BAULKHAM HILLS HIGH SCHOOL

HALF YEARLY EXAMINATION

2010

YEAR 11

PHYSICS

GENERAL INSTRUCTIONS

- Reading Time - 5 min
- Working Time - 2 hours
- Board approved calculators may be used
- Write, using black or blue pen only
- Draw diagrams in pencil
- A Data Sheet and Formulae Sheets are provided at the back of this paper
- Please show all working

TOTAL MARKS: 76

Part A – Multiple Choice
17 marks

Part B – Short Response
59 marks

Answer **ALL** questions in the spaces provided

Part A – Multiple Choice
17 marks
Indicate the most correct answer A, B, C or D on the grid provided on the Answer Sheet.

1. A 1200 kg vehicle is travelling around a corner of radius 30m at a constant speed of $10ms^{-1}$. The frictional force between the car and the road is :

   a) 100 N
   b) 400 N
   c) 1000 N
   d) 4000 N

2. 

A body A, of mass m, moving with velocity v collides with another body B, of mass $\frac{m}{2}$ moving in the same direction with velocity $\frac{v}{2}$

During the collision body A exerts on body B an average force F
During the collision body B exerts on body A an average force of magnitude.

a) $\frac{F}{2}$

b) $\frac{F}{4}$

c) F

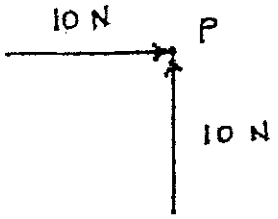
d) $2F$

3. A bicyclist travelling along a straight road travels at 11 ms^{-1} for 15s and at 4.6 ms^{-1} for 25s.

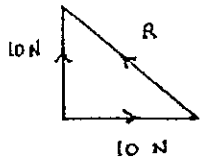
   The average speed of the bicycle is:

   a) 7.0 ms^{-1}
   b) 7.8 ms^{-1}
   c) 8.6 ms^{-1}
   d) 11.2 ms^{-1}

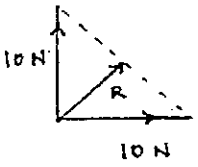
The diagram below refers to Question 4.



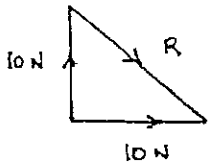
4. Which of the following vector diagrams correctly determines the resultant R of the two forces above?



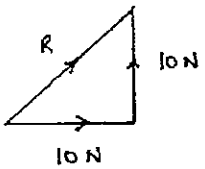
(A)



(B)



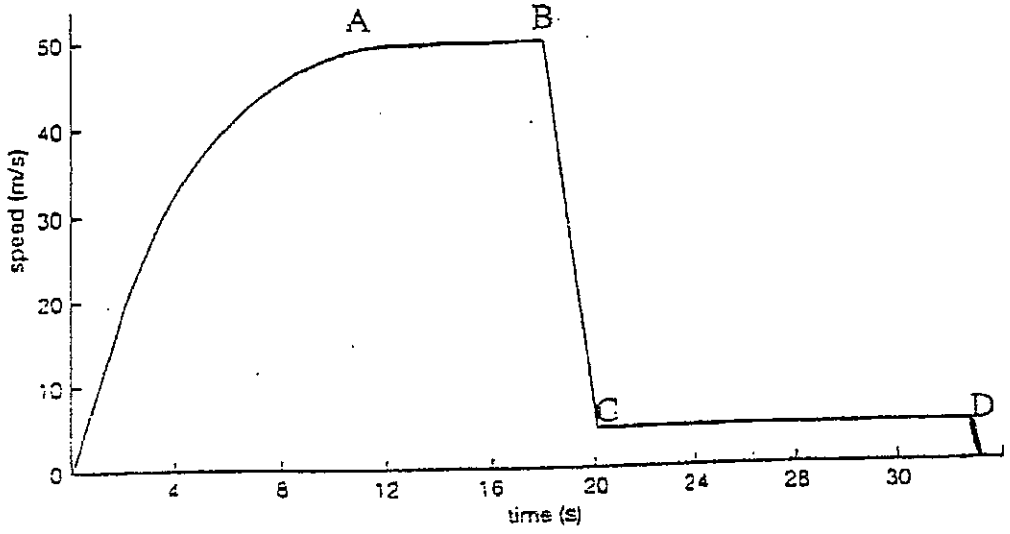
(C)



(D)

5. The following is a speed vs time graph of a parachutist from when she leaves the plane until she lands safely on the surface of the Earth. The letters A B C and D indicate points of change on this graph.

Which letter on the graph identifies the moment the parachute opens?



a) Letter A
b) Letter B
c) Letter C
d) Letter D

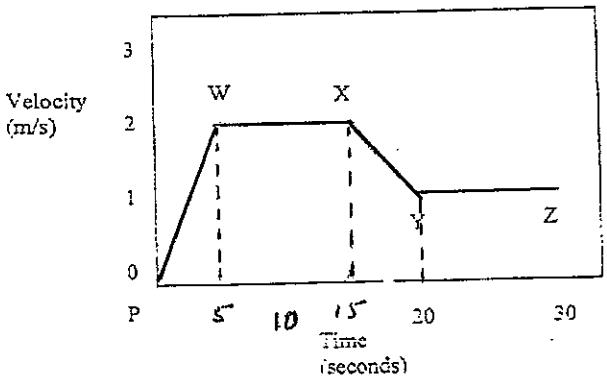
6. During a trip to Mars a space probe's booster rocket is fired, doubling the speed and halving the mass. If the original momentum was p units, the new momentum is :

a) $p/8$ units
b) $p/4$ units
c) p/s units
d) p units

7. A stationary truck moves from a set of traffic lights, reaching a velocity of 8 ms^{-1}. It took the truck 4 seconds to achieve this velocity. What was the truck's acceleration?

a) 2 ms^{-2}
b) 4 ms^{-2}
c) 12 ms^{-2}
d) 32 ms^{-2}

Use the diagram below to answer Questions 8 and 9



8. Which of the following measurements has been correctly calculated from the above graph?

	Positions	Displacement (m)
a)	P to W	5
b)	W to X	15
c)	X to Y	5
d)	Y to Z	25

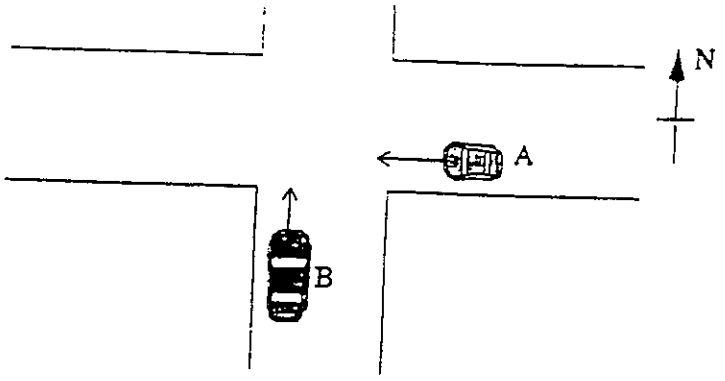
9. Which of the following statements is most correct for the motion of the object in the above graph?

a) Between P and W the acceleration is 1.0 ms^{-2}
b) The unbalanced force between W and X is being applied in the forward direction.
c) The acceleration at 18 seconds is -5.0 ms^{-2}
d) There are no unbalanced forces between Y and Z

10. A car engine exerts a force of 500 N in moving the car 1000m in 200s
The work done by the engine is :

a) 1000 J
b) 100 000 J
c) 200 000 J
d) 500 000 J

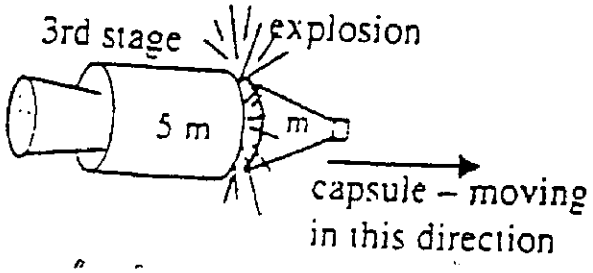
11. Two cars, A and B are approaching an intersection in the directions shown in the diagram. Both A and B are travelling 10 ms^{-1} relative to an observer standing at the intersection.



The velocity of Car B relative to Car A is :

a) 20 m s^{-1} NE
b) 14 m s^{-1} NE
c) 20 m s^{-1} NW
d) 14 m s^{-1} NW

12. During a space mission, an explosion separates the third stage of the rocket from the space capsule. The mass of the third stage is 5 times the mass of the capsule.



The ratio of the change in momentum of the space capsule to the change in momentum of the third stage of the rocket is

a) 1 : 1
b) 1 : 5
c) 5 : 1
d) 1 : 25

13. When a driver has a 'micro-sleep' he may have an accident. Which of the following best explains what happens as the vehicle runs into another object?

a) Kinetic energy changes into chemical energy
b) Sound energy changes into kinetic energy
c) Kinetic energy changes into potential energy of deformation
d) Heat energy changes into sound energy

14. A car of mass 1000kg enters a corner with a radius of 80m and needs a force of 5000 N to turn through it on a constant radius. Calculate the instantaneous velocity halfway through the turn.

a) 20 ms^{-1}
b) 12.2 ms^{-1}
c) 28 ms^{-1}
d) 120 ms^{-1}

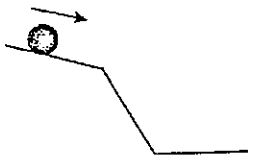
15. A 40 000 kg truck collides with an 8 000kg car and the car and truck join together after colliding. If the truck was moving at 8ms^{-1} and the car was moving at 5ms^{-1} in the opposite direction, the speed of the joined car and truck is :

a) 9.0 ms^{-1}
b) 7.5 ms^{-1}
c) 5.8 ms^{-1}
d) 3.0 ms^{-1}

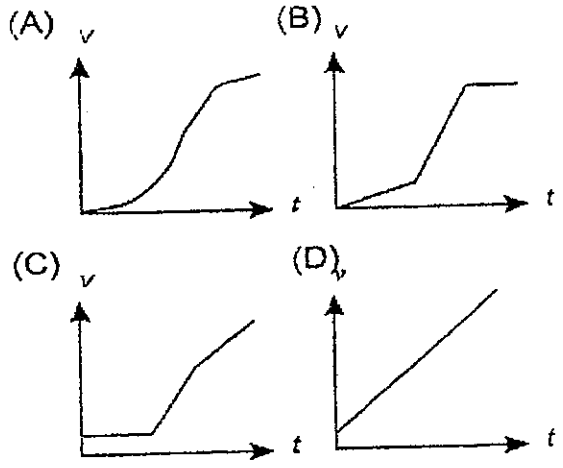
16. A moving truck travelling at 15ms^{-1} north has a mass of 2000kg. It collides with a stationary 1500kg car. If the car and truck stick together, what would be the velocity of the wreck after the collision?

a) 8.6 ms^{-1} north
b) 8 ms^{-1} south
c) 15 ms^{-1} north
d) 15 ms^{-1} south

17. A ball rolls down an inclined plane as shown below.



Which of the velocity-time graphs in the above diagram best illustrated the motion of the ball?



End of Part A

Name: ..... Teacher: .....

BAULKHAM HILLS HIGH SCHOOL

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2010

PHYSICS

Part A - Multiple Choice Answer Sheet

Select the alternative A, B, C or D that best answers the question.
For each question, indicate your choice by circling the appropriate letter on the grid

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D

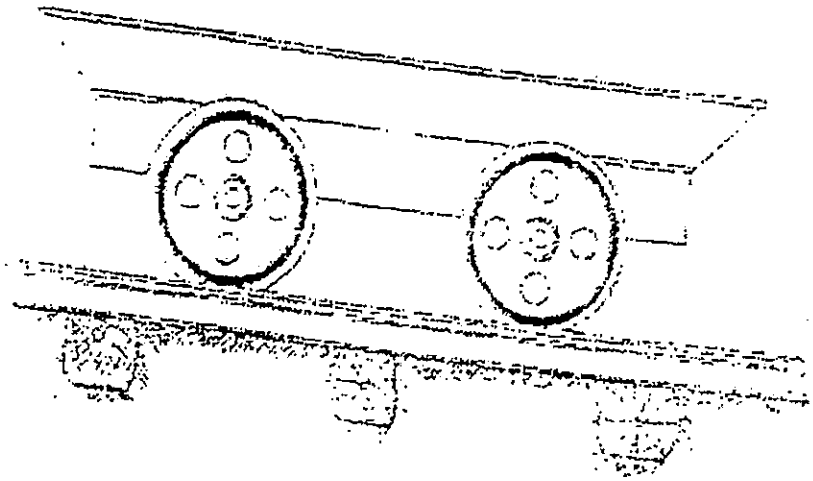
STUDENT NAME: TEACHER:

Part B

Write your answers in the spaces provided

Marks

Question 18 (6 marks)
A rail cart of mass 1200 kg is stationary on a hill



a) On the diagram above, draw the forces acting on the rail cart. **2**

b) The brakes are released and the rail cart begins to roll down the hill.

If the acceleration of the rail cart is $0.04ms^{-2}$, calculate the work done on the rail cart and its velocity after it has travelled 2 kilometres. **4**

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Question 19 (3 marks)

A car is speeding along the road in the Snowy Mountains and comes to an icy bend. As the driver tries to turn the car it slides straight ahead and off the road. State which of Newton's Laws best explains this failure to turn the corner and in your own words explain why this happened. **3**

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Marks

Question 20 (6 marks)

A 1500 kg car moves from a set of traffic lights along a straight road until it reaches a speed of $28ms^{-1}$. This occurs over 4 seconds. Determine :

a) The acceleration of the car. **2**

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b) The force needed to achieve this acceleration **2**

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c) The momentum of the car at the end of this acceleration. **2**

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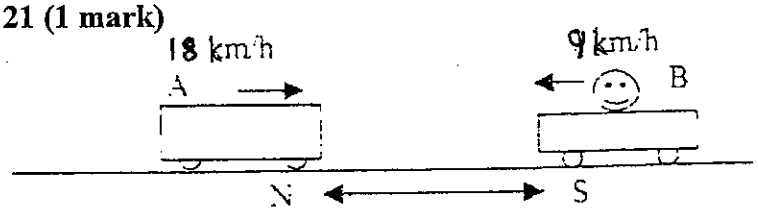
Question 21 (1 mark)



In the diagram above, two trains are heading for a big crash. What is the apparent velocity of train A from the relative position of a passenger on train B? **1**

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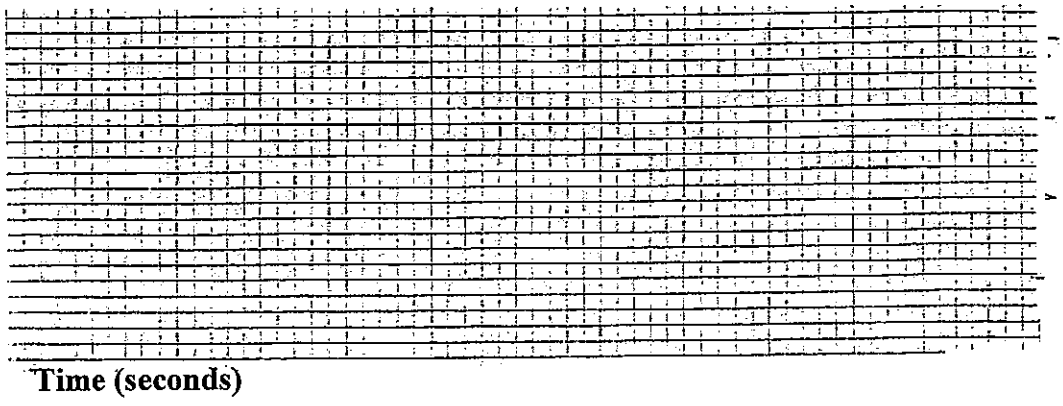
Question 22 (4 marks)

A girl jumps on a stationary bike and accelerates smoothly up to 3m/s in 5 seconds, stays at that speed for 8 seconds then slows down to 1 m/s over a time of 4 seconds. She maintains this speed for 12 seconds and then comes to a screeching halt to avoid a stray cat on the road

a) Draw a speed versus time graph of the journey **1**



Marks

Question 22 continued

b) Assuming that the accelerations are all constant, calculate :

i) The acceleration at 3 seconds **1**

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ii) The acceleration at 15 seconds **1**

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iii) The distance covered between the times of 5 seconds and 13 seconds **1**

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Question 23 (6 marks)

Outline the forces involved in changing the velocity of a car when :

a) i) it is coasting on a flat surface at 60km/h in the neutral gear. **2**

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ii) accelerating up a steep hill **2**

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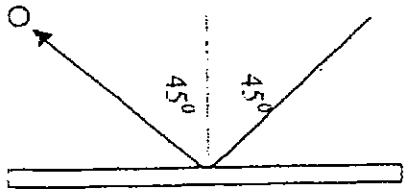
b) A tennis ball is rolled against a brick wall at 45° with a velocity of 2m/s as shown below. **2**



If the ball rebounds at 2/ms, calculate the change in velocity.

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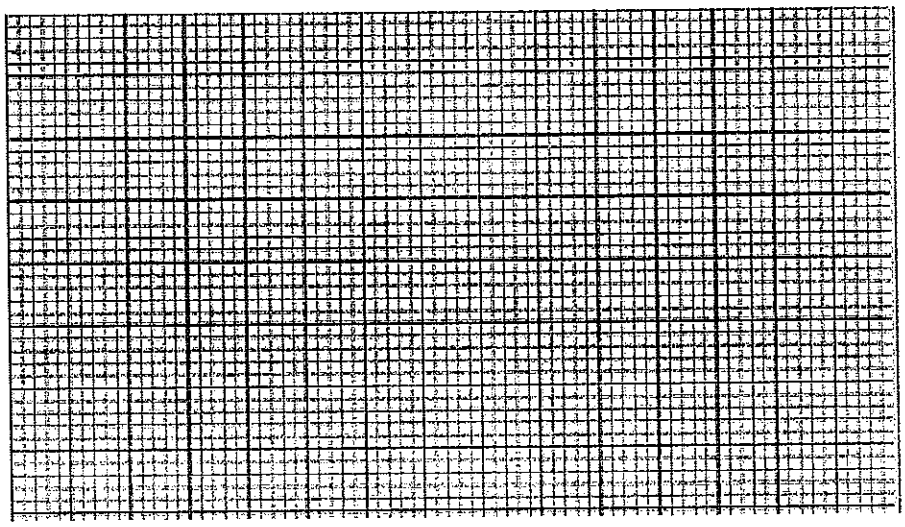
Marks

Question 24 (7 marks)

The Starship Enterprise has been ordered to make measurements of the acceleration due to gravity on the planet Tantalus-4. Science Officer Spock has set up an experiment in which an object is dropped from a height of 100m and its position measured as a function of time. His data is displayed below:

Time (s)	Height (m)
0	100
1	97
2	92
3	81
4	68
5	51
6	28

a) Plot a graph of distance travelled versus time squared. **3**



b) Use your graph to calculate the acceleration due to gravity on Tantalus-4. **1**

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c) Spock weighs his Tricorder on Tantalus-4 and it weighs 10N. What is its mass on Tantalus-4? **1**

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d) What is the weight of the Tricorder on Earth? **1**

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e) What is the mass of the Tricorder on Earth? **1**

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Marks

Question 25 (2 marks)

A cyclist travelling at 12kmh^{-1} east makes a right-hand turn at an intersection without changing speed. **2**

What is his change in velocity?

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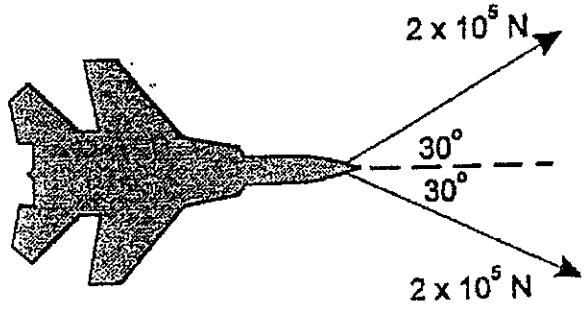
Question 26 (4 marks)

On an aircraft carrier, the catapult wires used for launching the aircraft are attached to winches, as shown in below.



If each winch exerts 200,000 N tension in its cable, find:

a) the acceleration of a 10,000kg aircraft **2**

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b) the time taken to accelerate the plane to 50ms^{-1} from rest. **2**

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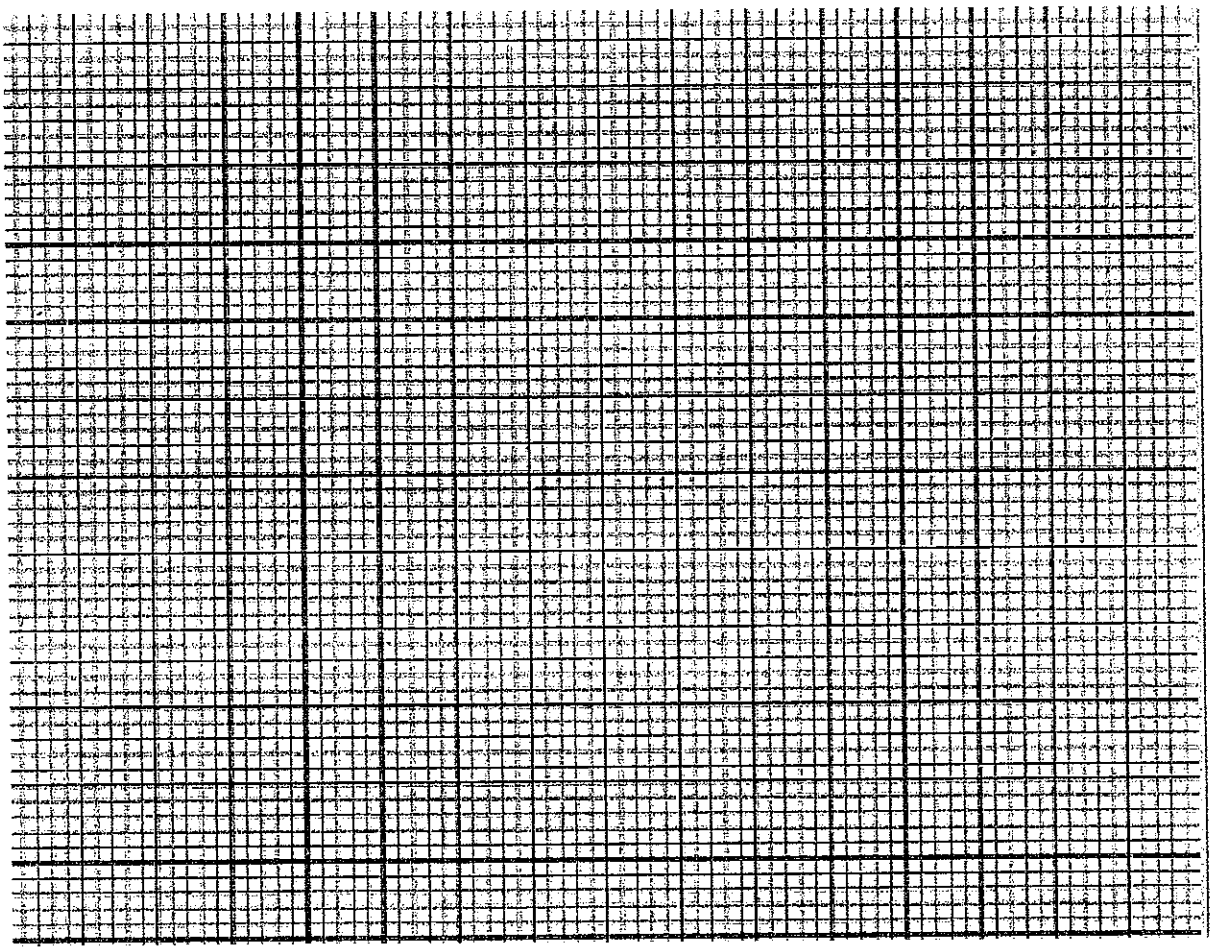
Marks

Question 27 (6 marks)

A train initially at rest at station A accelerates at 1.5 ms^{-2} for 8 seconds and then continues to move with uniform motion for a further 16 seconds, after which it decelerates at 2ms^{-2} in coming to rest at station B. The track from station A to station B is level and straight.

a) Draw velocity-time graph which represents the motion of this train (numerical values are required). **4**



b) What is the distance between the two train stations, A and B? **1**

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c) What is the average speed of the train during its journey between the two stations? **1**

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Marks

Question 28 (4 marks)

A man pushes a 100kg wheelbarrow along a path. He moves it from rest to a velocity of $4ms^{-1}$ in 8 seconds.

a) Neglecting friction calculate the average force he must apply to the wheelbarrow. **2**

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b) Determine the energy expended by the man in this time. **2**

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Question 29 (4 marks)

A 1500kg vehicle travelling $3ms^{-1}$ West collides with a 1200kg vehicle travelling $7ms^{-1}$ East. The vehicles lock together. The collision takes 0.12s to occur.

Determine the average force of the 1200kg vehicle on the 1500kg vehicle. **4**

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Marks

Question 30 (2 marks)

A 1000kg vehicle is accelerated from rest to a speed of $17.8ms^{-1}$ over 9.4s.

Determine the force acting on the vehicle during this time. **2**

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Question 31 (4 marks)

An object is thrown directly up into the air from the surface of the earth with a velocity of 98 m/s.

Ignoring air resistance:

a) How high will it go? **2**

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b) How long will it take to return to the level from which it was thrown? **2**

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End of Paper

DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

FORMULAE SHEET

$$v = f\lambda$$

$$I \propto \frac{1}{d^2}$$

$$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$$

$$E = \frac{F}{q}$$

$$R = \frac{V}{I}$$

$$P = VI$$

$$\text{Energy} = VIt$$

$$v_{av} = \frac{\Delta r}{\Delta t}$$

$$a_{av} = \frac{\Delta v}{\Delta t} \text{ therefore } a_{av} = \frac{v-u}{t}$$

$$\Sigma F = ma$$

$$F = \frac{mv^2}{r}$$

$$E_k = \frac{1}{2}mv^2$$

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

$$E_p = -G\frac{m_1 m_2}{r}$$

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

$$v_y^2 = u_y^2 + 2a_y\Delta y$$

$$\Delta x = u_x t$$

$$\Delta y = u_y t + \frac{1}{2}a_y t^2$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$F = \frac{Gm_1 m_2}{d^2}$$

$$E = mc^2$$

$$l_v = l_0\sqrt{1-\frac{v^2}{c^2}}$$

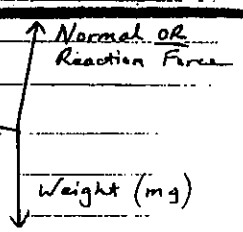
$$t_v = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$m_v = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

BHHS Yr 11 PHYSICS Solutions

1D 7A 13C
2C 8A 14A
3A 9D 15C
4D 10D 16A
5B 11B 17B
6-D-12A

Q18(a)



All 3 correct = 2 mks
2 correct = 1 mk
Including forces that don't apply to a stationary cart eg air resistance + driving force can reduce above marks

(b) Work done

$W = F \times r$ $F = ma$ $= 120 \times 0.04$ $= 48\ N$

$= 48 \times 2000$

$W = 96{,}000\ J$

Velocity

$u = 0$ $v^2 = u^2 + 2ar$

$v = ?$ $v^2 = 160$

$a = 0.04\ ms^{-2}$ $v = 12.6\ ms^{-1}$

$r = 2000\ m$ (4 mks)

Q19 State "First Law" or (3rd Law can also be justified) (1mk)

Explain how this law applies to this particular situation including terms "lack/absence of friction" (related to ice), "little acro unbalanced force" "motion continues at constant velocity" (2mks)

Q20

a) $a = \frac{\Delta v}{\Delta t} = \frac{28-0}{4} = 7\ ms^{-2}$ (2 mks)

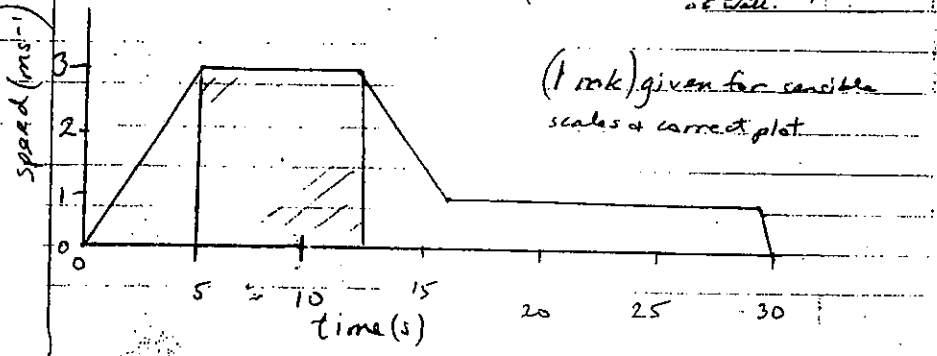
b) $F = ma = 1500 \times 7 = 10{,}500\ N$ (2 mks)

c) $p = mv = 1500 \times 28 = 42{,}000\ kg\,ms^{-1}$ (2 mks)

Q21 $V_{A\,rel\,B} = V_A - V_B = 18 - -9 = 27\ km\,h^{-1}$ North or right (1mk)

(Direction must be correct)

Q22



(1 mk) given for sensible scales + correct plot

(b) (i) $a = \frac{\Delta v}{\Delta t} = \frac{3}{5} = 0.6\ ms^{-2}$ (1 mk)

(ii) $a = \frac{\Delta v}{\Delta t} = \frac{-2}{4} = -0.5\ ms^{-2}$ (1 mk)

(iii) displacement = area under graph $= 3 \times 8 = 24\ m$ (1 mk)

Question 23 (6 marks)

Outline the forces involved in changing the velocity of a car when :

a) i) it is coasting on a flat surface at 60km/h in the neutral gear. 2

- friction between tyres and road surface
- air resistance
- these forces will cause car to decelerate slowly

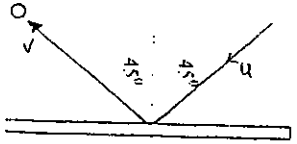
* 3 points (2mk)
* 2 points (1mk)
* 1 point (0mk)

ii) accelerating up a steen hill 2

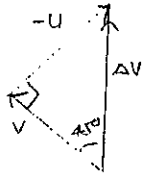
(4 points (2 marks) 3 points (1mk))

- weight force
- friction between tyre and road surface } forces opposing motion
- normal reaction force
- thrust of engine provides sufficient force to overcome opposing forces, so car can accelerate uphill

b) A tennis ball is rolled against a brick wall at 45° with a velocity of 2m/s as shown below. 2



If the ball rebounds at 2/ms, calculate the change in velocity.



$\Delta V = V - u$ $\Delta V = 2.8\ ms^{-1}$ away at 90°/perpendicular to the wall

$= V + (-u)$

$\Delta V^2 = V^2 + (-u)^2$

$\Delta V = \sqrt{2^2 + 2^2}$

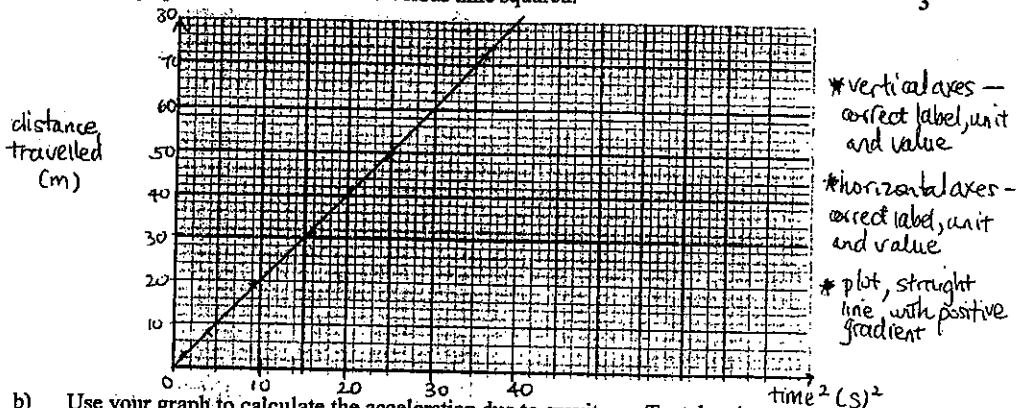
* correct numerical value + unit (1mk)
* correct direction (1mk)

Question 24 (7 marks) **Marks**

The Starship Enterprise has been ordered to make measurements of the acceleration due to gravity on the planet Tantalus-4. Science Officer Spock has set up an experiment in which an object is dropped from a height of 100m and its position measured as a function of time. His data is displayed below:

time^2 (s^2)	Time (s)	Height (m)	distance travelled (m)
0	0	100	0
1	1	97	3
4	2	92	8
9	3	81	19
16	4	68	32
25	5	51	49
36	6	28	72

a) Plot a graph of distance travelled versus time squared. 3



* vertical axes — correct label, unit and value
* horizontal axes - correct label, unit and value
* plot, straight line with positive gradient

b) Use your graph to calculate the acceleration due to gravity on Tantalus-4. 1

$s = ut + \frac{1}{2}at^2$; $u = 0$ $\therefore \frac{s}{t^2} = \frac{1}{2}a$ = gradient of slope * use gradient

$\therefore a = 2 \times \text{gradient} = 2 \times \left(\frac{80-0}{40-0}\right) = 4.0\,ms^{-2}$ * correct numerical value + unit

c) Spock weighs his Tricorder on Tantalus-4 and it weighs 10N. What is its mass on Tantalus-4? 1

$10 = m(4)$ * correct numerical value + unit

$m = 2.5\,kg$

d) What is the weight of the Tricorder on Earth? 1

$F_W = 2.5 \times 9.8$ * correct numerical value + unit

$= 24.5N$

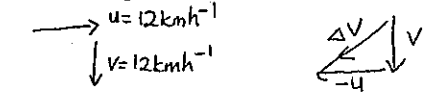
e) What is the mass of the Tricorder on Earth? 1

$2.5kg$ * correct numerical value + unit

Question 25 (2 marks) **Marks**

A cyclist travelling at 12kmh^{-1} east makes a right-hand turn at an intersection without changing speed. 2

What is his change in velocity?



$\Delta V = v - u$

$\Delta V = v + (-u)$ * correct numerical value + unit

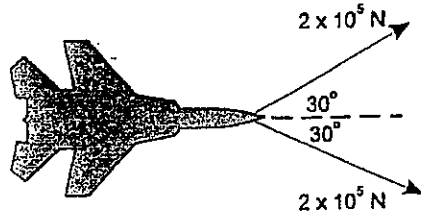
$(\Delta V)^2 = v^2 + (-u)^2$ (1mk)

$\Delta V = \sqrt{12^2 + (-12)^2}$ * correct direction (1mk)

$\Delta V = 17\,kmh^{-1}$ (or $4.7ms^{-1}$) SW

Question 26 (4 marks)

On an aircraft carrier, the catapult wires used for launching the aircraft are attached to winches, as shown in below.



If each winch exerts 200,000 N tension in its cable, find:

a) the acceleration of a 10,000kg aircraft 2

$F_{net} = (2 \times 10^5 \cos 30°) \times 2$ * correct calculation for Fnet (1mk)

$a = F_{net}/m$

$a = \frac{(2 \times 10^5 \cos 30°) \times 2}{10000}$ * correct numerical value + unit (1mk)

$a = 34.6\,ms^{-2}$ forward

b) the time taken to accelerate the plane to 50ms^{-1} from rest. 2

$u = 0$ $v = 50ms^{-1}$ $a = 34.6ms^{-2}$

$v = u + at$ * correct working (1mk)

$t = \frac{50 - 0}{34.6}$ * correct numerical value + unit

$t = 1.45s$ (1mk)

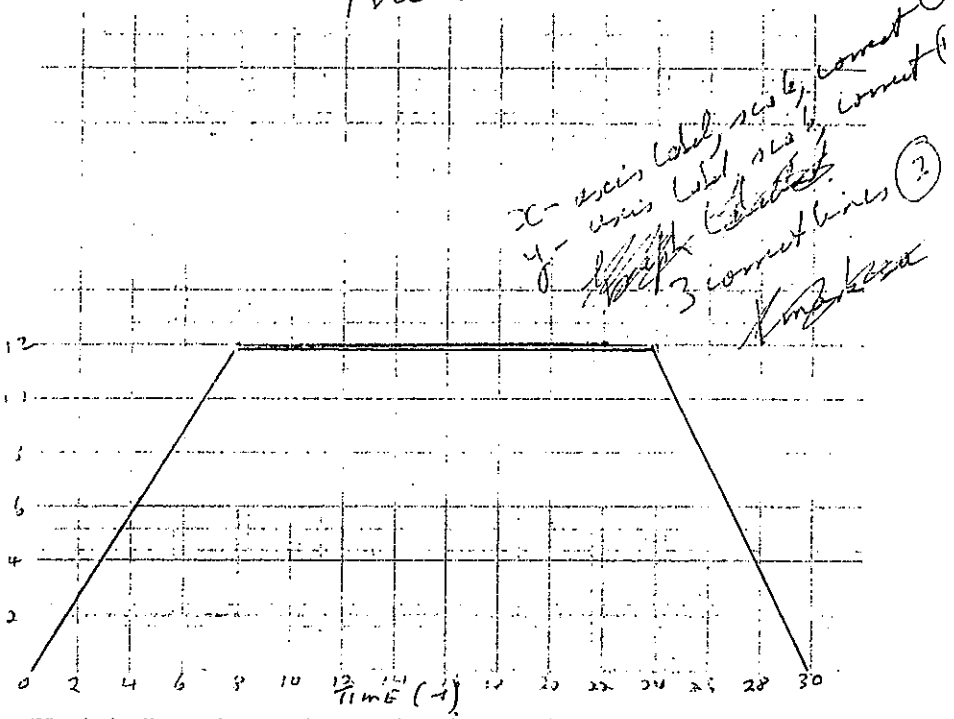
Marks

Question 27 (6 marks)

A train initially at rest at station A accelerates at 1.5 ms^{-2} for 8 seconds and then continues to move with uniform motion for a further 16 seconds, after which it decelerates at 2ms^{-2} in coming to rest at station B. The track from station A to station B is level and straight.

a) Draw velocity-time graph which represents the motion of this train (numerical values are required). 4

Train vel-time



x-axis label, scale, correct (1)
y-axis label, scale, correct (1)
3 correct lines (2)

b) What is the distance between the two train stations, A and B? 1

Dist = $(\frac{1}{2} \times 8 \times 12) + (16 \times 12) + (\frac{1}{2} \times 6 \times 12)$

= 48 + 192 + 36

= 276 m 1 mk.

c) What is the average speed of the train during its journey between the two stations? 1

$t = 8 + 16 + 6 = 30$ sec

av sp = $\frac{276}{30}$

= 9.2 m/s 1 mk.

Marks

Question 28 (4 marks)

A man pushes a 100kg wheelbarrow along a path. He moves it from rest to a velocity of 4ms^{-1} in 8 seconds.

a) Neglecting friction calculate the average force he must apply to the wheelbarrow. 2

$u = 0$
$v = 4$ m/s
$t = 8$ sec
$F = ?$

Impulse = change in momentum = $m(v-u)$

$Ft = m(v-u)$

$F = \frac{100(4-0)}{8}$ 1 mk

$= 50N$ 1 mk.

b) Determine the energy expended by the man in this time. 2

Work done = change in KE

$= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$= \frac{1}{2} \times 100 \times 4^2 - 0$ 1 mk

$= 800$ J.

Question 29 (4 marks)

A 1500kg vehicle travelling 3ms^{-1} West collides with a 1200kg vehicle travelling 7ms^{-1} East. The vehicles lock together. The collision takes 0.12s to occur.

Determine the average force of the 1200kg vehicle on the 1500kg vehicle. 4

1200kg 7 m/s E 1500kg 3 m/s W

Total momentum = $1200 \times 7 + 1500 \times -3$

$= 8400$ N.s E + 4500 N.s W

$= 3900$ N.s E --- (1 mk)

After collision mass = 1200 + 1500 = 2700kg.

$p = 2700v = 3900$ N.s E

$v = \frac{3900}{2700}$ m/s E ---- (1 mk)

Force on 1500kg

$= m\left(\frac{v-u}{t}\right)$

$= 1500\left(\frac{\frac{3900}{2700} - -3}{0.12}\right)$ (1 mk)

$= \frac{1500 \times 12000}{2700 \times 12}$

$= 55555.6$ N (to E) (1 mk)

Question 30 (2 marks) — Marks

A 1000kg vehicle is accelerated from rest to a speed of 17.8ms^{-1} over 9.4s.

Determine the force acting on the vehicle during this time. 2

$m = 1000\,kg$ $\quad Ft = m(v-u)$

$u = 0$ $\quad F \times 9.4 = 1000(17.8-0)$ ——— 1 mk

$v = 17.8\,m/s$ $\quad F = \frac{1000 \times 17.8}{9.4}$

$t = 9.4\,s$ $\quad = 1893.6\,N$ ——— 1 mk

Question 31 (4 marks)

An object is thrown directly up into the air from the surface of the earth with a velocity of 98 m/s.

Ignoring air resistance:

a) How high will it go? 2

$u = 98\,m/s$ $\quad v^2 = u^2 + 2as$

$v = 0$

$a = -9.8\,m/s^2$ $\quad 0 = 98^2 - 2 \times 9.8 s$ 1 mk

$s = ?$ $\quad s = \frac{98^2}{2 \times 9.8} = 490\,m$ 1 mk

b) How long will it take to return to the level from which it was thrown? 2

$v = u + at$

$0 = 98 - 9.8t$ 1 mk

$t = 10$ sec to go to top

$\therefore$ time to return $= 2 \times 10 = 20$ sec. 1 mk

End of Paper

	a	b	c
1	x	y	x
2	y	z	z
3	z	x	y