Physics ATAR - Year 11

Motion and Forces
Test 1
2019

Name:	Mark: / 46 = %

Teacher (please circle)

PCW JRM

Time Allowed: 50 Minutes

Notes to Students:

1. You must include **all** working to be awarded full marks for a question.
2. Marks will be deducted for incorrect or absent units or direction and answers stated to an incorrect number of significant figures.
3. **No** graphics calculators are permitted – scientific calculators only.

Question 1 **(7 marks)**

A gardener has adjusted a water hose nozzle for a hard stream of water. She points the nozzle vertically upwards at a height of 1.70 m above the ground. When the nozzle is quickly moved off the vertical, the water is observed to remain striking the ground next to her for 2.30 s.

(a) Calculate the speed that the water leaves the nozzle. (3 marks)

$s = ut + \frac{1}{2}at^2 + s_i$ (1)

$-1.70 = u(2.30) + (1/2)(-9.8)(2.30)^2$ (1)

$24.2 = 2.30u$

$u = 10.5\ ms^{-1}$ (1)

if students use s = +1.70, u = 12.0 ms-1 (maximum 2 marks)

(b) Calculate the maximum height the water travels above the ground. (If you could not do (a), use u = 9.00 ms^{-1}.

(4 marks)

$v^2 = u^2 + 2as$ $s = \frac{v^2 - u^2}{2a}$ set v = 0 (1)

$= \frac{0 - (10.5^2)}{-19.6}$ (1)

= 5.63 + 1.70 (1)

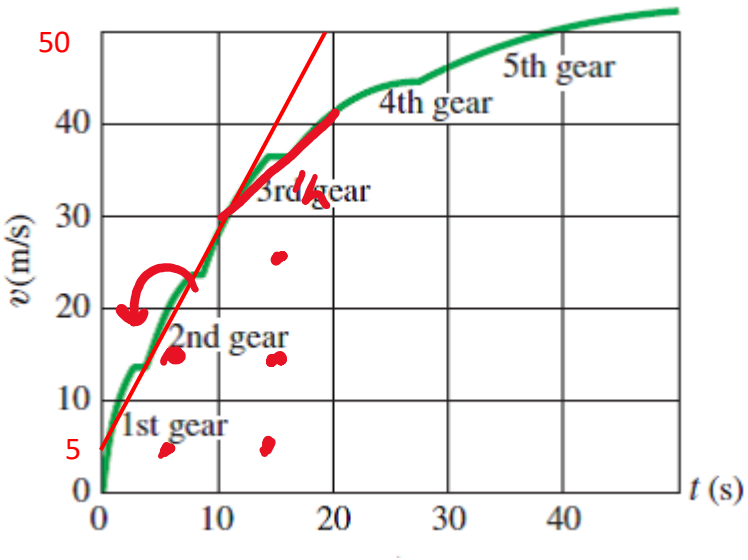
= 7.33 m (1)

With u = 9.00, s = 4.13 + 1.70

= 5.83 m

Question 2 **(5 marks)**

A car can accelerate as shown in the velocity time graph. The short flat spots represent the shifting of gears.



(a) Estimate the average acceleration of the car whilst it is in 3rd gear. Include your working on the graph and express your answer to 2 significant figures.

(3 marks)

1 mark for appropriate tangent line.

Gradient = $\frac{\text{rise}}{\text{Run}} = \frac{50 - 5}{18 - 0}$ (1)

= ~2.5 ms^{-2} (1)

(b) Estimate the distance travelled in the first 20 seconds.

(2 marks)

~ 5.5 squares @ 10x10 = 100 m per square (1)

= 550 m (1)

If students use triangle approximation or $v_{ave} = v + u / 2$ maximum 1 mark

Question 3 **(6 marks)**

A sprinter accelerates from rest to 9.00 m/s in 2.25 seconds. Calculate her average acceleration in m/s^2 and km/h^2

$a = \frac{v-u}{t}$ (1)

$= \frac{9-0}{2.25}$ (1)

= 4.00 s (3.s.f) (1)

Conversion $4.00 \ \frac{m \rightarrow km \quad \div 1000}{s^2 \rightarrow hr^2 \quad (60 \times 60)^2}$ (1)

4.00 x 12960 (1)

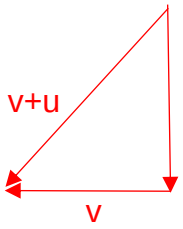
= 51840

= 51800 $km.h^{-2}$ (1)

Question 4 **(4 marks)**

A car travelling 5.00 ms^{-1} South turns at a constant rate, changing its velocity to 7.50 ms^{-1} West. Calculate the average velocity of the car during this period of change.

$V_{ave} = \frac{\bar{v}+\bar{u}}{2}$ (1)



(diagram not necessary for marks)

$v + u = \sqrt{5^2 + 7.50^2}$

= 9.01 (1)

$\theta = \tan^{-1}(7.50/5)$ (1)

= 56.3

V_{ave} = 4.51 ms^{-1} S 56.3° W (1)

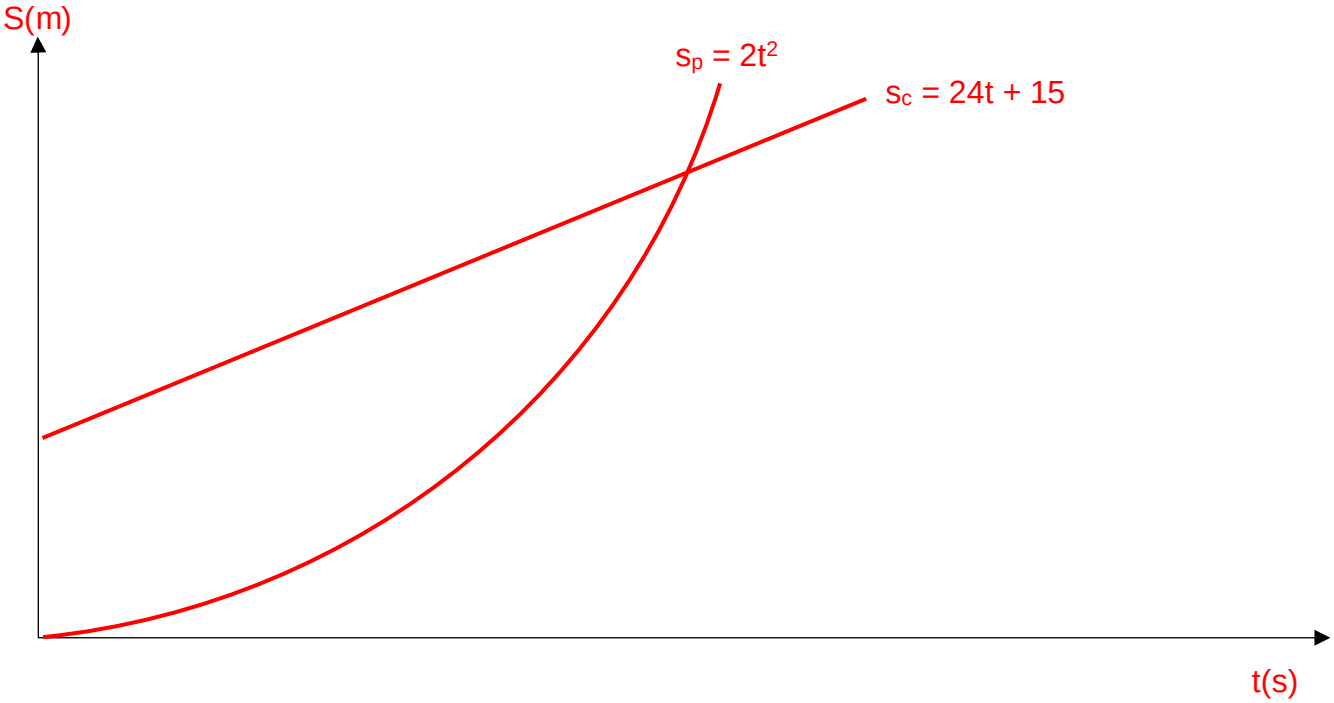
(If student calculates Δv , maximum 2 marks)

Question 5 **(6 marks)**

A car speeding at 24.0 m/s passes by a stationary police car. The police car starts accelerating at a constant rate of 4.00 m/s/s when the car is 15.0 m past it and continues accelerating at this rate until it catches the speeding car.

(a) Sketch a position-time graph of the pursuit from start to finish.

(2 marks)



(b) Calculate the time taken for the police car to catch the speeding car.

(4 marks)

$s_c = 24t + 15$ (1) stating s terms

$s_p = 2t^2$ $s_p = s_t$

$2t^2 = 24t + 15$

$0 = -2t^2 + 24t + 15$ (1) equating and setting up quadratic

(a) (b) (c)

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ (1) using quadratic solution

$$= \frac{-24 \pm \sqrt{24^2 - 4(-2)15}}{2(-2)}$$

$$= \frac{-24 \pm 26.4}{-4}$$

= - 0.500 or 12.6 s (1) answer

disregard

Question 6 **(6 marks)**

A boy drops a rock down a deep abandoned mine shaft and listens for the sound (of the rock striking the ground) to return to him. He knows that the speed of sound is constant 340 m/s and that this mine shaft has a depth of 145 m.

(a) Using the terms s, t_{up}, t_{down}, t_{total}, v_{air} and g, write a general equation for the time taken for the rock to accelerate to the bottom of the mine shaft and the sound to return to the surface. Ignore air resistance.

(3 marks)

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

$t_{down} = \sqrt{\frac{2s}{g}}$ $t_{up} = \frac{s}{v}$ (1)

$t_{total} = t_{down} + t_{up}$ (1)

$= \sqrt{\frac{2s}{g}} + \frac{s}{v}$ (1)

* must use all terms provided for full marks

(b) Using the equation above, calculate the time taken from dropping the rock to the sound of rock striking the ground to the return to the boy. Hint: consider the **distance** travelled, not total displacement.

(3 marks)

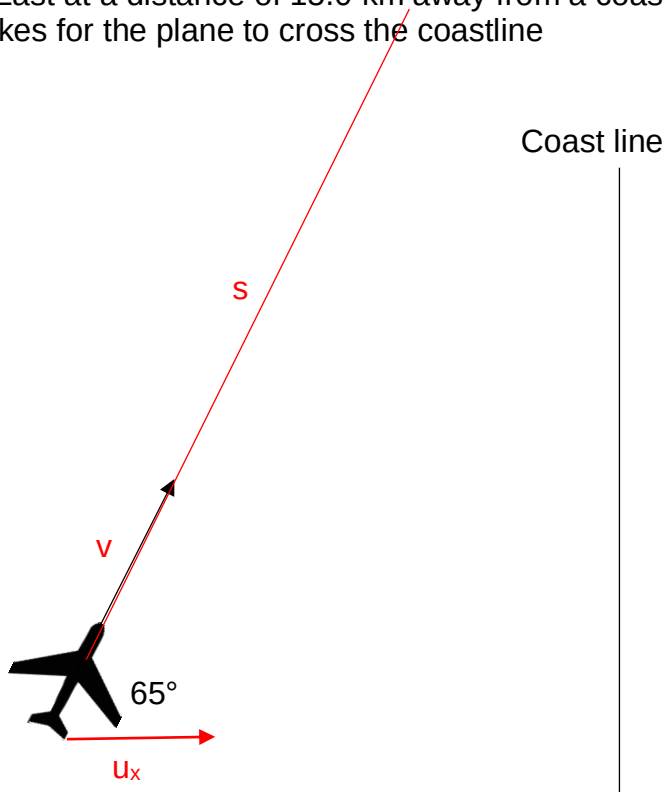
$t_{total} = \sqrt{\frac{2s}{g}} + \frac{s}{v}$ (1)

$= \sqrt{\frac{2(-145)}{-9.80}} + \frac{145}{340}$ (1)

$= 5.87$ s (1)

Question 7 **(4 marks)**

A plane is travelling at 125 ms^{-1} North 25.0° East at a distance of 15.0 km away from a coastline that runs north-south. Calculate the time it takes for the plane to cross the coastline



ux = u cos65 = u sin25 (1/2)

= 125 cos 65 (1/2)

= 52.8 ms^{-1} (1)

t = $\frac{s}{v}$ (1/2)

= $\frac{15 \times 1000}{52.8}$ (1/2)

= 284 s (1)

(or 4.73 minutes)

OR s = 15x1000 / cos65 (1)

= 35493 (1)

t = $\frac{s}{v}$ (1/2)

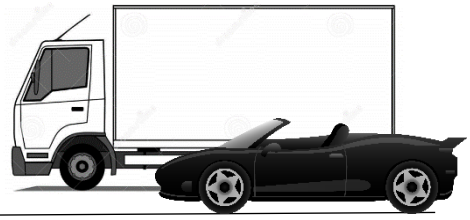
= $\frac{35493}{125}$ (1)

= 284 s (1/2)

(or 4.73 minutes)

Question 8 **(8 marks)**

A runner is running 3.20 ms^{-1} South along a footpath towards a car travelling 14.5 ms^{-1} West and truck travelling 12.2 ms^{-1} West at a cross road.



a) Calculate the velocity of the truck relative to the car.

(2 marks)

$\underset{t\sim c}{v} = v_t - v_c$ Set west = + (1/2)

$= (+12.2) - (14.5)$ (1/2)

$= -2.3 = 2.3\ ms^{-1}$ East (1) Must convert to direction in final answer

b) Calculate the velocity of the car relative to the truck.

(2 marks)

$\underset{c\sim t}{v} = v_t - v_c$ Set west = + (1/2)

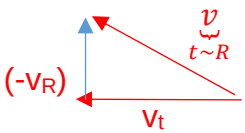
$= (+14.5) - (12.2)$ (1/2)

$= +2.3 = 2.3\ ms^{-1}$ West (1) Must convert to direction in final answer

c) Calculate the velocity of the truck relative to the runner.

(4 marks)

$\underset{t\sim R}{v} = v_t - v_R = v_t + (-v_R)$ (1)



$= \sqrt{3.2^2 + 12.2^2}$ (1/2)

$= 12.6 ms^{-1}$ (1/2)

$\theta = \tan^{-1}(3.2/12.2)$ (1/2)

$= 14.7$ (1/2)

$V = 12.6\ ms^{-1}$ W 14.7° N (1)

END OF TEST