BELMONT CITY COLLEGE

PHSICS 2AB PHYSICS TEST – 2013

MOVEMENT 1

Student Name: ANSWERS

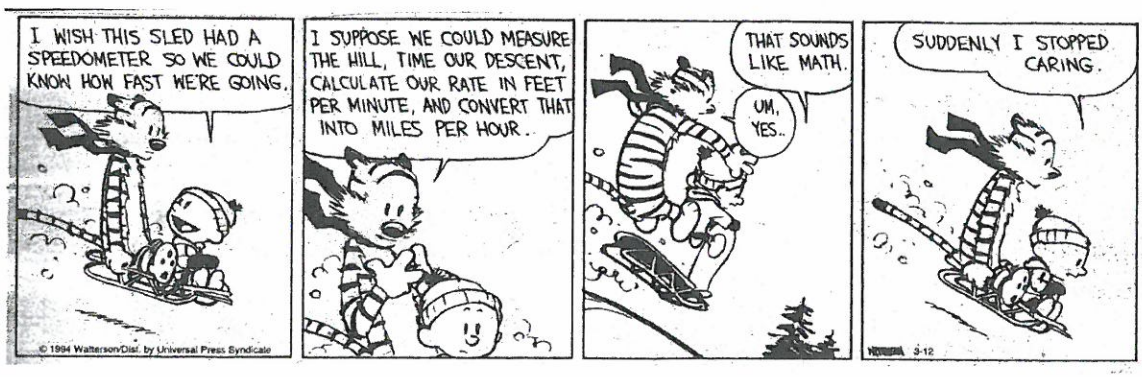
40

TIME: 1 Hour

* A data sheet is supplied for student use

NOTE:

1. Calculations must show clear working with answers written in scientific notation stated to **three significant figures unless you are answering a question specifically asking you how many significant figures are technically required**
2. Full Marks will be allocated for clear and logical setting out.
3. To help identify your answer, underline each answer.
4. State **assumptions** if working on open ended type questions.
5. Not all questions carry equal number of marks



Q1. Listed below are physical quantities in scalar and vector columns. **Circle** the **incorrect** quantities from the two columns below

[3 marks]

Scalar	Vector
displacement	mass
speed	force
velocity	temperature
distance	acceleration
deceleration	energy

Convert the given numbers into scientific notation and express your answer correct to 4 significant figures.

a. 1 007 421 = 1.007×10^{6}

b. 0.0061856 = 6.186×10^{-3} [2 marks]

Q2. One of the most famous physics equations is $E = m c^2$ where m is the mass of the material in kg, c is the speed of light which is 300 000 000.0 metres per second and E is the energy produced in joules. If 0.00053 g of mass is theoretically converted into energy using the above formula, convert the given numbers into scientific notation and calculate the theoretical amount of energy in joules released. Round your answer to the technically correct number of significant figures. [3 marks]

$c = 3 \times 10^{8}$ m/s

$m = 5.3 \times 10^{-4}$ g

$= 5.3 \times 10^{-7}$ kg

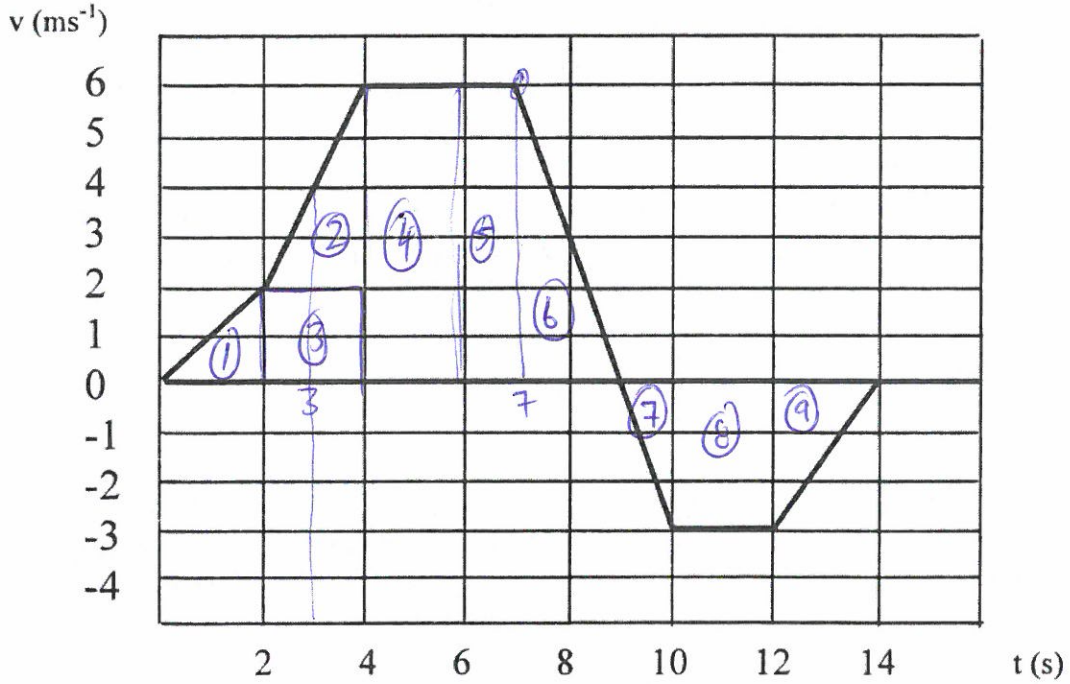
$E = mc^2$

$= 5.3 \times 10^{-7} \times (3 \times 10^{8})^2$

$= 5.3 \times 10^{-7} \times 9 \times 10^{16}$

$= 4.77 \times 10^{10}$ J

Q3. The velocity – time graph below shows the movement of a soccer (football) player moving in a straight line during part of a match. From the graph below:



(a) Calculate the acceleration between t = 2.00 s and t = 3.00 s [1 mark]

$a = \frac{\Delta v}{t} = \frac{4-2}{1} =$ 2 ms^{-2} (+ive / forward)

(b) Calculate the acceleration between t = 7.00 s and t = 10.0 s. [1 mark]

$a = \frac{v-v}{t} = \frac{-3-6}{3} = -\frac{9}{3} =$ −3 ms^{-2} (ie. negative)

(c) What distance does the soccer player cover in the first 6.00 seconds? [2 marks]

Area of graph is broken up into 4 sections. Each 'block' represents

$2 \times 1 = 2$ m.

$A_1 = 2$, $A_2 = 4$, $A_3 = 4$, $A_4 = 12$

TOTAL =

$12 + 4 + 4 + 2 =$

22 m (+ive, forward)

(d) What is the total displacement of the player between t = 0.00 s and t = 14.0 s? [2 marks]

$A_5 = 6$, $A_6 = 6$, $A_7 = -1.5$, $A_8 = -6$, $A_9 = -3$

Subtracting $A_{7,8,9}$ from $A_1 + \ldots + A_6$ gives:

$22 + 6 + 6 - 1.5 - 6 - 3 =$ 23.5 m (+ive)

Q4. The figure below shows a cricket ball as it comes into contact with a cricket bat.

+ve direction →

The cricket ball has a mass of 0.16 kg and it hits the bat with a speed of 25.0 m s^{-1}. After being in contact with the bat for 3.32 milliseconds (ms) the ball rebounds with a speed of 22.0 m s^{-1} in the direction exactly opposite to its original direction.

↑ -ve direction

(a) State the difference between speed and velocity [1 mark]

Velocity is a vector & includes a magnitude (measured in m/s) and a direction. Speed is a scalar quantity & has magnitude only.

(b) Calculate the change in velocity of the cricket ball. [2 mark]

$\Delta v = v - u$

$= -22 - (+25)$

$= -47 \text{ m s}^{-1}$

ie $\Delta v = 47 \text{ ms}^{-1}$ in opposite direction to initial velocity

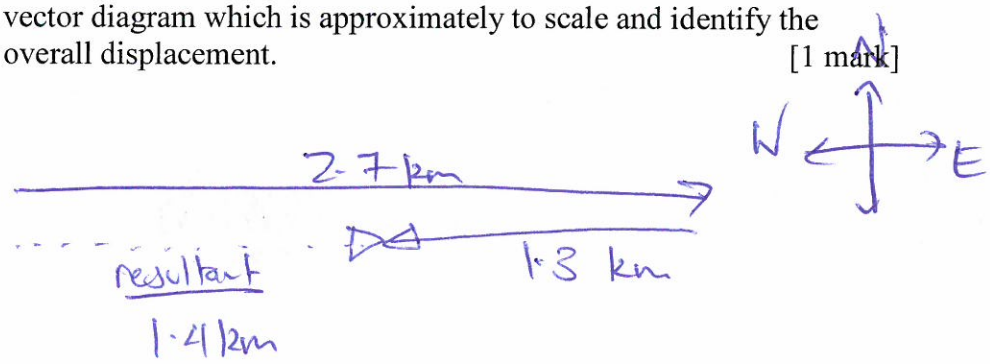
(c) The average acceleration of the ball whilst it is in contact with the bat. [2 marks]

$a = \frac{\Delta v}{t} = \frac{-47}{3.32 \times 10^{-3}} = 14156.6 \text{ ms}^{-2}$

$= 14200 \text{ ms}^{-2}$ (3 sig figs)

Q5. A motorcyclist visits his friend who lives 2.70 km East from his home. The motorcyclist drops in at the shops after travelling in a straight line 1.30 km back to his home from his friends house.

(a) Draw a neat labelled vector diagram which is approximately to scale and identify the motorcyclist's net or overall displacement. [1 mark]



(b) Calculate the motorcyclist's overall displacement from his home to the shops. Include this overall displacement value on your vector diagram above. [1 mark]

1.4 km E

Q6. Mei Lin rowed out from the shore in her dinghy at a constant acceleration of 0.131 m s^{-2}. What speed would she have reached travelling 45.1 m to her yacht anchored off shore? Neglect any friction. Show full working out. [3 marks]

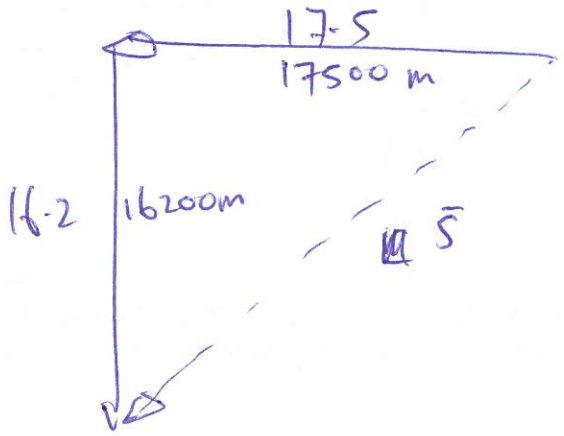
$u = 0$
$v = ?$
$a = 0.131\ ms^{-2}$
$s = 45.1\ m$
$t = X$

$v^2 = u^2 + 2as$
$= 0 + 2 \times 0.131 \times 45.1$
$= 11.8162$
$v = 3.43747\ ms^{-1}$
$= \underline{3.44\ ms^{-1}}$ (3 sig figs)

Q7. A car travels due west for 17.5 km and it then travels 16.2 km due south. The total journey takes 520 s.

(a) Complete a neatly labelled vector sketch of the car's displacement below.

Vector diagram [2 marks]



(b) Calculate the car's average speed for the journey. Show all working. [2 marks]

$s = \frac{\text{distance}}{\text{time}} = \frac{17500 + 16200}{520}$

$= 64.80769$ m/s

$= 64.8$ m/s.

(c) Determine the car's average velocity for the same journey. ~~Show all working.~~ [2 marks]

$\underline{S} = \sqrt{16200^2 + 17500^2}$

$= 23\,847.222$ m

$v = \frac{\underline{S}}{t} = \frac{23847.222}{520} = 45.8600$ m/s

$= 45.9$ m/s @ 42.8° South of west.

$\theta = \tan^{-1}\frac{16.2}{17.5} = 42.8°$

Q8. The table below shows the data from the department of transport on how the overall stopping distance for a car varies with the speed of the car. The overall stopping distance is the sum of the thinking distance and the braking distance.

Speed of car ($m\ s^{-1}$)	10	15	20	25	30
Thinking distance (m)	6	9		15	18
Braking distance (m)	8	18		50	72
Overall stopping distance (m)	14	27		65	90

(a) Explain briefly what is meant by 'thinking distance'? [1 mark]

~~Time to react. Time between spotting a reason to stop & deciding to stop & acting.~~

Distance car travels whilst driver is reacting. Distance travelled in time between spotting a hazard & applying brake.

(c) What is the relationship between the thinking distance and the speed of the car? [2 marks]

Directly proportional. Since $s = v \times t$ and velocity does not change prior to braking, as v increases, s will increase proportionally

(c) What is the thinking distance which corresponds to a speed of 20 $m\ s^{-1}$? [1 mark]

Car is travelling at 10 ms. Thinking time $= \frac{s}{v} = \frac{6}{10}$ $= 0.6$ seconds. Therefore, at $20 ms^{-1}$ $s = vt = 20 \times 0.6 = 12$ m

(or just double the 10m/s distance, since they are proportional quantities)

Q9. A jet aircraft, initially taxiing **west** on the runway at a constant speed of 3.40 metres per second, has its throttle fully opened so that it accelerates in a straight line along the runway with an average acceleration of 4.30 metres per second per second. Given that the aircraft is still on the ground accelerating, calculate the aircraft's displacement over the period of time when the throttle is first fully opened till 13.7 seconds later. Neglect air and rolling resistance.

[3 marks]

$u = 3.4\ m/s$

$t = 13.7\ s$

$a = 4.3\ m/s^2$

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

$= 3.4 \times 13.7 + \frac{1}{2} \times 4.3 \times 13.7^2$

$= 46.58 + 403.5335$

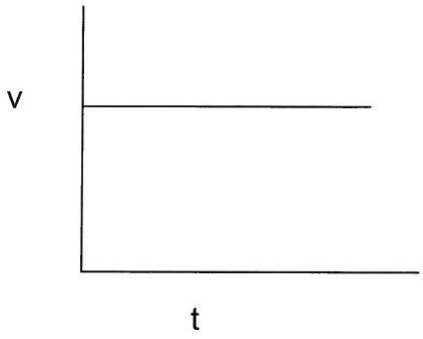
$= 450.1135$

$= \underline{450\ m.}$ (2 sig figs)

$= \underline{4.50 \times 10^2}$ (3 sig figs)

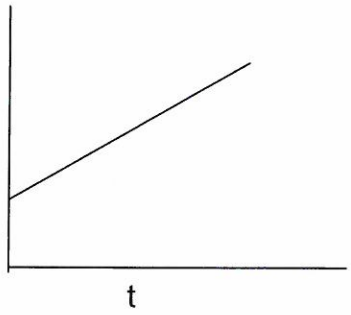
Q10 For each of the **v** versus **t** graphs below describe the motion of the object in terms of change of velocity and acceleration. [1 mark /graph]

(a)



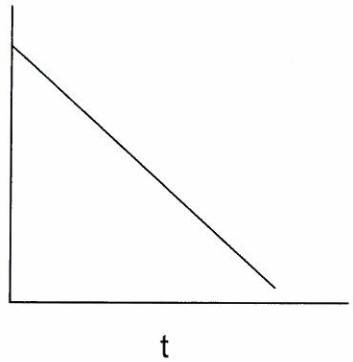
+ve
Constant velocity
Zero acceleration

(b)



Increasing velocity
+ve acceleration
Starts at +ve ~~speed~~ velocity & increases

(c)

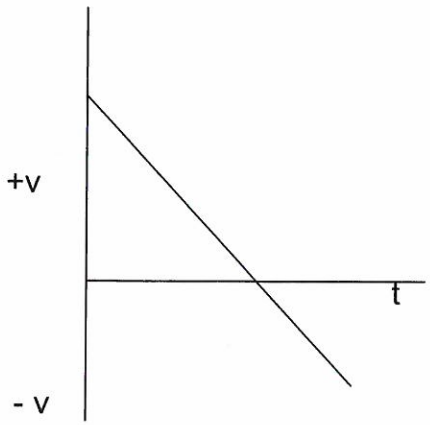


Decreasing velocity
-ve acceleration
Starts at +ve velocity & decreases to nearly zero.

reducing to zero, then

Decreasing velocity, becoming negative (ie. heading back to origin)
Negative acceleration

(d)



N.B. v = velocity in m s^{-1} and t = time in s

END OF TEST – UNDERLINE AND CHECK YOUR ANSWERS!