Physics ATAR - Year 11

Linear Motion
Unit Test 1
2018

SOLUTIONS

Mark: / 32

= %

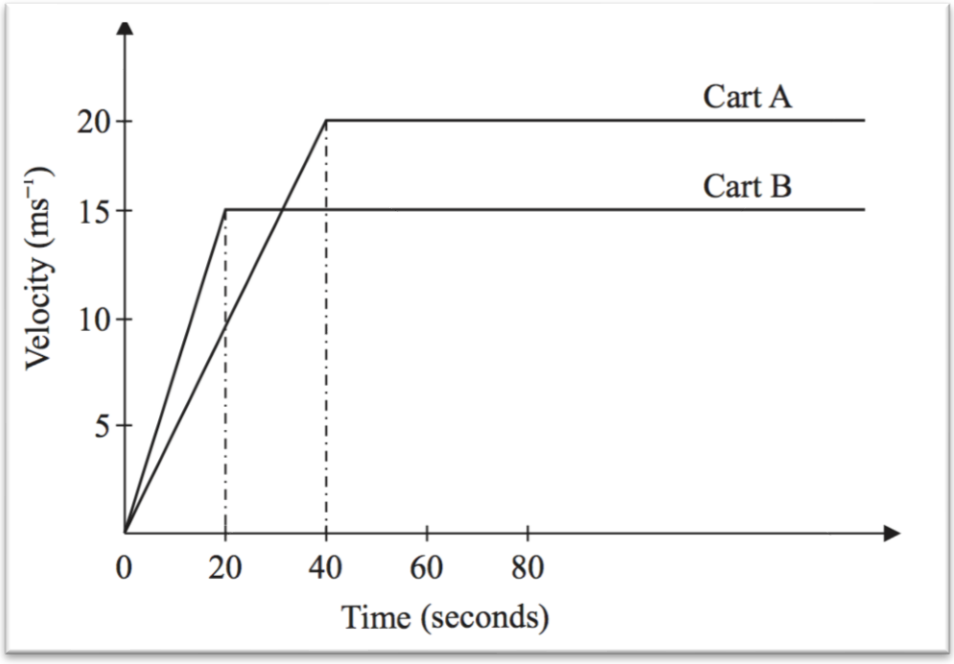
Time Allowed: 30 Minutes

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)**

Cart A and Cart B are in a race. Their V-T graphs are displayed to the right.



(b) Calculate the acceleration of Cart A in the first 40 seconds. Express your answer to 2 significant figures.

(2 marks)

$a = \frac{v-u}{t}$ ½

$= \frac{20-0}{40}$ ½

= 0.50 ms^{-2} 1

(b) Calculate the distance Cart B travels in the first 40 seconds. Express your answer to 2 significant figures.

(2 marks)

Cart B = area under graph

= ½(20 x 15) + 15 x (40-20) 1

= 150 + 300 = 450 m 1

(c) Cart B completes the 0.750 km race in a time of 60 seconds, determine through appropriate calculations which cart wins the race.

(3 marks)

Area Cart A = 750 = ½ (40 x 20) + 20 x (t - 40)

750 = 400 + 20 (t – 40) 1

t – 40 = 17.5

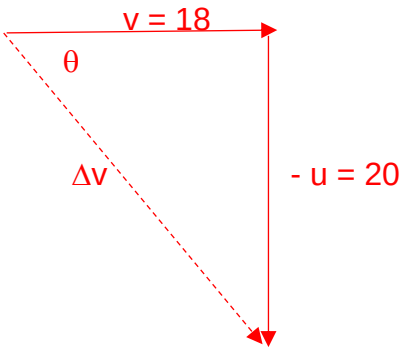
t = 57.5 seconds 1 Cart A wins the race. 1

Question 2 **(7 marks)**

A plane initially travelling 20.0 ms^{-1} North changes its velocity to 18.0 ms^{-1} East in a time of 15.0 seconds.

(a) Calculate the change in velocity of the plane, including a vector diagram to support your answer.

(4 marks)



1 mark for complete labelled diagram

$\Delta v = \sqrt{18^2 + 20^2}$ ½

$= 26.9\ ms^{-1}$ ½

$\theta = \tan^{-1}\left(\frac{20}{18}\right)$ ½

$= 48.0\ °$ ½

$\Delta v = 26.9\ ms^{-1}$ S 42.0° E 1

(b) Calculate the average acceleration of the plane during its turn. If you could not complete (a), use $\Delta v = 22.0\ ms^{-1}$ South East.

(3 marks)

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

$= \frac{26.9}{15}$ 1

$= 1.79\ ms^{-2}$ S 42.0° E 1

Question 3 **(9 marks)**

A student throws a rock vertically upwards. It leaves his hand at a height of 1.60 m above the ground. A second student on a balcony 4.40 m above the ground sees the rock continuing past him upwards with a speed of 4.00 ms^{-1}.

(a) Calculate the speed of the rock when it was initially thrown.

(3 marks)

$v^2 = u^2 + 2as$ 1

$4^2 = u^2 + (2)(-9.8)(4.4-1.6)$ (set s = 2.8) 1

$u^2 = 70.9$

$u = 8.42\ ms^{-1}$ 1

(b) Calculate the maximum height above the second student on the balcony that the rock reaches.

(3 marks)

Set v = 0

$v^2 = u^2 + 2as$

$0 = 8.42^2 + 2(-9.8)\ s$

$\Delta s = \frac{8.42^2}{19.6}$

$= 3.62\ m + 1.60 = 5.22$

OR

$v^2 = u^2 + 2as$ 1

$0 = 4^2 + 2(-9.8)\ s$ 1

$\Delta s = \frac{4^2}{19.6}$

$= 0.816\ m$ (3.s.f) 1

Therefore, height above 4.40m student is 5.22 – 4.40 = 0.82m (2 d.p)

The rock is then allowed to fall back down past both students.

(c) Calculate the velocity of the rock as it strikes the ground.

(3 marks)

$v^2 = u^2 + 2as$

$= 8.42^2 + 2(-9.8)(-1.6)$

$= 102.2$

$v = \pm 10.1\ ms^{-1}$

$= 10.1\ ms^{-1}$ down

OR

$= 0^2 + 2(-9.8)(-5.21)$

$= 102.2$

$v = \pm 10.1\ ms^{-1}$

$= 10.1\ ms^{-1}$ down

OR

$= 4^2 + 2(-9.8)(-4.4)$ 1

$= 102.2$ 1

$v = \pm 10.1\ ms^{-1}$

$= 10.1\ ms^{-1}$ down 1

Question 4 **(3 marks)**

It is always said that cats land on their feet. A cat is perched on top of a 1.83 m fence when it falls off. Calculate the time the cat has to arrange its feet correctly before hitting the ground.

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

$= \frac{1}{2} at^2$

$t = \sqrt{\frac{2s}{a}}$

$= \sqrt{\frac{2(-1.83)}{-9.8}}$ (1)

$= 0.611$ s (1)

Question 5 **(6 marks)**

A ball approaches an inclined ramp with a speed of 2.30 ms^{-1}. It is seen to travel 1.55 m up the ramp before coming to rest.

(a) Assuming a constant acceleration, calculate the time taken to come to rest. (3 marks)

$s = v_{ave}\, t$

$s = \frac{v+u}{2} . t$ (1)

$1.55 = \frac{0+2.30}{2} . t$ (1)

$t = 1.35$ s (1)

Note: If student uses acceleration from (b) to answer (a), maximum 2 marks

(b) Calculate the acceleration of the ball as it is on the ramp. (3 marks)

$v^2 = u^2 + 2as$ (1)

$a = \frac{v^2 - u^2}{2s}$

$= \frac{0^2 - (2.30^2)}{2(1.55)}$ (1)

$= 1.71\ ms^{-2}$ down the incline. (1)