Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

AO3a : **planning**:
measurements:
(to determine the transit time of the falling cake-case)
use a <u>stopwatch</u> (**not** from rest) **(1)**
(to determine (vertical) distance fallen)
use a (metre) ruler or tape measure (**not** from rest) **(1)**
(to determine mass (weight) of cake-case)
measure with <u>balance</u> (not scales) **(1)**
(to determine the cross-sectional area of the cake-case)
measure the (mean) diameter / radius using (300 mm) ruler **(1)** any three **(1) (1) (1)**

strategy:
find v using correct physics e.g. $\frac{\text{(vertical) distance}}{\text{transit time}}$ **(1)**
(no credit for measuring vertical distance in a certain time)
find A from $\frac{\pi(\text{diameter})^2}{4}$ **(1)**

D is same as weight (mg) (when falling at terminal velocity) **(1)**
repeat either using different weights (e.g.stacked cases) or
paper cases of different diameters (cross-sectional areas) **(1)**
shape factor found by graphical method: expect explanation,
suitable graph e.g. D against $\rho A v^2$; <u>determine gradient</u> **(1)** any four **(1) (1) (1) (1)**

control:
any sensible e.g. avoid draughts **(1)**

difficulties:
(*difficulty* + *how overcome* = 2)
any **two** of the following

reduce uncertainty in timing
by making cases fall through large distance (e.g. ≥ 2 m) and / or

by repeating readings and <u>averaging</u>
by avoiding parallax error (viewing at eye level)

reduce uncertainty in diameter / radius
by measuring across several diameters and <u>averaging</u>

reduce uncertainty in vertical distance
by ensuring ruler is vertical: expect description of how this is done **(1) (1) (1) (1)**

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Q2.

(a) (i) $d = \frac{50 \times 10^6}{3.26} = 15.3 \times 10^6$ (pc)

(ii) (use of $v = Hd$ gives) $v = 65 \times 10^{-6}$ (km s^{-1} pc^{-1}) $\times 15.3 \times 10^6$ **(1)**

≈ (1000 km s^{-1})

(iii) (use of $\frac{\Delta\lambda}{\lambda} = -\frac{v}{c}$ gives) $\Delta\lambda = \frac{1000 \times 10^3}{3 \times 10^8} \times 656.3$ (nm) = 2.19 (nm) **(1)**

(allow C.E. for value of v from (ii)

$\lambda_{galaxy} = 656.3 + 2.19 = 658.5$ nm **(1)**

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(b) for the furthest point of the Universe, $d = \frac{c}{H}$ **(1)**

age of Universe = $\frac{d}{c} = \frac{1}{H}$ **(1)**

[or use of $v = Hd$ and $t = \frac{d}{v}$ **(1)**

if all started from same point t = age of Universe = $\frac{1}{H}$ **(1)**]
assumption: that H remains constant

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Q3.

(a) (i) supernova: star whose luminosity increase enormously due to it exploding **(1)**

(ii) neutron star: star with the density of nuclear matter **(1)**

(iii) black hole: an object whose escape velocity is greater than speed of light **(1)**

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(b) $\left(\text{use of } R = \frac{2GM}{c^2} \text{ gives}\right) \quad R = \frac{2 \times 6.67 \times 10^{-11} \times 10 \times 2 \times 10^{30}}{(3 \times 10^8)^2}$ **(1)**

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