Unit 2 Physics 2015 — Motion Test

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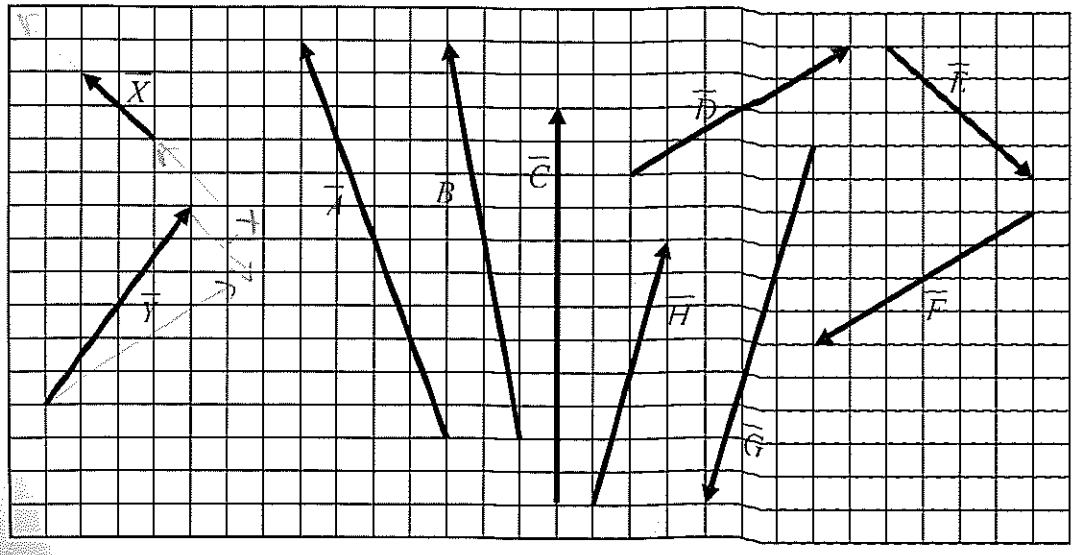
(60 mins)

Name SOLUTIONS

On the grid below two displacement vectors, $\overline{X}$ and $\overline{Y}$, are drawn to scale, along with a sample of other vectors.



Question 1

Which vector best represents $3\overline{X} + \overline{Y}$?

$\overline{B}$

(1)

Question 2

Which vector best represents $\overline{Y} - \overline{X}$?

$\overline{D}$

(1)

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3 Convert 60 km h^{-1} into metres per second. (1)

A 1.7 m s^{-1}

B 17 m s^{-1}

C 216 m s^{-1}

D 21.6 m s^{-1}

$\frac{60 \times 1000}{60 \times 60} = 16.7$

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4 A super bouncy ball hits a wall with a velocity of 7.0 m s^{-1} east and rebounds with a velocity of 6.0 m s^{-1} west. Determine the change in velocity of the ball. (1)

A 1 m s^{-1} west

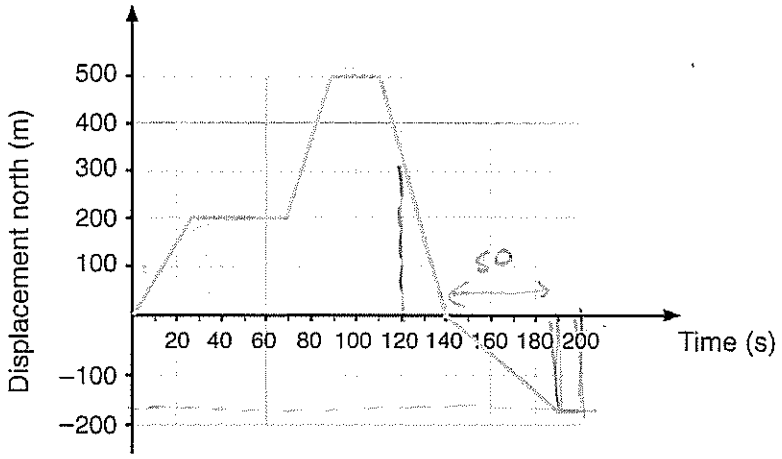
B 13 m s^{-1} east

C 13 m s^{-1} west

D 1 m s^{-1} east

7 → (v_i) ← v_f 6 west

The following information applies to questions 5–8. The graph shows the displacement of a farmer on a motorcycle, riding to and fro along a boundary of his property while counting livestock. He initially was travelling north.



5 How far did the farmer travel during the first minute? **(1)**

A 60 m

B 9000 m

C 200 m

D 6.7 m

6 At t = 120 s the farmer was: **(1)**

A stationary.

B heading south with a speed of 17 m s^{-1}.

C decelerating.

D heading north with a speed of 17 m s^{-1}.

7 What was the total distance was travelled by the farmer over the entire period? **(1)**

A 500 m

B 300 m

C 700 m

D 1200 m

500 + 500 + 180.

180 .

X

8 What was the average velocity of the farmer during the last 60 seconds of his journey? (1)

A -3.3 m s^{-1}

B -4.0 m s^{-1}

C 0 m s^{-1}

D -18 m s^{-1}

average velocity = $\frac{\Delta x}{t}$

$= \frac{180}{60} = -3 \text{ m/s}$

X

9 A car reached a speed of 72 km h^{-1}, from rest, in a time interval of 5.0 seconds.

a What was the average acceleration of the car in m s^{-2}? (2)

$\vec{a} = \frac{\Delta \vec{v}}{t} = \frac{72 \times 1000}{60 \times 60 \times 5} = \frac{20}{5} = 4 m/s^2$

b) How far did the car travel in this time? $\Rightarrow x = \frac{1}{2} \times 4 \times 5^2$

$= 50 m$.

c) **b** The car then maintained this speed for 15 seconds. How far is it from its starting position now? (3)

$u = 0$
$v = ?$
$a = 4$
$t = 5$

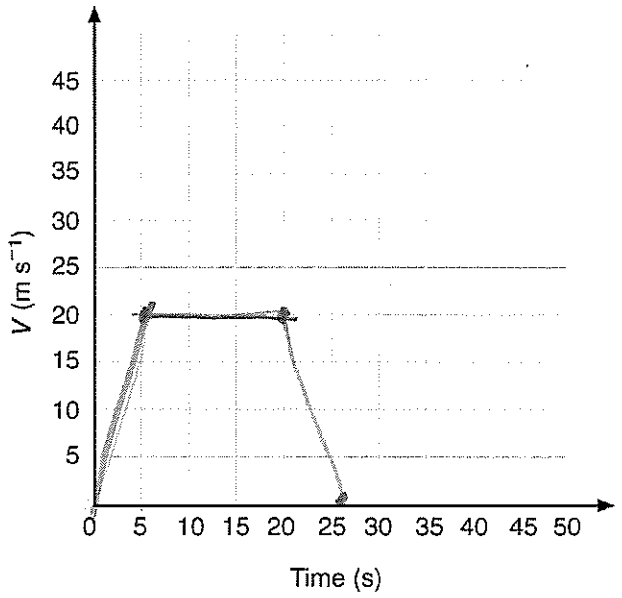
$4 = \frac{v}{5}$

$v = 20 m/s$

$50 + 15 \times 20 = 50 + 300$

$= 350 m$

d) **c** The car now decelerates uniformly at a rate of 4.0 m s^{-2}, until it comes to a stop. On the axes provided, draw the velocity–time graph for the car's *entire* journey. (3)



e) **d** What was the average velocity of the car during the entire journey? (2)

average velocity = $\frac{\text{displacement}}{\text{time}}$

$= \frac{350 + 50}{25}$

$= 16 m/s$.

Question 10 (2)

In a road test, a car was uniformly accelerated from rest over a distance of 400 m in 19.0 s. The driver then applied the brakes, stopping the car in 5.1 s with constant deceleration.

Calculate the acceleration of the car for the first 400 m.

$u = 0$
$x = 400$
$t = 19$

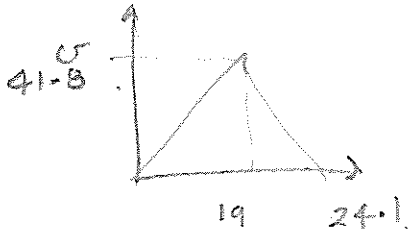
$x = ut + \frac{1}{2}at^2$

$400 = \frac{1}{2} \times a \times 19^2$

$a = 2.2 \text{ m/s}^2$

Question 11 (3)

Calculate the average speed of the car for the entire journey, covering both the acceleration and braking sections. (Hint consider the velocity-time graph)



$\bar{a} = \frac{V}{19}$

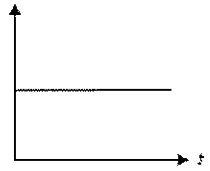
$V = 2.2 \times 19 = 41.8 \text{ m/s}$

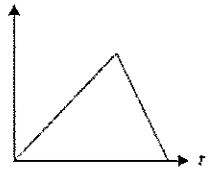
$d = 400 \text{ m} + \frac{1}{2} \times (24.1 - 19) \times 41.8$

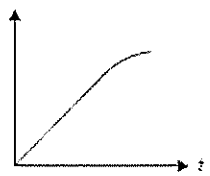
$= 400 + 106.6 \approx 506.6$

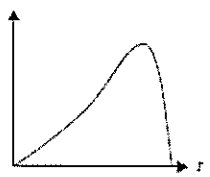
$s = \frac{d}{t} = \frac{506.6}{24.1} \approx 21.0 \text{ m/s}$

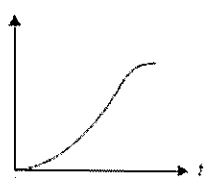
The graphs (**A – F**) in the key below should be used when answering the two questions below. The horizontal axis represents time and the vertical axis could be velocity or distance.

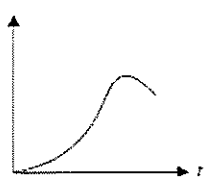
A.


B.


C.


D.


E.


F.


Question 12 (1)

Which of the graphs (**A – F**) best represents the velocity–time graph of the car for the entire journey?

B

Question 13 (1)

Which of the graphs (**A – F**) best represents the distance–time graph of the car for the entire journey?

E

A stone dropped from rest down a mine shaft takes 3 seconds to reach the bottom. Neglect air resistance when determining the answers to questions **14 & 15. SHOW YOUR WORKING FOR 2 MARKS**

Use $g = 10\ m/s^2$

Question 14 **(2)**

What is the depth of the mine shaft?

a) 90 m **b)** 45 m **c)** 30 m **d)** 15 m

$a = 10\ m/s^2 \downarrow$ — $u = 0$, $t = 3$

$x = ut + \frac{1}{2}at^2$

$= \frac{1}{2} \times 10 \times 9 = 45\ m$

Question 15 **(2)**

What is the magnitude of the velocity of the stone at the instant before striking the bottom?

a) 90 m/s **b)** 45 m/s **c)** 30 m/s **d)** 15 m/s

$v^2 = u^2 + 2ax$

$v^2 = 2 \times 10 \times 45$ $\quad v = 30\ m/s$

Use the following information to answer questions **16 to 20.** A ball is thrown vertically upwards, so that it reaches a maximum height of 20 m. It is caught at the same point that it was thrown from. Use g = 10 m/s^2 down. **SHOW YOUR WORKING FOR 2 MARKS**

Question 16 **(2)**

The initial upward velocity of the ball was

a) 40 m/s **b)** 20 m/s **c)** 10 m/s **d)** 5 m/s

$g = -10\ m/s^2$ ↓ $v = 0$, $x = 20\ m$ ↑, $u =$?

$v^2 = u^2 + 2ax$

$0 = u^2 + 2(-10) \times 20$

$u^2 = 400$ $\quad u = 20\ m/s$ ↑

Question 17 **(2)**

The time it takes to reach the maximum height is

a) 1.0 s **b)** 2.0 s **c)** 3.0 s **d)** 4.0 s

$v = u + at$

$0 = 20 - 10t$

$t = 2s$

Question 18 (2) (1)

The total time of flight was

a) 2.0 s **b)** 4.0 s **c)** 6.0 s **d)** 8.0 s

Question 19 (1) (2)

The speed of the ball when it was caught (at the same point of projection) was

a) 40 m/s **b)** 20 m/s **c)** 10 m/s **d)** 5 m/s

$u = 0$

$+10\downarrow$

$\Delta x = 20\,m$

$v = ? \downarrow$

$v^2 = u^2 + 2ax$

$v^2 = 2 \times (+10) \times 20$

$v = 20\,m/s$

Question 20 (1)

At the top of the flight, the acceleration of the ball was

a) 10 m/s^2 up **b)** 10 m/s^2 down **c)** 0 m/s^2 **d)** impossible to determine.

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21. A truck travelling at a constant speed of 15.0 ms^{-1} passes a stationary car. The car starts to move just as the truck passes, accelerating at 2.50 ms^{-2}.

a. When does the car reach the same speed as the truck?

$u = 0$

$a = 2.5$

$v = 15$

$t = ?$

$2.5 = \frac{15}{t}$

$t = \frac{15}{2.5} = 6\,s$

(2 marks)

b. How long does the car take to catch the truck?

$\vec{x}$ must be the same

$15 \times t = \frac{1}{2} \times 2.5\, t^2$

$t = \frac{30}{2.5} = 12\,s$

(3 marks)

c. What distance does the car travel before it catches the truck?

$\vec{x} = 15 \times 12 = 180\,m$

(2 marks)
