HWA CHONG INSTITUTION (COLLEGE SECTION)
2024 JC2 9744 H2 BIOLOGY
PRELIMINARY EXAMINATIONS PAPER 4 MARK SCHEME

QUESTION 1

(a)(i) State the independent variable in this investigation. [1]

number of beads

(ii) Record your results in an appropriate table. [4]

number of beads	time taken for appearance of the first colour change / s
1	more than 120
2	more than 120
4	42
8	20
16	13

1 correct column headings and units
2 times recorded for five sets of beads
3 all times recorded in seconds
4 correct trend

(iii) Explain your results in **(a)(ii)**. [2]

1 ref. to more active sites available
2 ref. to more reducing sugar produced

(iv) Other than lack of replicates and repeats, identify **one** main source of error in this investigation and suggest an **improvement** to reduce the effect of this error. [2]

Source of error	Improvement
S1 ref. to beads having different sizes	**I1** ref. to use of different concentration of yeast enzymes
S2 ref. to beads not left for the same duration in sucrose	**I2** ref. to staggering start times
S3 ref. to sodium alginate and yeast may not be mixed well manually	**I3** ref. to use of magnetic stirrer

(v) A student set up a beaker as a control experiment. The result of the control experiment showed that the sucrose was hydrolysed by an enzyme.

Suggest what substances the student put in the beaker for the control experiment. [1]

boiled and cooled yeast

(vi) The procedure described in step 1 to step 20 investigated the effect of changing the number of yeast beads on the rate of hydrolysis of sucrose.

Describe how you would modify the procedure to investigate the effect of changing the concentration of the sucrose solution on the rate of hydrolysis of sucrose. [2]

1 use a set number of yeast beads

2 prepare at least five concentrations of sucrose by dilution

(b)(i) Record the colour change of TTC after 10 minutes. [1]

colourless to pink

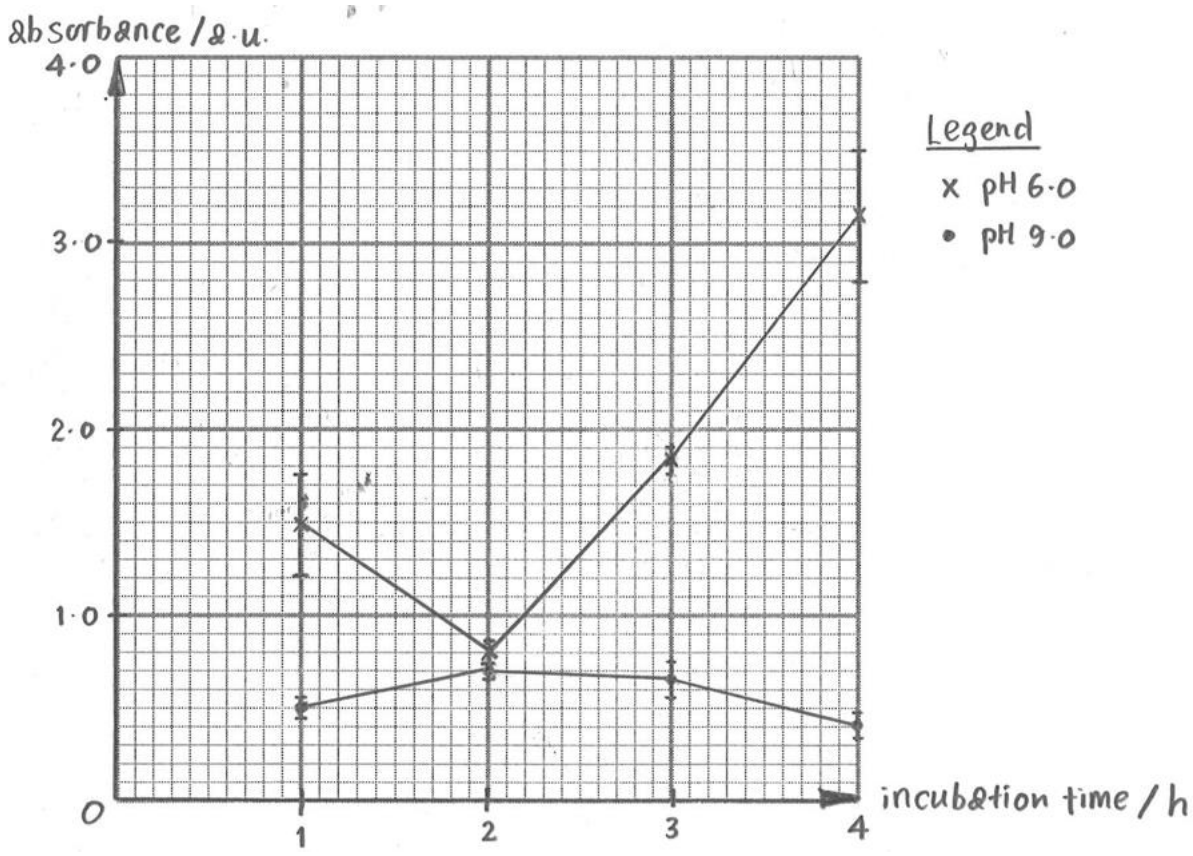
(ii) Explain why the colour change of TTC in **(b)(i)** can only be observed after 10 minutes and not immediately upon addition. [2]

1 ref. to hydrolysis sucrose into reducing sugars
2 ref. to reduction of TTC due to respiration

(c) Describe a method that students could use to compare the respiration rates of the three varieties of yeast. [7]

1 same / stated / known, volume (suspension), of each yeast (added to separate flasks)
2 same / stated / known, volume of, nutrient solution / sucrose
3 ref. to method to maintain temperature
4 suitable temperature in range 15 °C – 80 °C
5 idea of equilibration / bringing yeast suspension and nutrient solution, to temperature, before mixing
6 add TTC / redox indicator, to yeast / yeast and nutrient mixture
7 *time for recording absorbance*
8 ref. to procedure on use of colourimeter including zeroing (with distilled water)
9 ref. to method of maintaining homogeneity (of yeast)
10 use (at least) 3 replicates / repeats and find mean or identify / eliminate / remove, anomalies
11 ref. to low risk

(d)(i) Use the grid provided to display the results shown in Table 1.2 in an appropriate form. [4]



1 correct axes labels and units

2 use of appropriate scale

3 correct plotting of points

4 correct plotting of S_M

(ii) State what the standard error (S_M) shows. [1]

idea of how close the (sample) mean is to the true / population mean

(iii) The data in Table 1.1 shows the 95% confidence intervals for the data.

95% confidence interval = +/− 2 × S_M

State what this indicates about the data. [1]

1 95% of the data would be expected to lie within this range

2 at 1 / 3 / 4, hours, the (sample) mean was reliable because the confidence intervals do not overlap

(iv) After completing these two experiments the students concluded that the growth rate of yeast is highest when incubated at 30 °C and pH 6.0 for 4 hours.

State **two** ways in which the data support this conclusion. [2]

1 *from Table 1.2* / *experiment 1*
pH 6.0 gives the highest absorbance at 4 hours incubation
or
from Table 1.3 / *experiment 2*
at 30°C at pH 6 absorbance is highest

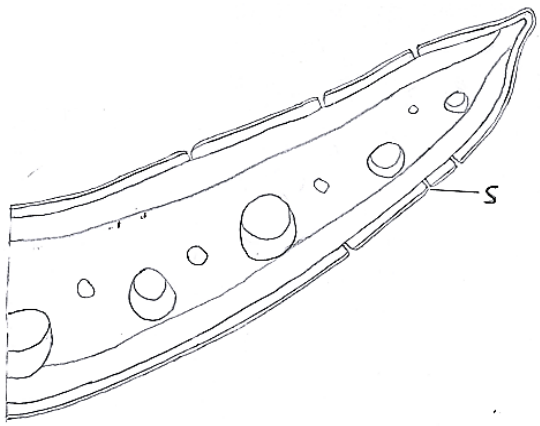
2 *from Table 1.2* / *experiment 1*
the CI / error bars (for pH 6) do not overlap (at 4 hours)
or
from Table 1.3 / *experiment 2*
standard errors / S_M, do not overlap (with other, temperatures / pHs)

[Total: 30]

QUESTION 2

(a)(i) Draw a large plan diagram of the part of the leaf on slide **K1** shown by the shaded area in Fig. 2.1.

Use **one** ruled label line and the label **S** to identify a stomatal opening. [4]



1 no cells + clear continuous lines + correct sector

2 correct size of plan drawing + correct labelling of S

3 correct arrangement of tissues

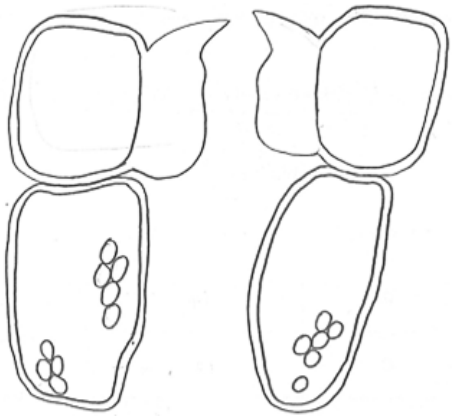
4 correct shape + correct proportion

(ii) Observe the outermost layer of cells on the upper and lower surfaces of the leaf on slide **K1**. This outermost layer is called the epidermis and is one cell thick. Select a pair of guard cells, which are epidermal cells that surround a stomatal opening, and two cells from the layer below the guard cells.

Each guard cell must touch at least one cell from the layer below it.

Make a large drawing of this group of four cells.

Labels are not required. [4]



1 clear continuous lines + cell wall shown as double lines + correct size

2 correct arrangement

3 correct shape

4 correct proportion

(b)(i) Use the ruler to measure the length of each half of the leaf, along the lines **P** and **Q**. [1]

length of leaf along **P** = 3 mm

length of leaf along **Q** = 3 mm

makes measurement of length in whole numbers in mm

(ii) State which objective lens you have decided to use and give a reason for your choice. [1]

1 low-power + all stomata for each half of the leaf blade are in the field of view
2 high-power + guard cells / stomata can be identified for accurate count

(iii) Using the objective lens selected in **(b)(ii)**, determine the number of stomata on each half of the leaf blade.

Count every stoma for which the **pair of guard cells** surrounding it is visible. Record your results in Table 2.1. [1]

Table 2.1

part of blade	number of stomata
P	17
Q	15

makes count in whole numbers

(iv) Calculate the stomatal density of the leaf on slide **K1**. The number of stomata per unit length of the leaf blade can be calculated. Show your working. [3]

1 summation of number of stomata + summation of length of leaf blade
2 shows division of total number of stomata by total length of leaf blade
3 shows answer expressed to whole number + correct units

(c)(i) Use Fig. 2.3 to estimate the total number of stomata on the leaf.
Show your working. [3]

1 shows conversion of cm^2 to mm^2
2 shows division of leaf area by 0.04
3 shows multiplication by 4 + correct answer

(ii) One way to improve the accuracy of the estimate of the total number of stomata on a leaf is to use a photomicrograph with a larger area.

State **one other** way to improve the accuracy of the estimate of the total number of stomata on a leaf. [1]

use more fields of view / more micrographs

(iii) Identify the observable differences between the leaf surface shown in Fig. 2.3 and the leaf surface shown in Fig. 2.4.

Record the observable differences in Table 2.2. [4]

Table 2.2

feature	**Fig. 2.3**	**Fig. 2.4**
1 nucleus in guard cells	nucleus not visible	nucleus visible
2 chloroplasts in guard cells	chloroplasts visible	chloroplasts not visible
3 nucleus in surrounding epidermal cells	nucleus not visible	nucleus visible
4 stomatal opening	stomata closed	stomata opened

(iv) Using the information provided, suggest how a stoma opens during daytime to facilitate gaseous exchange. [3]

1 ref. to accumulation of K^+ makes water potential of guard cells more negative than surrounding epidermal cells

2 ref. to endosmosis / movement of water from surrounding epidermal cells into guard cells

3 ref. to guard cell becomes turgid + ventral wall bends less / dorsal wall bends more

[Total: 25]