BOARD OF STUDIES
NEW SOUTH WALES

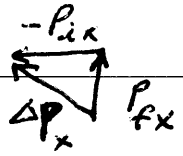
Centre Number: ..... Student Number: .....

MULTIPLE CHOICE ANSWERS – Section I

1. C

2. $\Delta\vec{p} = \vec{p}_f - \vec{p}_i$, $p_{fx} = MV_{fx} = 0.5 \times 18 = 9\ Ns$, $p_{ix} = 0.5 \times 24 = 12\ Ns$

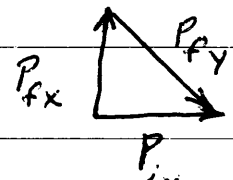
From vector diagram



$\Delta p_x = 15\ Ns$

So answer B is correct.

3. Since $\vec{p}_B = \vec{p}_A \Rightarrow$



$\vec{p}_B = \vec{p}_{ix} + 0$

$\vec{p}_A = \vec{p}_{fx} + \vec{p}_{fy}$

So $\vec{p}_{fy}$ is in direction shown $\therefore$ answer D is correct.

4. $\Delta p = F.t$, so $F = \frac{\Delta p}{t} = \frac{p_{fy}}{t} = \frac{15}{0.1} = 150\ N$

So answer A is correct.

5. B

6. A since $F = Ma = m\left(\frac{v-u}{t}\right) = 2.\left(\frac{10-5}{0.2}\right) = 50\ N$

7. C

8. B

9. D

10. D Note: The answer to 10 has been taken as D since Freidmann actually promoted the idea. Einstein actually predicted the expansion first + then added the cosmological constant to get rid of the expansion.

11. A since if $I_0 \propto \frac{1}{d^2}$, then $I_N \propto \frac{1}{(4d)^2} \propto \frac{1}{16d^2} \propto \frac{I_0}{16}$

12. B Note: question 11 should read "If the distance is increased to 4d the intensity is:"

QUESTION 13 (5 Marks) **Marks**

SAMPLE ANSWERS:

(a) Define the relationship between the temperature of a blackbody and the dominant wavelength of the radiation emitted from that blackbody.

The temperature of a blackbody (in kelvin) is inversely proportional to the wavelength of maximum emission of the blackbody. **1**

(b) The three stars Rigel, Betelgeuse and α-Centauri have colours of blue-white, orange-red and yellow respectively. Arrange these three stars in order of increasing surface temperature.

Betelgeuse, α-Centauri and Rigel **1**

(c) The star Regulus has a brightness of 7.17×10^{-9} Wm^{-2} as seen from Earth. Regulus is 7.8×10^{14} km from Earth. Calculate the brightness of Regulus as seen from Earth if this star was located at half its actual distance from Earth. **1 for method**

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

So, halving the distance from Earth, quadruples the intensity of the light. Therefore, brightness of Regulus would become 2.87×10^{-8} Wm^{-2}. **1 for correct answer including correct units**

(d) Star A has a luminosity of **L watts**. Star B has a luminosity of **3L watts**. Both of these stars are located an equal distance from Earth. Determine the ratio of the brightness of Star A to the brightness of Star B as seen from Earth. You may assume the path the light travels to Earth from each Star is equally free from interstellar dust and other material that may absorb or scatter the light.

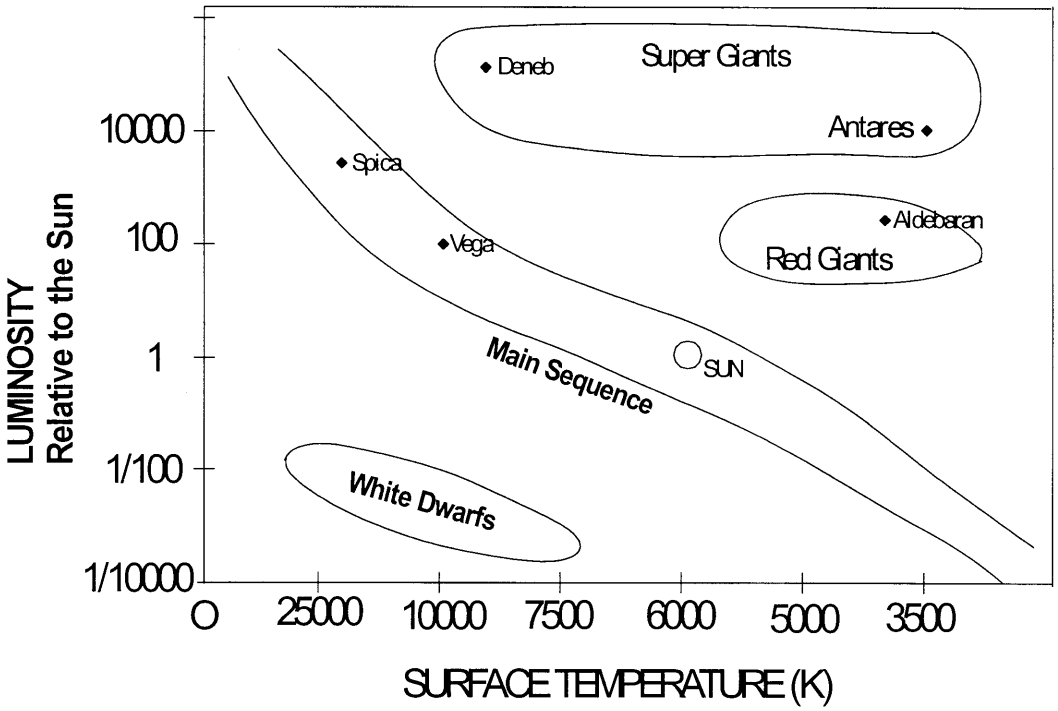
$$B \propto L$$

Ratio of brightness of Star A to brightness of Star B = 1:3 (or 1/3). **1**

NOTE: Marking criteria are obvious. Only point to note in this question is in part (c) students get 1 mark for clearly showing they understand the inverse square law for light and then 1 mark for a completely correct answer including correct units.

QUESTION 14 (5 Marks) – SAMPLE ANSWERS:

This question refers to the following Hertzsprung-Russell Diagram.



(a) Antares is a star with a surface temperature of 3400K and luminosity relative to the Sun of about 10^4. Clearly label the position of Antares on the HR Diagram. 1

(b) The HR Diagram above has been drawn with a horizontal axis of "Surface Temperature". Identify one other **physical characteristic** of a star that can be used as the horizontal axis variable in an HR plot.

Colour (note that **"spectral type"** would also be acceptable) 1

(c) Identify the correct name of the star group labelled "Group X".

Red Giants (or simply Giants will do) 1

(d) Identify the energy source characteristic of stars in Group X.

Helium fusion 1

(e) A certain star is described as being "about the same size as the Earth, blue in colour, with no thermonuclear reactions occurring in its core". Identify the star group into which you would place this star.

White dwarfs 1

Again marking criteria are obvious.

QUESTION 15 (5 Marks)

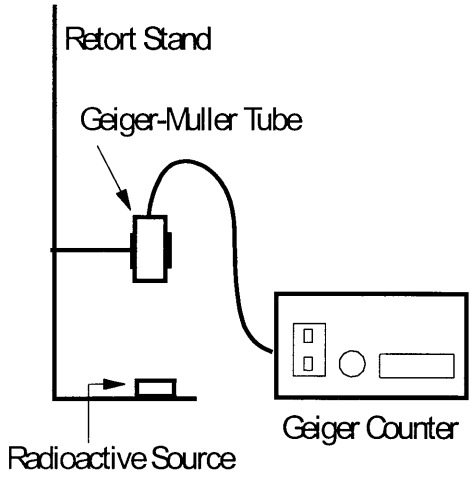
Marks

Describe the Experimental Method used in a first-hand investigation that you have carried out to compare the penetrating power of alpha, beta and gamma radiation in a range of materials.

As part of your description:

- Draw a labelled diagram of the experimental set-up;
- Outline the method used;
- Identify the independent and dependent variables involved in the investigation;
- Identify 2 potential hazards inherent in this experiment and the steps that were taken to protect the experimenters from these.

SAMPLE ANSWER:



1

1. Place an alpha source (radium-226) under Geiger-Muller tube (detector). Set detector 2cm from source.
2. Remove source & record **background radiation count for 30 seconds**. Subtract this from all counts taken.
3. **Return source & record number of counts of radiation in 30 seconds. This is the dependent variable**.
4. Place 1 sheet of paper over top of source and record count for 30 seconds. Add extra sheets, one at a time and repeat count to measure the penetration ability through paper. **The number of sheets added (or thickness of absorbing material) is the main independent variable.**
5. Repeat step 4 using in turn aluminium and then lead instead of paper.
6. Repeat steps 3 to 6 using first a **beta source** (strontium-90) and then a **gamma source** (cobalt-60).

3
(1 mark total for correct identification of independent & dependent variables.

2 marks total for correct & complete Method.)

The obvious **hazard** in this experiment is **radioactive contamination**. The experiment was done as a demonstration by the Teacher **to protect the students from risk**. **Also, the Teacher wore plastic gloves and a lab coat and handled the radioactive samples with tweezers.**

1

Marking Criteria:	Marks
Marks are to be allocated as shown below.	
Appropriate diagram & correctly labelled.	1
Description of a complete and correct Method that would allow for the comparison of the penetrating power of alpha, beta and gamma radiation in a range of materials. Note that a range of materials means more than two different materials. So, paper, aluminium & lead would be a suitable range of materials, as used in the sample answer.	2
Description of a partial and/or partially correct Method that would allow for the comparison of the penetrating power of alpha, beta and gamma radiation in a range of materials. This includes answers that only include one or two materials as the "range of materials".	1
Correctly identifying one independent and one dependent variable. Independent variables could include: number of sheets or thickness of shielding material, nature of radioactive source or distance from source to detector for those measuring penetration power through air. Dependent variable is radiation counts/30s or whatever the time interval happens to be.	1
Correctly identifying at least ONE major risk factor in the experiment & providing at least ONE appropriate step that was taken to protect people against this risk.	1

Question 16 **Marks**

ks

A vehicle of mass 1000kg increases its velocity from 5 ms^{-1} to 10 ms^{-1} in 15 seconds.

(a) Determine the increase in kinetic energy.

$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = \frac{1}{2}m(v+u)(v-u)$

$= 500(15)(5)$

$= 37\,500$ J (2)

($\frac{1}{2}mv^2 = \frac{1}{2}m(\Delta v)^2$ $= 500 \times 5^2$ $= 12\,500$ J) (1) 2

for complete answer

(b) Define the law of conservation of energy. 37500 = 1½ (No correct units)

Energy can neither be created nor destroyed. only changed from one form to another 1

(c) A vehicle of mass 800 kg is travelling at 8 ms^{-1} is brought to rest in a distance of 40m. Determine the **magnitude** and **direction** of the average force exerted by the brakes to achieve this event.

$Fs = \frac{1}{2}m\Delta v^2$ (1)

$40F = \frac{1}{2} \times 800 \times 64$

$\therefore F = \frac{400}{40} \times 64$

$= 640$N in the opposite direction (1)

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

$0 = 64 + 2 \times a \times 40$ (1)

$\therefore a = -\frac{64}{80}$ N.

$\therefore F = ma$

$= -\frac{64}{80} \times 800$

$= -640$N (1) 3

(d) Identify what happens to the kinetic energy of the vehicle as it comes to rest.

The kinetic energy is converted into heat energy in the brakes. 1

(e) Station wagons are popular because of the amount of goods that they can carry in the rear section of the vehicle. Discuss a potentially dangerous situation that this could pose and name a precaution that could be taken to minimize the dangers.

The nature of the goods mean that when the vehicle begins to slow down they may continue to move forward and so could strike occupants and cause injury. (1)

Install a barrier between passengers and rear section

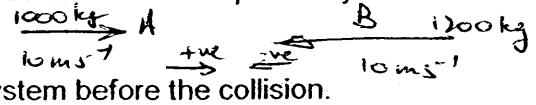
Do not carry goods above the level of seat, Not overload vehicle

secure load across the vehicle (1) 2

7

Question 17 **Marks**

Vehicle A of mass 1000 kg is travelling East at 10 ms^{-1} collides with another vehicle B of mass 1200 kg but travelling West at 10 ms^{-1}. On impact they become locked together. Assume friction is negligible.



Determine:

(a) The total momentum of the system before the collision.

$10000 - 12000 = -2000$ kgms^{-1} East 1

or 2000 kgms^{-1} West

(b) The velocity of the combined vehicles after the collision.

$\Sigma p_i = \Sigma p_f$

$-2000 = 2200v$ 1

$v = -0.91$ ms^{-1} East or 0.91 ms^{-1} West

(c) The change in momentum of vehicle A.

$\Delta p = p_f - p_i$ $1000 \times -0.91 - 10000 = -910 - 10000$ (1)

$= -10910$ Ns East 2

or 10910 Ns West

(1)

(d) Given that the collision took place in 2 seconds, determine the average force acting on vehicle A.

$Ft = \Delta p$ 2

$F2 = 10910$

$= 5455$ N West

Question 18

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852 00?	P	8.5.2.d	2 – 4	**Marks 4**

Marking Criteria	**Marks**
Outline covering at least three of the factors leading to accretion. The factors are outlined coherently	**4**
Outline two factors and identify two	**3**
Outline one factor and identify at least two others Identify at least three factors leading to accretion	**1 - 2**

Sample Answer

- After the big bang the universe rapidly expanded.
- As the universe expanded it cooled.
- Temperature is a measure of the kinetic energy of particles.
- Therefore as the universe the kinetic energy of particles decreased.
- As the KE decreased the gravitational attraction between particles became significant. That is the gravitational force between particles began strong enough to cause particles to drift towards each other.
- Because the density of the matter in the universe was not uniform (lumpiness of the gas cloud) gravitational forces a re slightly stronger in certain areas. This results in the density of matter becoming less uniform.
- The process continues until significant amounts of matter accrete until galaxies form.

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Question 19 **Marks**

A 1200 kg car travelling east at 20.0 ms^{-1} moves around a curve at constant speed until it is travelling south at the same speed. The radius of the curve is 30.0 m and the car takes 5.0 s to move through the curve.

Include a vector diagram.

(a) Calculate the **magnitude** of the change in velocity.

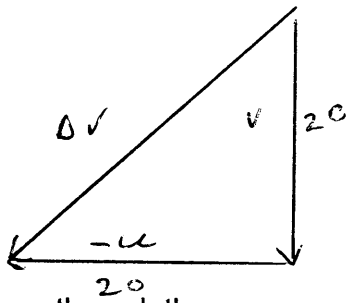
$\Delta v = v - u$

$= v + -u$

$\Delta v = 20^2 + 20^2$

$= \sqrt{800}$

$= 28.3\ ms^{-1}$



2

(b) Determine the **magnitude** of the acceleration as the car moves through the curve.

$a = \frac{\Delta v}{t}$ $5.7\ ms^{-2}$

$= \frac{28.3}{2.1}$ $13.4\ ms^{-2}$

1

(c) Calculate the **magnitude** and **direction** of the force on the car as it moves through the curve.

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

$= 1200 \times 13.4$

$= \frac{1200 \times 20^2}{30}$ $F = 16080\ N$

2

$F = 16000\ N$ perpendicular to motion

Question 20

A 1000.0 kg car is at rest when it is acted upon by a force of 10 000.0 N from the engine. Assuming no slippage, a rolling friction of 2 000.0 N and air friction of 7 000.0 N.
Find:

(a) The net force acting on the car?

$\Sigma F = 10000 - 2000 - 7000$

$= 1000\ N$

1

(b) The acceleration of the car?

$F = ma$

$a = \frac{F}{m} = \frac{1000}{1000} = 1\ ms^{-2}$

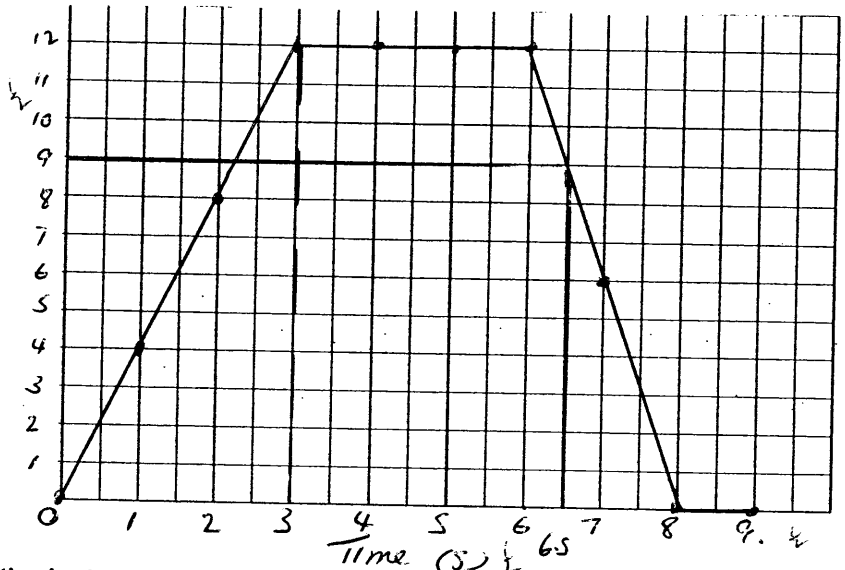
1

Question 21 **Marks**

The table shows the instantaneous velocity of a car starting from rest.

Velocity (ms^{-1})	0	4	8	12	12	12	12	6	0	0
Time (s)	0	1	2	3	4	5	6	7	8	9

(a) Plot a **velocity – time** graph for the car.



- Label
- Axis Scale
- Graph plot
- Full use of grid.

4

(b) What is the instantaneous velocity after 6.5 s? (Show your working on the graph)

$9 ms^{-1}$

2

(c) Determine the displacement of the car after 9 s.

Area of $\triangle = \frac{1}{2} \times 3 \times 12 = 18m$ Area of $\square = 3 \times 12 = 36m$ Area of $\triangle = \frac{1}{2} \times 2 \times 12 = 12$

Total area $= 18 + 36 + 12 = 66m$. $A = \frac{1}{2}h(x+y) = \frac{1}{2} \times 12 \times (3 \ldots) = 66m$

2

(d) Determine the average velocity of the car for the time interval from t = 0 to t = 9 s.

$V_{av} = \frac{\text{Displacement}}{\text{time}} = \frac{66}{9} = 7.3 ms^{-1}$

2

(e) Determine the acceleration for the time interval t = 6 to t = 8 s.

$a = \frac{\Delta v}{t} = \frac{0-12}{2} = -6 ms^{-2}$ $6 ms^{-2}$ retardation.

2

Question 22

a Outline the contribution of Edwin Hubble to the development of the current model of the universe.
b What is the Big Bang?

852 00?	P	8.5.1.i	2 – 6	**Marks 3**

Marking Criteria Part a	**Marks**
Provides three points related to Hubble's contribution including 'red-shift' and galaxies receding from the earth	**3**
	1 - 2

Sample Answer Part a
Showed that the wavelengths of the spectral lines from other galaxies in the universe are red-shifted (ie longer wavelength). Hubble showed further that the greater the distance to a galaxy the greater the red shift. The red shift indicates the galaxy is receding from the earth. The further away the galaxy is from us, the faster it is receding. This provided

Marking Criteria Part b	**Marks**
Identify the Big Bang as an explosion or rapid expansion of the singularity	**1**

Sample Answer
At some time in the distant past, all the matter, energy and space in the universe must have been located in a very small volume – a **singularity** (point) of infinite density. It is generally believed that our universe has resulted from the explosion or rapid expansion of this singularity – the so called **Big Bang**. It occurred about 15 billion years.

Question 23

a Describe one model of the universe developed from the time of Aristotle to Newton. **[2 marks]**

b Assess this model to identify limitations placed on the development of the model by technology available at the time. **[3 marks]**

852 00?	P	8.5.1.i	2 – 6	Marks	5

Marking Criteria Part a	Marks
Provides at least two significant features of Ptolemy's model	2
Provides one significant feature of Ptolemy's model	1

Sample Answer Part a

Ptolemy developed a geo-centric model (earth-centered)
In this model, all heavenly bodies revolved around the earth in perfect circles.
Ptolemy used epicycles to accommodate the retrograde motion of the planets
Over time Ptolemy's model was adjusted by adding epicycles to accommodate more accurate data on the motion of planets

Marking Criteria Part b	Marks
Makes a judgment about the quality of the model Relates answer to development of the model Identifies technologies that limit the development of the model	3
Makes a judgment or relates answer to development of the model Identifies technologies that were unavailable	2
Identifies technologies that were unavailable	1

Sample Answer Part b

The purpose of a model is to describe observations and predict future events. Ptolemy's model was therefore useful as it satisfied these two criteria – ie it adequately described the observed motion of planets and predicted where they would be at some time in the future.

Models remain accepted as long as they adequately describe observations. Ptolemy's model remained accepted for a long time because no new data was collected to disprove the model. Data was collected that caused the model to be modified by adding additional epicycles.

The data that could be collected was limited by available technology. It was only when Tycho Brahe developed a systematic approach for observing planets and stars, that significant problems with were found. He stressed the importance of making observations on a regular basis. Brahe used instruments such as astrolabes and quadrants to estimate the position of celestial objects. His observations were far more precise than those of earlier astronomers.