SHENTON COLLEGE

11 PHYSICS A1/A2 Motion and Forces Test 1

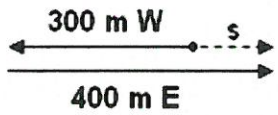
Name

/48 = %

48 marks for working + 2 mark for correct units and significant figures

1. A student was answering a question. *An elephant walks 300 m West then 400 m East, what was the displacement of the elephant?* The student gave the answer as 100 m. Was he correct? Explain? (2 marks)

Numerically the answer is correct but as displacement is required then a direction should be given.



Therefore numerically the answer is 100 m but the direction is east. [1 mark]

s = 100 m East [1 mark]

2. Cheetahs, the fastest land animal, can reach speeds of over 100 kmh^{-1} for short distances. A cheetah, travelling at 9.00 ms^{-1}, sees a zebra in front of it and reaches a velocity of 25.0 ms^{-1} to catch its prey. What was the cheetah's acceleration during this time if the chase took 3.00 s. (3 marks)

u = 9.00 ms^{-1}

v = 25.0 ms^{-1}

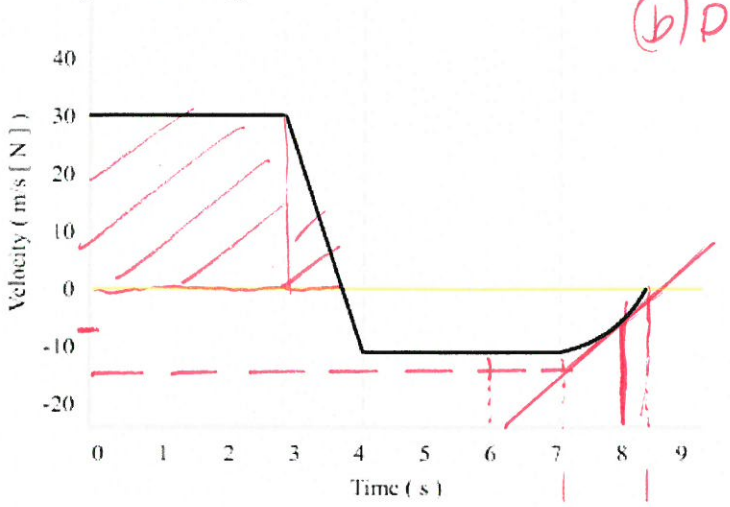
t = 3.00 s

$$a = \frac{v - u}{t} = \frac{25 - 9}{3} = \frac{16}{3}$$ **[2 mark]**

a = 5.33 ms^{-2} [1 mark]

3. For the graph below, calculate:
   a. acceleration between 3 and 4 seconds (1)
   b. displacement for the first 3.75 seconds (3)
   c. acceleration at 8 seconds (2)

Show your working. (6 marks)



(a) Grad = a = $\frac{-40}{1}$

= $-40\ ms^{-2}$ (ie S)

(b) DISP = Area

= $(30 \times 3) + (\frac{1}{2} \times 0.75 \times 30)$

= $90 + (\frac{90}{240} \times 30)$ = $90 + 11.25$

= 101.25m (N)

(c) Approx. Grad = $\frac{(-7 - (-15))}{1}$

= $8\ ms^{-2}$ (N)

4. John is running around a 400m circular track at a constant speed. He takes 4.00 minutes to cover 8.00 x 10^2 m and returns to the start.

a. What was his speed? (2 marks)

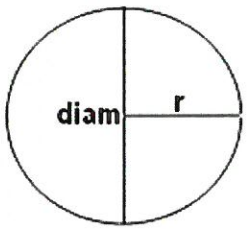
dist = 800 m

t = 4 x 60
= 240 s

$$\text{speed} = \frac{\text{dist}}{t} = \frac{800}{240}$$ [1 mark]

speed = 3.33 ms^{-1} [1 mark]

b. What was his velocity half way around the track (assume it took 1.5 minutes)? (3 mark)



circum = πd

400 = πd
d = 127.3 m
[1 mark]

t = 1.5 x 60
= 90 s

$$v = \frac{s}{t} = \frac{127.3}{90}$$ [1 mark]

v = 1.41 ms^{-1}
[1 mark]

5. Explain why a motorbike, travelling around a corner at a constant speed, is accelerating. (2 marks)

Speed is a scalar quantity so has a magnitude but no direction.

Velocity is a vector quantity so needs a magnitude and a direction. [1 mark]

If in velocity, the direction changes then so does the velocity even if the magnitude is the same. [½ mark]

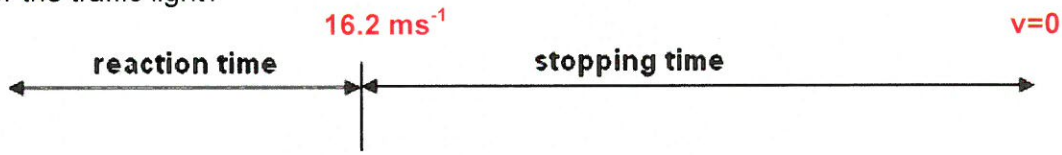
Now acceleration is change in velocity over time so if the direction changes, the velocity changes and the motorbike is accelerating. [½ mark]

6. A speedboat is travelling down a straight river at 14.8 ms^{-1}. The speedboat then accelerates at 1.60 ms^{-2} for 4.50 s. How far did the speedboat travel during this time? (2 marks)

u = 14.8 ms^{-1}
a = 1.60 ms^{-2}
t = 4.50 s

$s = ut + \frac{1}{2}at^2$
$s = (14.8 \times 4.50) + (0.5 \times 1.6 \times 4.5^2)$ [1 mark]
$s = 66.6 + 16.2$
s = 82.8 m [1 mark]

7. Victoria sees a traffic light turn orange when she is 25.0 m from it. She has a reaction time of 0.300 s and is travelling at 16.2 ms^{-1}. If the car can decelerate at 7.60 ms^{-2}, will she stop in time for the traffic light? (4 marks)



t = 0.300 s
u = 16.2 ms^{-1}

s = ut
= 16.2 x 0.30
= 4.86 m

[1 mark]

displacement in which to stop = 25 – 4.86 = 20.14 m
need to find actual displacement
u = 16.2 ms^{-1}
v = 0 ms^{-1}
a = -7.60 ms^{-2}

$v^2 = u^2 + 2as$
$0 = 16.2^2 + (2 \times -7.6 \times s)$ [1 mark]
$0 = 262.44 - 14s$

$$s = \frac{262.44}{14}$$

s = 17.26 m [1 mark]

as she has 20.14 m in which to stop and can stop in 17.26 m then she will stop in time.
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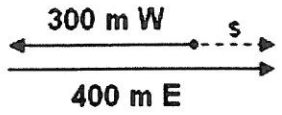

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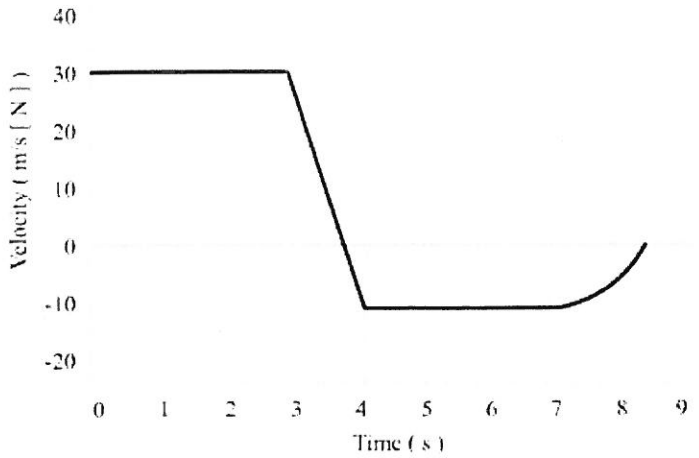

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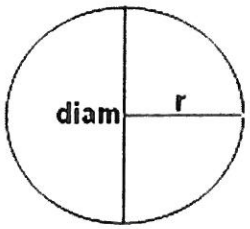

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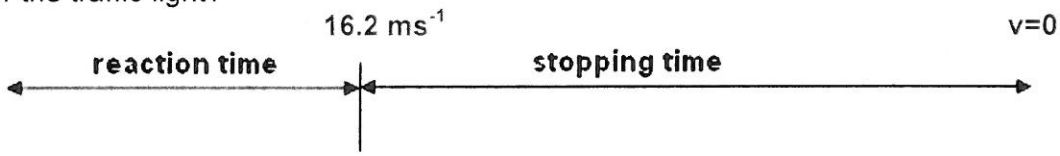

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8. While working on a demolition job, a workman throws a tile down to the ground below with an initial velocity of 1.90 ms^{-1}. What was the tile's velocity if it hit the ground 2.58 s after being released? (3 marks)

$u = 1.9\ ms^{-1}$
$g = 9.8\ ms^{-2}$
$t = 2.58\ s$

$v = u + at$
$= 1.9 + (9.8 \times 2.58)$ [2 mark]
$= 1.9 + 25.284$
$= 27.184$

$v = 27.2\ ms^{-1}$ [1 mark]

OR

$s = ut + \frac{1}{2}at$
$= 37.518\ m$

$v^2 = u^2 + 2gs$
$= 27.2\ ms^{-1}$

9. You are in a helicopter which is ascending at 2.90 ms^{-1} when you look out of the door and your sunglasses fall off. Assuming no air resistance, how long before the sunglasses hit the ground if they fell out when your head was 255 m above the ground? (3 marks)

up is positive
$u = +2.90\ ms^{-1}$
$s = -255\ m$

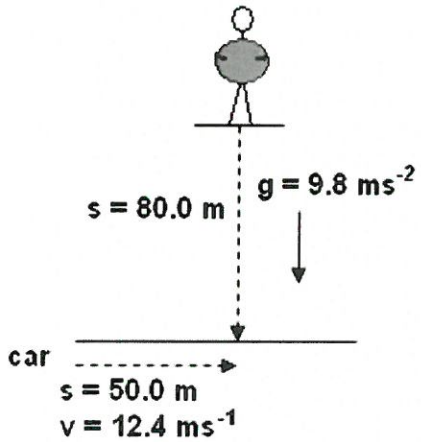
$v^2 = u^2 + 2gs$
$= 2.9^2 + (2 \times -9.8 \times -255)$
$= 8.41 + 4998$
$= 5006.41$
$v = 70.756\ ms^{-1}$ down [2 marks]

$$t = \frac{v - u}{t} = \frac{-70.756 - 2.9}{-9.8} = \frac{73.656}{9.8}$$

$t = 7.52\ s$

[1 mark]

10. In a cartoon, the white spy is trying to escape the black spy. The white spy is on a ledge 80.0 m directly above a road when he sees the black spy in a car travelling towards him at a constant velocity of 12.4 ms^{-1}. The white spy drops a large rock off the ledge when the black spy is 50.0 m from the point on the road directly below the ledge. Does the white spy stop the black spy and therefore get away? Show all working to justify your answer. (4 marks)



Car

$t = \frac{s}{v} = \frac{50}{12.4}$

$t = 4.03\ s$
[1 mark]

Rock

$s = ut + \frac{1}{2}gt^2$ OR $v^2 = u^2 + 2as$

$80 = 0 + (0.5 \times 9.8 \times t^2)$ $v = 39.598\ ms^{-1}$
$80 = 4.9t^2$
$t = \sqrt{(80 \div 4.9)}$ $t = 4.04\ s$
$= 4.04\ s$
[1 mark]

As times so close, the rock does land on the black spy's car and stops him allowing white spy to escape.
[1 mark]

OR $s = vt$
$= 12.4 \times 4.04 = 50.096 \sim 50\ m$

11. A car is travelling on the highway at a constant speed of 24 ms^{-1} in an 80 $kmhr^{-1}$ zone as it passes a police car. The police officer accelerates from rest at 2.1 ms^{-2} at the exact moment that the speeding car passes him. How long will it take the police car to catch up to the speeder? Assume that the speeding car and the police car travel the same distance during this time. (4 marks)

12. Draw a displacement time graph below for the following situation.

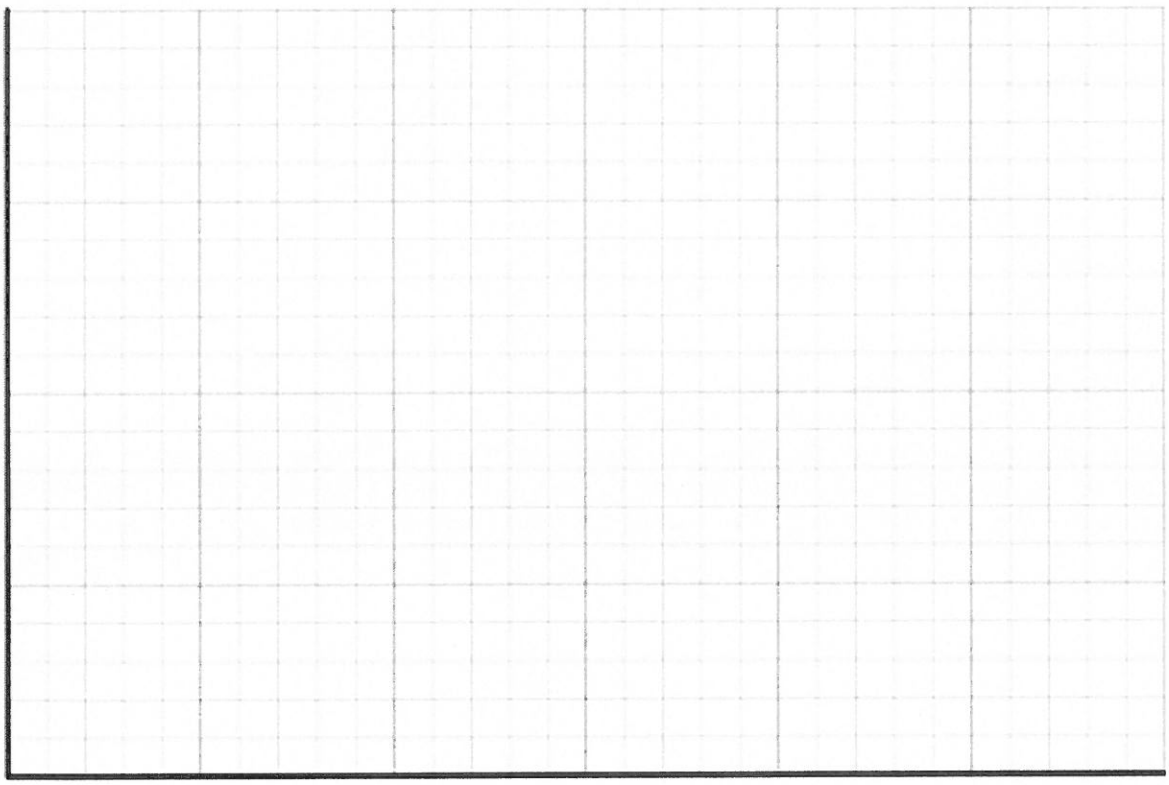
A car is stopped at a set of traffic lights. When the light turns green, it accelerates at a rate of 2.50 ms^{-2} for 6.00 seconds.

The driver then keeps the car at a constant speed for 5.00 seconds.

The driver then enters a new speed zone and accelerates again at a rate of 1.25 ms^{-2} for 4.00 seconds.

At that time the driver sees another traffic light in front of him and decelerates at a constant rate in 5.00 seconds

(10 marks)



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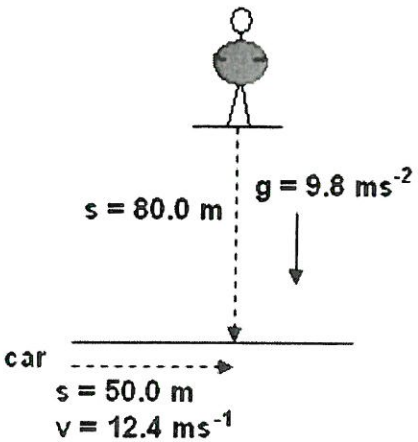

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S and t both constants.

$S_{CAR} = v \times t = 24t = ut + \frac{1}{2}at^2$ (Police)

But $u = 0$

$\therefore 24t = \frac{1}{2} \times 2.1 \times t^2$

ie $24t = 1.05t^2$

ie $24 = 1.05t$

$\therefore t = \frac{24}{1.05}$

$= 22.86s$

$= 22.9s$

$= 23s$