acting on John by the seat.



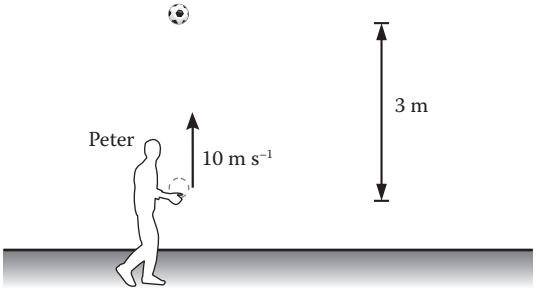
Answer:

The normal reaction from the seat, N is equal to the John's weight, mg in magnitude. Thus,

$N = mg = 70 \times 9.81 = 686.7$ N.

That's all ?

Peter throws a ball vertically upwards at an initial speed of 10 m s^{-1}. The ball is now 3 m above the position it leaves Peter's hands. What is its speed at the instant?



Answer:

The speed can be determined by

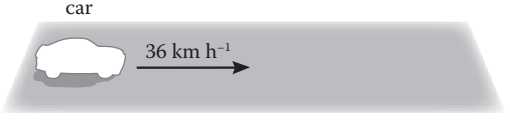
$v^2 - u^2 = 2as$

$v^2 - 10^2 = 2 \times 9.81 \times 3$

$v \approx 12.6$ m s^{-1}

Gains speed in air ?

A car of mass 2000 kg is moving at a uniform speed of 36 km h^{-1}. What is its kinetic energy?



Answer:

Its kinetic energy is

$\frac{1}{2}mv^2 = \frac{1}{2} \times 2000 \times 36^2$

$= 1\ 296\ 000$

Plug the speed in km h^{-1} ?

Shoot-the-stars questions

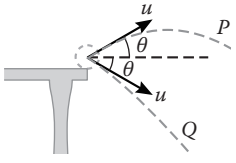
Reason-assertion

	1st statement	2nd statement
1.	For an object launching and landing at the same level, the larger the angle of projection (0° to 90°), the larger the range.	For an object launching and landing at the same level, the larger the angle of projection (0° to 90°), the longer the time of flight.
2.	For an object launching and landing at the same level, if the angle of projection is the same, doubling the initial speed increases the range by a factor of 4.	For an object launching and landing at the same level, both the time of flight and horizontal speed are proportional to the projection speed.

Reminder:
A. = T T and (1 because of 2)
B. = T T
C. = T F
D. = F T
See p.10 for detailed directions.

Think and solve

3. Two identical balls P and Q are projected from the same position with the same speed u as shown. P is projected with an angle θ above the horizontal while Q is projected with the same angle below the horizontal.

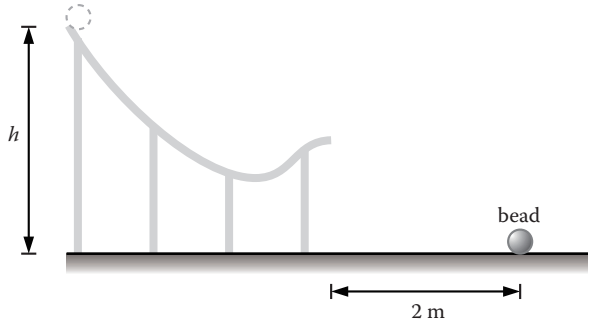


Suppose they land on the same level. What is the distance between their landing positions? (Given $\sin 2\theta = 2 \sin\theta \cos\theta$.)

A. $\frac{2u^2}{g}\tan\theta$ B. $\frac{2u^2}{g}\sin 2\theta$

C. $\frac{u^2}{2g}\sin 2\theta$ D. $\frac{u^2}{g}\sin 2\theta$

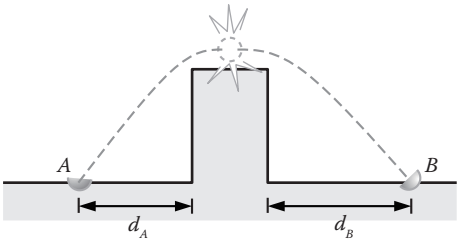
4. A bead is released from rest and travels down a smooth track as shown. The bead hits the ground at a position 2 m from the end of the track in a time of 0.4 s after leaving the track.



Suppose the bead leaves the track in the horizontal direction. Find the height h at which the bead is released.

A. 0.79 m B. 1.27 m
C. 2.06 m D. 4.12 m

5. An object is initially placed on a horizontal smooth platform. It explodes and is split into two parts A and B of mass m and $2m$ respectively in the horizontal direction. The parts finally land on the same level. The horizontal distances of the landing positions of A and B from the platform are d_A and d_B respectively.

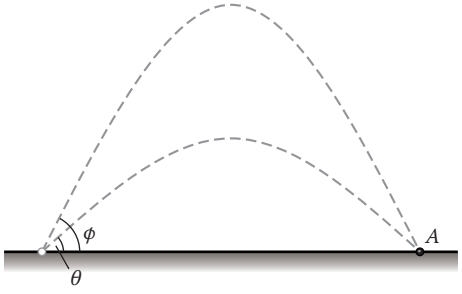


Ans: **1.** D **2.** A **3.** D **4.** C

Find the ratio $d_A : d_B$.

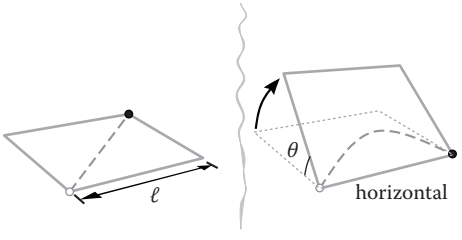
A. 1 : 1 B. 1 : 2
C. 2 : 1 D. 4 : 1

6. A particle is projected at an angle θ above the horizontal and hits a point A when it returns to the same level. Another particle is projected with the same speed from the same position at an angle ϕ ($\phi > \theta$) and hits the same point A. What is the relation between θ and ϕ?



A. $\phi = 90° - \theta$ B. $\phi = 45° + \theta$
C. $\phi = 2\theta$ D. $\phi + \theta = 180°$

7. A particle travels along the diagonal of a horizontal square plane of side length ℓ. The time of travel is t.



The plane is now tilted at an angle of θ to the horizontal. The particle is projected with the same speed, travels on the plane and lands at the adjacent angle of the square plane. What are the time of travel and the max. height of the particle from the horizontal ground?

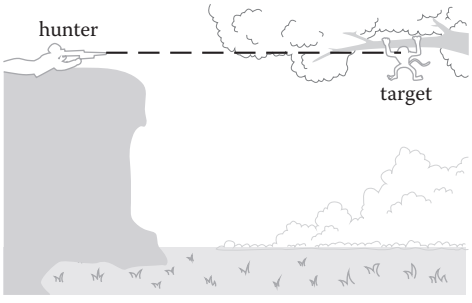
	time of travel	**max. height**
A.	t	$\frac{1}{2g}\left(\frac{\ell}{t}\right)^2$
B.	t	$\frac{1}{2g}\left(\frac{\ell}{t}\right)^2 \sin\theta$
C.	$t\cos\theta$	$\frac{1}{2g}\left(\frac{\ell}{t}\right)^2$
D.	$t\cos\theta$	$\frac{1}{2g}\left(\frac{\ell}{t}\right)^2 \sin\theta$

8. A ball rolls horizontally off a platform with a velocity u. It lands on a point at a vertical distance h below.

(a) What is the horizontal distance travelled by the ball in the air? Express your answer in terms of u and h. (2 marks)

(b) Another ball rolls horizontally off the top of a staircase with a speed 5 m s^{-1}. Each step is 20 cm wide and 15 cm high. Which step does the ball hit first? (4 marks)

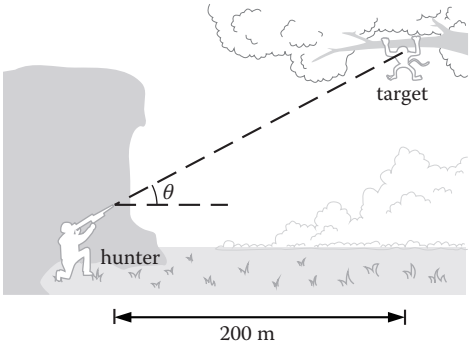
9. A hunter aims his gun at a target horizontally as shown.



At the instant the gun is fired, the target falls from rest.

(a) The target will be hit. Why? (2 marks)

(b) Suppose the hunter aims at the target at an angle θ as shown. The horizontal distance between the gun and the target is 200 m.



(i) At the instant the gun is fired, the target falls from rest. Show that the target can still be hit. (2 marks)

(ii) If the initial speed of the bullet is 250 m s^{-1} and $\theta = 60°$, when and where will the target be hit? (3 marks)

Ans: **5.** C **6.** A **7.** A **8a.** $u\sqrt{2h/g}$ **8b.** 20th **9b.** 1.6 s, 12.6 m

F9

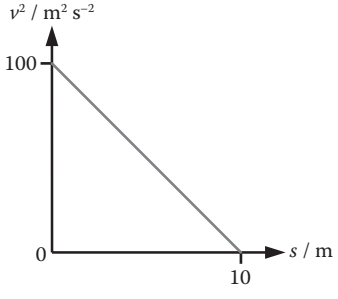
Skill-sharpening Exercises

Categories:
- From-a-graph
- Which-graph
- Sketch-a-graph
- Which-case-is-possible
- Explain-whether-it's-true
- Explain-a-phenomenon
- Describe-a-method

Unless otherwise specified, take $g = 9.81\ \text{m s}^{-2}$ (near the Earth's surface), and $G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$.

A. From-a-graph

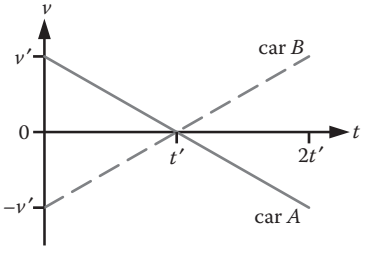
1. An object moves in a straight line with a velocity v. The variation of v^2 with the displacement s is as shown.



What is the acceleration of the object? The direction of travel of the object is taken as positive.

A. $10\ \text{m s}^{-2}$
B. $5\ \text{m s}^{-2}$
C. $-5\ \text{m s}^{-2}$
D. $-10\ \text{m s}^{-2}$

2. Two cars, A and B, starts to move from the same point at $t = 0$. The v–t graph of the cars is as shown.



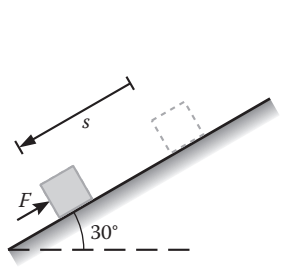
Which of the following statements is/are correct?

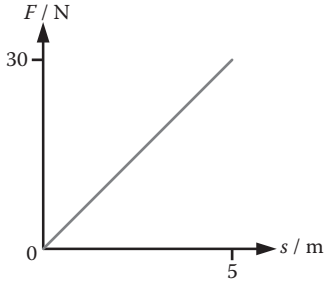
(1) At $t = t'$, the cars meet.
(2) At $t = 2t'$, the total distance travelled by the cars are both zero.
(3) The cars have the same magnitudes of average acceleration.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

Ans: **1.** C **2.** B

3. A force F is applied to a box of 2 kg which is sliding down a slope. The box has an initial speed of 8 m s^{-1} and is stopped when F acts on it for 5 m. The variation of magnitude of F with the displacement of the box s is as shown.

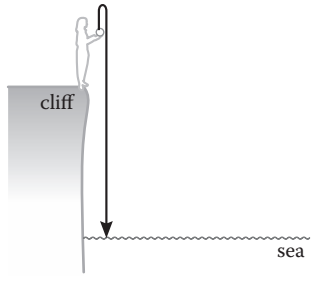


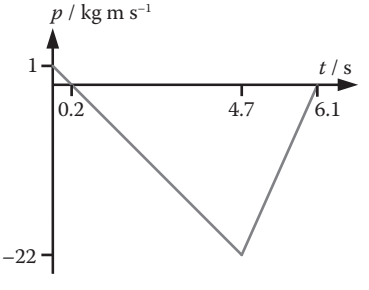


Estimate the frictional force acting on the box, assuming it to be constant.

A. 7.61 N B. 22.6 N
C. 38.1 N D. 75 N

4. Amy throws a ball vertically upwards on a cliff. The momentum–time (p–t) graph of the ball is shown.



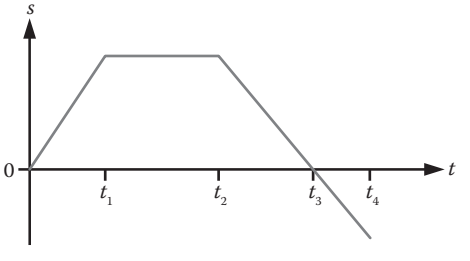


Find the average net force acting on the ball from t = 4.7 to 6.1 s.

A. 3.73 N B. 4.89 N
C. 15.7 N D. 64.9 N

5. A man walks along a straight line. The displacement–time (s–t) graph of his motion is as shown.

Which of the following statement is/are correct?



(1) From t = 0 to t_1, the acceleration of the man is zero.
(2) The direction of travel from $t = t_2$ to t_3 is opposite to that from 0 to t_1.
(3) At $t = t_3$, the man is momentarily at rest.

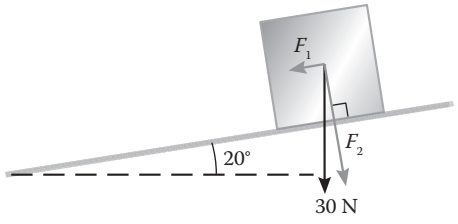
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

Ans: **3.** A **4.** C **5.** C

Exercise 3 (2 min)

Find the unknowns. Given that the components are perpendicular to each other. Figures are not drawn to scale.

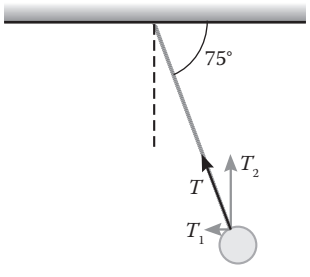
1.



F_1 = _____

F_2 = _____

2.

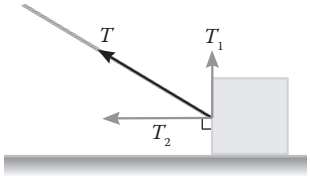


T = 15 N

T_1 = _____

T_2 = _____

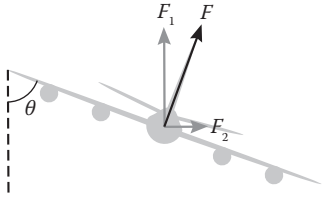
3. T is 80 N and is at 45° to the vertical.



T_1 = _____

T_2 = _____

4.



F = 1×10^7 N, F_1 = 8×10^6 N

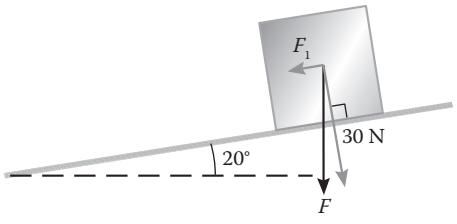
F_2 = _____

θ = _____

Exercise 4 (2 min)

Find the unknowns. Given that the components are perpendicular to each other. Figures are not drawn to scale.

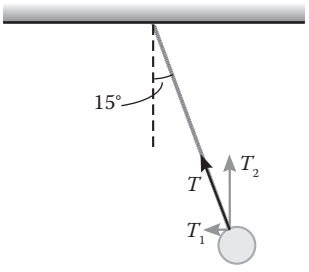
1.



F = _____

F_1 = _____

2.

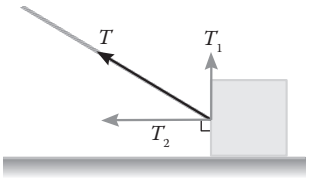


T_2 = 15 N

T = _____

T_1 = _____

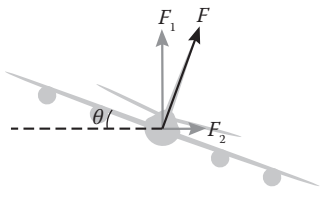
3. T_2 is $\sqrt{2}$N and is at 45° to the vertical.



T = _____

T_1 = _____

4.



Given F_1 = 8×10^6 N and θ = 30°.

F = _____

F_2 = _____

Ans: **(Ex 3) 1.** 10.3 N; 28.2 N **2.** 3.88 N; 14.5 N **3.** 56.6 N; 56.6 N **4.** 60 N; 53.1° **(Ex 4) 1.** 31.9 N; 10.9 N **2.** 15.5 N; 4.02 N **3.** 2 N; $\sqrt{2}$N **4.** 9.24×10^6 N; 4.62×10^6 N

A7. Sense of dependence

Exercise 1 (1.5 min)

State how the quantity will change while keeping others constant.

E.g. Given $F = ma$.

If $F \uparrow$ $\Rightarrow$ a? $\uparrow/\downarrow/$ ~~same~~

1. Given $v = u + at$. $(a > 0)$

If $v \downarrow$ $\Rightarrow$ t? _____

2. Given $R = \dfrac{u^2 \sin 2\theta}{g}$, where $0 \le \theta \le 90°$.

If $u \uparrow$ $\Rightarrow$ $\sin 2\theta$? _____

3. Given $\dfrac{1}{2}mv^2 = mgh$.

If $m \uparrow$ $\Rightarrow$ h? _____

4. Given $P = \dfrac{E}{t}$.

If $E \downarrow$ $\Rightarrow$ t? _____

5. Given $F = \dfrac{mv^2}{r}$.

If $v \uparrow$ $\Rightarrow$ F? _____

6. Given $\dfrac{mgh}{t} = P$.

If $g \downarrow$ $\Rightarrow$ h? _____

7. Given $F = \dfrac{m(v-u)}{t}$, where $0 \le u \le v$.

If $u \uparrow$ $\Rightarrow$ F? _____

8. Given $\dfrac{GMm}{r^2} = \dfrac{mv^2}{r}$.

If $r \downarrow$ $\Rightarrow$ v? _____

9. Given $H = \dfrac{u^2 \sin^2 \theta}{2g}$.

If $u \downarrow$ $\Rightarrow$ g? _____

Exercise 2 (1.5 min)

State how the quantity will change while others keeping constant.

E.g. Given $F = ma$.

If $F \to 2F$ $\Rightarrow$ $a \to$? 2a

1. Given $E_K = \dfrac{1}{2}mv^2$.

If $v \to \dfrac{1}{2}v$ $\Rightarrow$ $E_K \to$? _____

2. Given $F = mr\omega^2$.

If $r \to 4r$ $\Rightarrow$ $\omega \to$? _____

3. Given $v^2 - u^2 = 2as$.

If $a \to 0.2a$ $\Rightarrow$ $s \to$? _____

4. Given $v = \sqrt{2gh}$.

If $h \to 3h$ $\Rightarrow$ $v \to$? _____

5. Given $g \tan\theta = \dfrac{v^2}{r}$.

If $g \to 0.5g$ $\Rightarrow$ $r \to$? _____

6. Given $mu_1 + mu_2 = 2mv$.

If $m \to 10m$ $\Rightarrow$ $v \to$? _____

7. Given $\dfrac{1}{2}mv^2 = fs$.

If $v \to 4v$ $\Rightarrow$ $s \to$? _____

8. Given $\dfrac{GM}{r^2} = \dfrac{v^2}{r}$.

If $v \to 0.1v$ $\Rightarrow$ $r \to$? _____

9. Given $T = \dfrac{2u \sin\theta}{g}$.

If $g \to \dfrac{1}{6}g$ $\Rightarrow$ $T \to$? _____

Ans: **(Ex 1) 1.** ↓ **2.** ↓ **3.** same **4.** ↓ **5.** ↑ **6.** ↑ **7.** ↓ **8.** ↑ **9.** ↓ **(Ex 2) 1.** $E_K/4$ **2.** $\omega/2$ **3.** $5s$ **4.** $\sqrt{3}v$ **5.** $2r$ **6.** v **7.** $16s$ **8.** $100r$ **9.** $6T$