Mark schemes

Q1.

D

An increase in pressure increases the value of K_c

[1]

Q2.

(a) **M1** flask not clamped

allow *<u>only</u> the condenser is clamped*

1

M2 sealed system / bung in condenser

allow *explanation of effect of bung being there e.g. pressure build up*

not *reference to incorrect water direction*

1

(b) sulfuric acid needs adding

allow *hydrochloric / nitric / phosphoric*

ignore *conc/dil*

not *just acid/H^+*

1

(c) **M1** direction of water flow through condenser

allow *reference to water direction from answer to (a)*

1

M2 thermometer not needed

allow *references to safety issue(s) if **not** given in (a)*

ignore *reference to position of thermometer*

1

(d) to prevent 'bumping'

allow *prevent large bubbles / ensure small bubbles*

not *increases rate*

1

(e) **M1** (fractional) distillation

1

M2 $\frac{6.5}{60}$ mol propan-1-ol (= max $\frac{6.5}{60}$ mol propanoic acid) (0.108)

M2 $\frac{6.5}{60}$ *mol propan-1-ol (= max* $\frac{6.5}{60}$ *mol propanoic acid)*

1

M3 $\frac{6.5 \times 74}{60}$ = 8.02 g (i.e. M2 x 74)

M3 $\frac{3.25}{74}$ *mol propanoic acid formed*

1

M4 $\frac{3.25 \times 100}{8.02}$ = 40.5 %

M4 $\frac{3.25/74}{6.5/60} \times 100$ *= 40.5 %*

1

(f) **M1** add sodium carbonate/hydrogencarbonate

1

M2 effervescence / bubbles

not *gives off (CO_2) gas*

1

M3 no (visible) change/reaction

not *nothing / no observation*

allow *acidified sodium/potassium dichromate*

no visible change / stays orange

orange to green

allow *named alcohol + sulfuric acid plus sweet smell and no change/reaction*

allow *named carboxylic acid + sulfuric acid plus no change/reaction and sweet smell*

not *pH measurement*

incorrect reagent = 0/3

incomplete reagent – mark on

1

[13]

Q3.

C

$C_6H_5COCH_3$

[1]

Q4.

B

Biofuel ethanol is purified by fractional distillation

[1]

Q5.

(a) **M1** moles of propan-1-ol = $\frac{6.0 \times 0.80}{60.0}$ (= 0.080)

67 cm^3 scores 3 marks

1

M2 moles of $K_2Cr_2O_7 = \frac{M1}{3}$ (= 0.0267)

*Allow ECF for **M2** and **M3***

1

M3 volume of $K_2Cr_2O_7 = \frac{M2}{0.40} \times 1000 = 67\ (cm^3)$

(allow 66.666…. to 68)

final answer to at least 2 sf

200 (cm^3) scores 2 marks;

66.6 (cm^3) is outside range and scores 2 marks;

66.·6 (cm^3) (i.e. 66.6 dot scores 3 marks)

1

(b) **M1** an attempt to draw apparatus that is clearly for (fractional) distillation

On this occasion, the apparatus does not need a thermometer or a collection container

1

M2 suitable drawing of distillation apparatus with condenser attached to side of distillation head

- condenser must have outer tube for water that is sealed at the ends but have two openings for water in/out (that are open)
- condenser must have downwards slope
- condenser must be open at each end
- as this is a cross-section, there should be a continuous flow through the diagram from the flask to the end of the open condenser (there should be no lines drawn across implying a seal of any sort)
- there must be no gaps at joints between apparatus where vapour could escape
- there must be some opening to the system at the collection end

*Ignore any fractionating column in **M1** and **M2** between the flask and condenser.*

1

M3 condenser labelled including labels for water in and water out (water must come in at lower end)

*For **M3**, if water in and out clearly stated, ignore direction of any arrows drawn. Allow 'condensing tube' or 'condensing column' or similar for name of condenser.*

1

If a reflux diagram is drawn (any diagram with a condenser attached vertically into the flask is a reflux set up, even with a downwards tube from the top of the condenser):

- *cannot score **M1** or **M2***
- *could score **M3** for condenser labelled including labels for water in and water out (water must come in at the lower end)*

[6]

Q6.

D

3-methylbutan-2-ol

[1]

Q7.

C

[1]

Q8.

A

[1]

Q9.

(a) **M1** Moles of cyclohexanol = (10 × 0.96)/100.0 = 0.096
Correct answer scores all 3 marks

1

M2 Max mass of cyclohexene = 0.096 × 82.0 = 7.87(2)
= M1 × 82.0 (process mark)

1

M3 % yield = (5.97 / 7.87) × 100 = 76% (Allow range 75.8 – 76)
= (5.97 / M2) × 100 (process mark)

1

Alternative method

M1 Moles of cyclohexanol = (10 × 0.96)/100.0 = 0.096

M2 Moles of cyclohexene = 5.97/82.0 = 0.0728

M3 % yield = 0.0728 / 0.096 × 100 = 76% (allow range 75.8 – 76)
= (M2 / M1) × 100
Allow 1/3 for 62(.2)%

(b) Add bromine (water)
If M1 not correct then only allow M2 if reagent involves bromine (water)

1

Would turn (from orange to) colourless / decolourise

Do not allow incorrect starting colour, but allow brown/red/yellow

Not discolour.

Ignore clear

1

(c) Na_2CO_3 would neutralise/react with/remove (phosphoric) acid/H_3PO_4/H^+

1

(d) avoid pressure build-up / release pressure / release CO_2/air/gas / prevent stopper blowing out

Ignore explosion

Do not allow an incorrect named gas

Allow idea that build-up of gas/CO_2 would lead to increased pressure/stated effect of increased pressure

1

(e) Does not dissolve in/react with the cyclohexene

Allow remains a solid/is inert in cyclohexene

Allow organic product/organic compound formed/ organic layer/distillate instead of cyclohexene

Do not allow if answer implies cyclohexanol

Do not allow if answer says does not react with products

Ignore references to filtration

Do not allow insoluble/unreactive unless qualified by implied reference to cyclohexene

1

(f) If diagram drawn:

M1 diagram of basic set up to include flask or tube with side-arm/Buchner flask, flat-bottomed funnel/Buchner funnel, filter paper

M2 apparatus should work, flow through, air-tight connection between flask and funnel, arrow/label/description (to vacuum pump)

Do not allow "standard" Y-shaped funnel

1

If description given:

M1 Buchner funnel/flat-bottomed funnel containing filter paper

M2 Buchner flask/side-arm flask connected to vacuum pump

Do not allow just "funnel"

Penalise M2 if described apparatus would not actually work.

1

(g) Cyclohexene is less polar than cyclohexanol / cyclohexanol is more polar than cyclohexene

It = cyclohexene

Allow cyclohexene is non-polar and cyclohexanol is polar

1

Cyclohexene has a greater affinity/attraction for the mobile phase/hexane / cyclohexanol has a greater affinity/attraction for the stationary phase/silica

Allow cyclohexanol held in the stationary phase for longer

Allow cyclohexene is more soluble in the mobile phase/hexane or converse for cyclohexanol

Allow references to hydrogen bonds between cylcohexanol and silica

1

(h) Would be no peak at 3230 – 3550 cm^{-1} due to O—H((alcohol))

OR

There would be no additional peaks in the fingerprint region compared to a pure sample / fingerprint region exactly matches cyclohexene

Need wavenumber and bond for mark

1

[13]

Q10.

A

[1]

Q11.

B

[1]

Q12.

(a) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

Level 3
All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer communicates the whole process coherently and shows a logical progression through the distillation apparatus. The first two points in stage 1 are in the correct order and all other steps are in a logical order for carrying out the practical.

5-6 marks

Level 2
All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies.

Answer is mainly coherent and shows a progression through the distillation apparatus.

Some steps in each stage may be out of order and incomplete but the first two points in stage 1 are in the correct order.

3-4 marks

Level 1
Most points are covered but the explanation of each stage may be incomplete or may contain inaccuracies.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning. The first two points in stage 1 are present but not necessarily in the correct order.

1-2 marks

Level 0
Insufficient correct chemistry to warrant a mark.

Omission of heating of the apparatus.

0 marks

Indicative content:

Stage 1

- *Turn on the water.*
- *Heat the flask, with a Bunsen burner.*
- *This causes water and ethanol vapours to be produced.*

Stage 2

- *Vapours pass up the fractionating column A.*
- *Water and ethanol are separated in column A.*
- *Water condenses back into the flask in column A.*

Stage 3

- *Observe the thermometer at B to keep the temperature at or below the boiling point of ethanol.*

  Only ethanol vapour (with a little water) passes into the condenser.
- *Use the condenser at part C to cool the vapours and condense the ethanol back into a liquid.*

(b) Volume of sample = volume of ethanol + volume of water

Let m = mass of ethanol

$20 = m / 0.79 + (16–m) / 1.00$

$1.266m - m = 20 - 16$

1

$0.266m = 4$ so $m = 15$ (g)

1

[8]